International Journal of Services and Operations Management

ISSN online: 1744-2389 - ISSN print: 1744-2370
https://www.inderscience.com/ijsom

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DOI: 10.1504/IJSOM.2023.10053617

Article History:

Received:	28 September 2022
Last revised:	29 September 2022
Accepted:	25 December 2022
Published online:	31 January 2025

Psychological factors influencing the adoption of three-wheeler electric vehicles: a study on users in India

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Abstract: Emissions from internal combustion engine vehicles are one of the significant contributors to the increased air pollution. Studies indicate that EV is one of the possible practical implications for reducing air pollution. Out of all segments, the three-wheeler is one of the most widely used because of its public transport usage. Even though electric three-wheelers (e-rickshaws) are available in the market, customers refrain from buying them. This study aims to investigate and analyse the psychological factors impacting the adoption of e-rickshaw in Patna, India. The partial least square-structural equation modelling (PLS-SEM) technique was used to analyse the data. Awareness of EVs and environmental concerns are found to be the most influential factors affecting the adoption of EVs with the help of importance-performance map analysis (IPMA). The results obtained from this study can be used by government agencies and vehicle manufacturers to make policies for faster adoption of three-wheeler EVs.

Keywords: three-wheeler EV; adoption; PLS-SEM; awareness of EV; environmental concern.

Reference to this paper should be made as follows: Mathew, N. and Varaprasad, G. (2025) 'Psychological factors influencing the adoption of three-wheeler electric vehicles: a study on users in India', *Int. J. Services and Operations Management*, Vol. 50, No. 1, pp.53–75.

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1 Introduction

Greenhouse gases (GHGs) warm the earth's surface and atmosphere, affecting rainfall, glacier and sea ice retreat, and sea level, among other elements. It was realised about 30 years ago, that the increase in tropospheric ozone caused by air pollution (NO_x, CO, CO_2, and others) is a significant greenhouse-forcing factor (Ramanathan and Feng, 2009). As a result of continual and out-of-control emissions of deadly atmospheric pollutants from a variety of human activities, the challenge of environmental degradation has attracted a lot of attention in recent years (Asadi et al., 2021). The main reason for this increased air pollution and other corresponding environmental problems is the emissions from industries and transport systems. The usage of fossil fuels in industries and transport is a significant contributor to atmospheric pollutants (Asadi et al., 2020; Ju et al., 2019). The combustion of fossil fuels, particularly petrol, diesel, and coal, is the primary source of airborne fine particulate matter ($PM_{2.5}$) and a significant contributor to global sickness and death (Vohra et al., 2021). Air pollution or harmful pollutants cannot be controlled easily because of its various sources, but the changes in major contributors can make a difference. Along with pollution, the depletion of this non-renewable energy makes it a challenge to humankind. The over-dependency on fossil fuels is making its deficit faster. The Inter-Governmental Panel on Climate Change (IPCC) highlighted that the increase in the concentration of greenhouse gases is a significant danger to economic and physical living conditions. Thus, causing a profound and detrimental impact on the biodiversities and ecosystem, climate changes endanger 25% to 30% of plant and animal species. The struggle against climate change seems to be one of humanity's most pressing challenges (Santos et al., 2021).

One of the primary air pollutants is the toxic emissions from internal combustion (IC) engines (Khurana et al., 2020). Of the gross carbon emissions, 24% is from the transportation sector. As per the International Energy Agency (NEEM) report in 2017, the transport sector emissions will rise 50% by the end of 2030 (IEA, 2017). Out of the pollution caused by IC engine vehicles, light-duty vehicles are the major contributors because of their large number. India is one of the significant contributors to air pollution; thus, its damage is also severe. According to the World Health Organisation's air pollution statistics, 14 of the 15 world's top polluted cities are from India. Automotive pollution accounts for roughly 51% of air pollution in India, rising to 80% in urban areas (Balakrishnan et al., 2019). Governments are deploying electric vehicles (EVs) due to zero tailpipe emissions to reduce and eliminate these environmental problems.

EVs are being promoted energetically worldwide to alleviate the effects of fossil-fuel emissions and address environmental issues. In this sense, EVs are expected to minimise detrimental effects on the environment while also assisting in conserving non-renewable fuel reserves over their entire life cycle (Liu et al., 2019). As per the IEAs global EV outlook 2020, EV's performance in energy efficiency is three to five times better than IC engine vehicles. Also, energy security reduces emissions of GHG, and its positive impact on the environment makes EVs more acceptable compared to IC engine vehicles. Governments encourage people to switch to EVs because of their green behaviour. The Government of India has taken steps to minimise CO_2 emissions through production regulation, environmental protection measures, and the adoption of EVs. India is also planning to replace many IC engine vehicles with EVs by the end of 2030. The government has initiated National Electric Mobility Mission Plan (NEMMP) 2020 to boost EV awareness and usage. Recognising the benefits of promoting EVs, the Indian

Government launched Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) in 2015 as part of the NEMMP, which was announced in 2013 to promote electric mobility on a larger scale in India. The FAME scheme includes several financial incentives, including a reduction in the goods and services tax (GST) on EVs from 12% to 5% and a reduction in the GST on battery chargers from 18% to 5%. To promote EV adoption, central and state governments offer different subsidy schemes. The vehicle manufacturers in each segment are in the process of launching their EVs. A good number of new players are also in the market, mainly in two and three-wheeler EV segments. Even though the government supports the deployment and vehicles are available, the market is still in its initiation stage. Consumers step back from buying an EV, despite having an environmental friendly nature, enormous advantages over IC engine vehicles, and the government's support schemes.

The EVs are available in different segments for conventional vehicles, from the two-wheeler segment to heavy-duty vehicles. In general, EVs are more referred to as electric cars, but each segment has its significance because of its unmatchable uses. In developing countries like India, three-wheeler auto-rickshaws are a big part of the public transit system because they are cheap and convenient. Due to their small size and low maintenance, three-wheeler auto-rickshaws are most common in short-range transportation, mainly taxi services. India is the largest in three-wheeler vehicle manufacturing and sales. Also, sales in India are increasing year by year. IC engine three-wheelers in India are available in diesel, petrol, and gas. As the number of IC engine three-wheelers in India is vast, the amount of atmospheric pollutants it emits is also high. The electric three-wheelers can be a perfect solution as the tailpipe emission is zero. Three-wheeler EVs are available in India, and most of the market giants introduced their models in passenger autos/rickshaws and for goods carrying. The three-wheeler sector of EVs is in a stage of initiation in its life cycle, even though different vehicles are available. Most of the existing IC engine vehicle manufacturers in this sector and a few start-ups had already made electric three-wheelers available in India.

Studies indicate that using an EV can reduce air pollution because of its zero tailpipe emissions. Even though the e-rickshaw is available in the market, customers step back from buying it. This study aims to find the psychological factors that influence the adoption of e-rickshaw in Patna, India. There is a considerable gap in three-wheeler adoption studies in India. Hence, identifying the psychological factors affecting EV adoption can help manufacturers and the government frame policies to make the adoption faster.

The following section contains the literature review and the formulation of the research hypothesis. The third section deals with the methods adopted for the research. The fourth section discusses the results. The fifth section explains the overall interpretation of results and their discussions followed by the conclusion of the study along with practical implications and the limitations of the study as well as the future scope.

2 Literature review

The adoption studies on different areas like new technologies, methods and processes are carried out for a long time (Haartman et al., 2021; Juned and Farooquie, 2022). The

adoption studies on EVs find out the influencing factors have increased rapidly in the last decade (Singh et al., 2020). With the depletion of fossil fuels and the effects of global warming, studies on the impact of EVs on energy and the environment, development strategies, and policy research have sprung up in recent years (Ma et al., 2017). As countries aim for a sustainable environment, such as CO_2-free city logistics, the importance of EVs has been highlighted (Mashalah et al., 2022). As the automobile industry advances, emerging technologies, such as connected vehicles made achievable by electric mobility and other technologies, signal the next stage of digitising and information sharing (Reddy et al., 2021).

2.1 Adoption studies on EV

Several previous pieces of literature are available on factors affecting the adoption of EVs (e.g., She et al., 2017; Lin and Wu, 2018; Filippini et al., 2021; Patyal et al., 2021). The dependent variable for most of the studies is purchase intention (Carley et al., 2019), adoption intention (Alzahrani et al., 2019), willingness to adopt (Dash, 2021), willingness to purchase (Berliner et al., 2019), EV adoption (Chu et al., 2019), intentions to adopt (Higueras-Castillo et al., 2019), consumer purchase behaviour (Hardman, 2019), behavioural intentions (Khurana et al., 2020), etc. The independent variables considered for the studies include technical factors (Chen et al., 2020), and infrastructural, behavioural, financial, and external factors (Tarei et al., 2021). Also, the studies on adoption can be situational, demographic, psychological, and contextual (Singh et al., 2020). The variables subjected to adoption studies are addressed differently in research articles which are both behavioural and non-behavioural. Behavioural factors are more to consumer's psychological and environmental thoughts. There are studies in which consumer's views on technical sides (Noel and Sovacool, 2016), battery performance, vehicle characteristics, government policies on taxes, subsidies from different agencies, costs, availability, marketing techniques, etc., are evaluated. In various adoption studies, consumer behaviour and EV preferences are investigated eagerly around the globe (Jang and Choi, 2021). The heterogenic nature of customers leads to the necessity of behaviour-based adoption studies worldwide. Several studies have identified psychological factors (such as moral beliefs, behaviour, and attitudes) as significant predictors of EV adoption (He et al., 2018; Nayum et al., 2016). The studies on consumer psychological factors on EV adoption lead to meaningful conclusions that different agencies can use for faster EV adoption.

According to Schuitema et al. (2013), consumer emotions and sentiments influence attitudes and intentions to embrace EV. The study by Dash (2021) establishes a significant relationship between willingness to adopt and factors such as environmental concern, attitude, and knowledge of EV. The researcher tried to develop a statically significant model in India, and the study was concentrated in Delhi with respondents as users and potential EV users. In a study conducted in Malaysia by Asadi et al. (2021), perceived value, attitude, attribution of responsibility, subjective norms, personal norms, perceived consumer efficiency, and awareness of repercussions all influenced consumers' decisions to buy EVs. The adoption study by Tu and Yang (2019) in China shows a significant relationship between consumer attitudes, self-control ability, subjective norms, perceived usefulness, perceived ease of use, consumer compatibility, and external influences on purchase intention. Shetty et al. (2020) studied the barriers to adoption in the Asian market by considering the relationship between environmental and

sociotechnical factors towards adoption intention. A study by Chu et al. (2019) identifies that economic and environmental factors will positively impact EV adoption in early adopters of Korea and China. Cui et al. (2021) identified environmental concern, social influence, and self-esteem as influencing purchase intention. The adoption studies are more concentrated in developed countries like Australia, Nordic countries, European counties, Canada, the USA, and South Korea, and also in different parts of developing countries like China (Bansal et al., 2021). A large number of vehicles and the slow adoption rate of EVs in India are the significant reasons behind marketing researchers studying EV adoption more. The Indian Government, in reaffirming its commitment to the Paris Agreement, has been preparing to take drastic measures to transition to EVs by 2030 (Gyimesi and Viswanathan, 2011). The SEM is a common method used in marketing research to analyse the collected data, mainly in survey-based studies (Al-Ajlouni and Alghusin, 2021). The PLS-SEM method is used to conclude quantitative study (Jayashree et al., 2022; Saadat et al., 2022) and exploratory research (Subramanian et al., 2019). The PLS-SEM analysis is carried out with the help of SmartPLS (Kamble and Gunasekaran, 2021), especially for adoption studies (Christino et al., 2022).

2.2 Three-wheeler EV

Due to rising fuel prices and higher emission regulations, the short-range transportation sector is turning to EVs. An auto-rickshaw is an excellent option for short-distance commuting with a larger population. Electrification of auto-rickshaws is a feasible scenario for a developing country. Generally, the adoption studies in EVs are carried out considering all segments. Most studies indicate an EV as just an EV, whether a two-wheeler, three-wheeler, four-wheeler, or heavy-duty vehicle. Convenient and cost-effective transport and use in the public transport sector make three-wheeler EVs more relevant compared to other segments (Dhar et al., 2020).

This research aims to identify the psychological factors influencing the adoption of a three-wheeled EV. The factors for this study were identified through a qualitative survey of experts, users, dealers, and the majority from the literature review. Past studies emphasise environmental concern, product awareness, subjective norms, perceived behavioural control, and consumer innovativeness as determinants of willingness to adopt new technologies like EV.

2.3 Research hypotheses

This subsection discusses the research hypotheses derived from literature and qualitative study. The conceptual model showing the direct impact of all the factors on willingness to adopt is demonstrated in Figure 1.

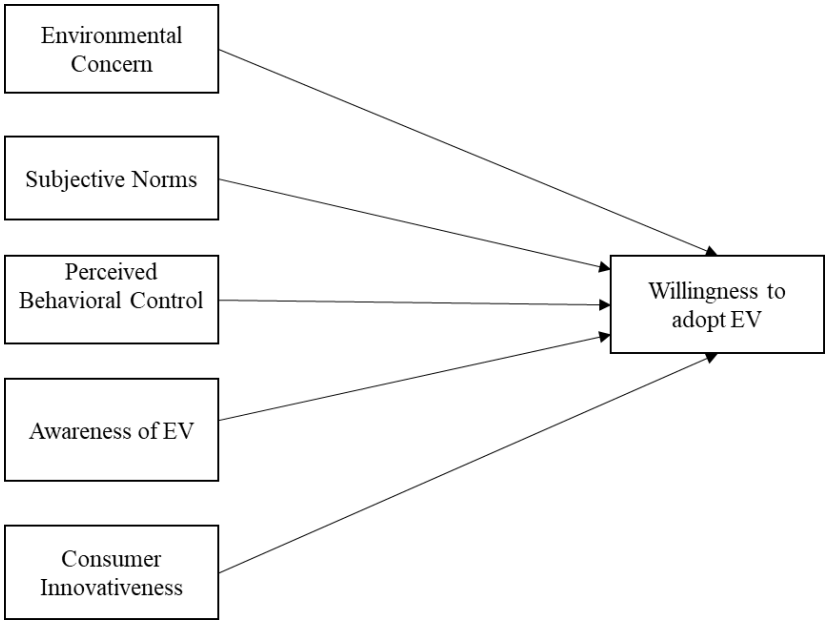
2.3.1 Environmental concern

The environmental concern relates to customer's emotions about environmental problems, such as stress, abhorrence and empathy (Hansla et al., 2008; Minton and Rose, 1997). Environmental considerations are strongly linked to customer behaviour, such as purchasing environmentally friendly items and recycling them after use (Kang and Park, 2011). Individuals who have a high degree of environmental concern are more likely to participate in activities that benefit the environment (Zhao et al., 2019). People who are

more aware and concerned about the environment have a positive attitude towards environmentally friendly things such as EVs (Dash, 2021). The relationship between buying behaviour and environmental concern was explored by various authors, and also positive environmental contributions led to improved EV adoption (Quak et al., 2016). So, the proposed hypothesis is,

H1 Environmental concern significantly influences willingness to adopt EV.

Figure 1 Conceptual model



2.3.2 Subjective norm

Subjective norm (SN) is what customers believe about their purchasing behaviour from the perspective of their most important persons (Ajzen, 2012; Asadi et al., 2021). The social pressure by the execution of a certain act, or the failure to do so, is the constraints or influence of surroundings, friends, family, customs, laws, and regulations on a person's behaviour (Ju et al., 2019; Wang et al., 2018a). Chen (2016) explains that subjective norms have a significant impact on energy conservation. In prior research, it was also proposed that an individual's subjective norm activates and sustains their pro-environmental attitude (Jansson et al., 2010). As pointed out by Axsen et al. (2013), the effect of people's behaviour impacts an individual's decisions in their social network; this influence acts as a critical determinant in EV promotion. Lane and Potter (2007) discovered that subjective norms had an impact on EV purchase decisions, with respondents admitting that perceived social norms play a factor in their purchasing habits. So, the proposed hypothesis is,

H2 Subjective norm significantly influences willingness to adopt EV.

2.3.3 Perceived behavioural control

It relates to the perceived ease or difficulty of carrying out the behaviour, and it is thought to be based on previous experience as well as predicted barriers and hurdles (Ajzen, 2012). It is one of the constraints in the theory of planned behaviour (Ajzen, 1991). It also refers to whether a person seems to have the necessary finances, time, and chance to achieve something (Chen, 2016). Burgess et al. (2013) discovered that having a significantly positive experience with EVs leads to a better sense of control, implying that EVs can grow if people are familiar with them. According to Carley et al. (2013), respondents with previous experiences with EVs, reported a higher adoption intention due to the high perception of vehicle control. Perceived behavioural control is one of those main factors influencing behaviour intention (López-Mosquera and Sánchez, 2012; Sánchez et al., 2018; Zhang et al., 2021). So, the proposed hypothesis is,

H3 Perceived behavioural control significantly influences willingness to adopt EV.

2.3.4 Awareness of EV

Awareness or knowledge is one of the major factors in behavioural research on EVs (Jing et al., 2019), and it is crucial in one's decision making. Knowing how to conduct the planned action, determining accountability for the intended action, and evaluating the perceived success of the behavioural act, are all instances of behavioural-related knowledge (Park et al., 1994). Previous researchers have identified knowledge as a legitimate cause of individual-level differences in adoption and consumption behaviour (Chéron and Hayashi, 2001). Consumers who have been exposed to EVs are more likely to value them highly and consider them as a potential buying choice (Axsen and Kurani, 2013). Consumers will become more likely to purchase EVs if they have more awareness about them (Wang et al., 2018b). Brucks (1985) conveyed that product knowledge makes it easier to determine whether or not to use a product. Consumer awareness of the environmental benefits of driving EVs is the catalyst for changing attitudes (Lane and Potter, 2007). So, the proposed hypothesis is,

H4 Awareness of EV significantly influences willingness to adopt EV.

2.3.5 Consumer innovativeness

Innovativeness is one of the few concepts that are very important to consumer behaviour (Hirschman, 1980). An individual's inherent tendency of being attracted to innovative ideas and having an intrinsic attraction to innovations is because of their distinctive traits (Morton et al., 2016). Innovative individuals have a high sense of curiosity and enjoy trying new things. Innovative consumers are more open to trying new things and adopting new ideas (He et al., 2018). Consumers with a high level of novelty seeking have a good attitude towards technology, a higher intrinsic drive, and taking up the challenge of trying new approaches to old problems (Hirschman, 1980). Jansson (2011) discovered that EV adoptees are more innovative than non-adopters. One of the most important personality attributes that influences EV adoption is personal inventiveness (He et al., 2018). So, the proposed hypothesis is,

H5 Consumer Innovativeness significantly influences willingness to adopt EV.

3 Methods

This study is exploratory and is conducted in two stages. A review of the literature was performed in the main exploratory phase of this investigation to acclimatise with the potential elements that may affect its adoption. In the next step, a questionnaire was used to collect primary data. The analysis of the primary data collected for the study was done with SmartPLS 3.3.3. Structural equation modelling (SEM) is carried out to analyse the data. Measurement and structural model assessments along with bootstrapping for hypothesis testing, give relevant factors for adoption.

3.1 Measures

The questionnaire formulation is done with the help of literature as well as the qualitative study. The individual in-depth interviews were conducted with auto drivers, passengers, and sales executives to determine the relevant constructs and items for the questionnaire. The interview questionnaire contains a total of 17 questions that fall under subdivisions of drivers, passengers, and dealers. Individual in-depth interviews are conducted with 40 respondents to draw the valid and relevant factors. So, the items for each factor in the questionnaire have been derived from previous literature and qualitative study. The first part of the questionnaire contains demographic variables like gender, age, family income, and education qualification. The second part contains 24 items in six constructs for measuring consumer behaviour towards EV adoption. A five-point Likert scale is used for output assessment from strongly disagree (1) to strongly agree (5). After developing the relevant constructs and items, a structured questionnaire was prepared, and a pilot study was conducted on existing e-rickshaw drivers in Patna. The reliability and validity of the questionnaire are checked here in the pilot study (He et al., 2018). The respondents were asked to check if the questions were identifiable (Dash, 2021), understandable and answerable during the pilot study. Thirty responses were subjected to a pilot study, and respondent's feedback helped rephrase the questions correctly. The Cronbach's alpha value of each constraint over 0.7 indicates a strong internal consistency.

3.2 Sample

The majority of the prior research in the EV segment has used the present vehicle users as their respondents (Jansson et al., 2010). The outcomes from them can be generalised to a bigger population (Dash, 2021). Hence, the existing e-rickshaw drivers from Patna are the respondents of this survey. The capital of the state Bihar in India, is chosen for the study because Bihar is one of the highest adopters of EVs. Convenience sampling is used to collect the data with a minimum sample size for the study determined as 384 using Cochran's formulae (Cochran, 2007). Considering the items developed and the respondent's nature of work, a face-to-face interview was chosen as the mode of data collection.

Table 1 Demographic profile of respondents

Demographic characteristics	*Frequency*	*Percentage*
Gender		
Male	405	100
Female	0	0
Age (years)		
Below 25	73	18.02
26–30	122	30.12
31–40	97	23.95
41–50	89	21.97
Above 51	24	5.93
Income (monthly) in INR		
Up to 10,000	113	27.9
10,000–20,000	158	39.01
20,000–30,000	126	31.1
Above 30,000	8	1.98
Qualification		
Up to High School	85	20.99
Graduate	251	61.98
Postgraduate	65	16.05
Above postgraduate	4	0.99

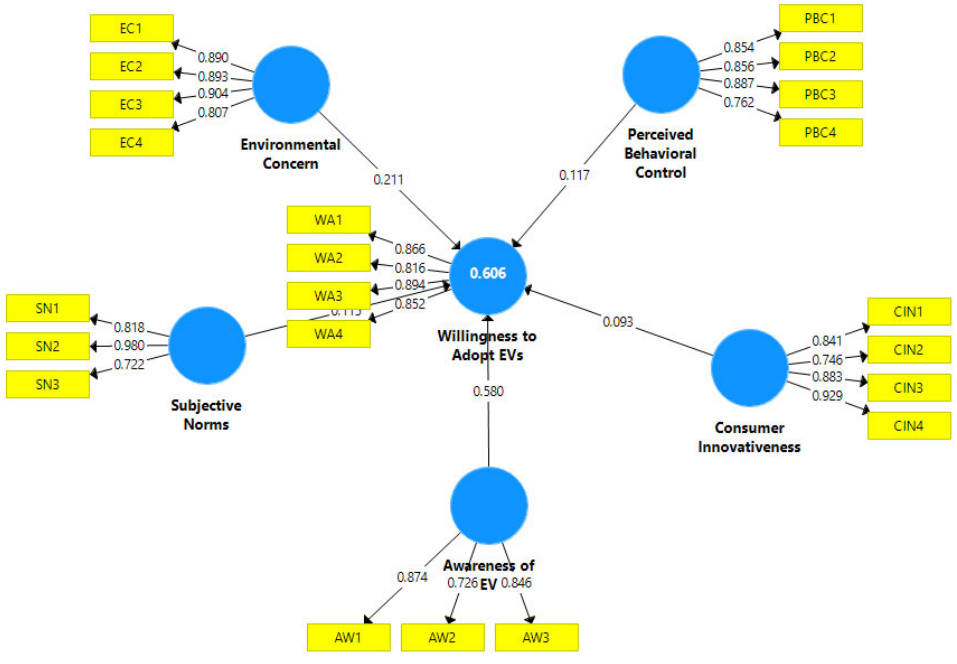
The data collection was done from different parts of Patna, including Patna Junction, Gandhi Maidan, Rajapur Pul, Rajendranagar, Danapur, and Patna Sahib. The responses were completely voluntary and anonymous. Table 1 depicts the demographic details of respondents. Males dominated the gender distribution in this study, accounting for 100% of the total population. This may be due to the smaller number of female drivers in India, addressed in the road transport yearbook 2015–2016 by the Ministry of Road Transport, or fewer adopters of three-wheeler EVs. The location of this study may also be the reason for the absence of female drivers. The number of female three-wheeler drivers in Patna is negligible. The age group of 26–30 years accounted for the majority of the responses (30.12%), followed by 31–40 years (23.95%) and 41–50 years (21.97%). So, most e-rickshaw drivers in Patna are aged 25 to 50 years. 18.02% are below 25 years, and 5.93% are above 51 years. The monthly income in rupees accounted for the majority of responses is between 10,000–20,000 INR (39.01%), followed by 20,000–30,000 INR (31.1%) and below 10,000 INR (27.9%), respectively. There are also cases of above 30,000 rupees for 1.98%. So, the majority have income between 10,000 INR and 30,000 INR. Regarding educational qualifications, the majority of the respondents (61.98%) were graduates, followed by high school or below (20.99%). 16.05% of the respondents have a master's degree, and hardly 1% are above that. So, this distribution indicates EV users have a good educational background. The over-representation of more educated people in the sample may be consistent with prior results that highly educated people are more likely to adopt EVs (e.g., Hidrue et al., 2011).

4 Results

4.1 Structural equation modelling – partial least squares analysis

SEM tests the relationship between environmental concern, product awareness, subjective norms, perceived behavioural control, and consumer innovativeness towards willingness to adopt three-wheeler EVs. Partial least squares structural equation modelling (PLS-SEM) is a causal modelling approach that seeks to maximise the explained variance of dependent latent constructs (Hair et al., 2011). Because of its ability to simulate composites and factors, it is a powerful statistical tool for new technology researches (Henseler et al., 2016a, 2016b). The PLS-SEM has been performed with the help of SmartPLS 3.3.3 software. A two-step analytical process, including a measurement model (outer model) and structural model (inner model), is the procedure for carrying out PLS-SEM (Hair et al., 2011). The model developed by performing the PLS algorithm in SmartPLS is given in Figure 2.

Figure 2 Adoption model developed using Smart-PLS (see online version for colours)



4.1.1 Measurement model

Examining the indicator loadings is the first step in evaluating a reflective measurement model. Loadings greater than 0.708 are preferred, as they imply that the factor explains more than 50% of the variance in the indicator, indicating acceptable item reliability (Hair et al., 2019). While performing the analysis, the items with fewer loadings are deleted. The outer loadings for all the items are shown in Table 2. The loadings for all the constructs are above the threshold value of 0.708. Next is assessing the internal consistency of the model using composite reliability (CR) (Jöreskog, 1971) and

Cronbach's alpha (CA) (Hair et al., 2019). All the values of CR and CA are above the threshold value of 0.7 (Hair et al., 2019), shown in Table 2. Convergent validity and discriminant validity are the other assessments that can be done in the measurement model. The amount to which a construct converges to demonstrate the variance of its elements is known as convergent validity. The average variance extracted (AVE) for all elements on each construct is the measure used to assess convergent validity (Hair et al., 2019). The acceptable value for AVE is 0.5 or higher (Hair et al., 2019) to prove the convergent validity.

Table 2 Measurement model

Factors	*Items*	*Outer loadings*	*Cronbach's alpha*	*Composite reliability*	*Average variance extracted (AVE)*
Awareness of EV	AW1	0.874	0.753	0.857	0.668
	AW2	0.726			
	AW3	0.846			
Consumer innovativeness	CIN1	0.841	0.903	0.914	0.727
	CIN2	0.746			
	CIN3	0.883			
	CIN4	0.929			
Environmental concern	EC1	0.890	0.897	0.928	0.765
	EC2	0.893			
	EC3	0.904			
	EC4	0.807			
Perceived behavioural control	PBC1	0.854	0.861	0.906	0.707
	PBC2	0.856			
	PBC3	0.887			
	PBC4	0.762			
Subjective norms	SN1	0.818	0.848	0.882	0.717
	SN2	0.980			
	SN3	0.722			
Willingness to adopt EVs	WA1	0.866	0.880	0.917	0.735
	WA2	0.816			
	WA3	0.894			
	WA4	0.852			

In this model, all the constructs have an AVE value above 0.5, and thus, all the constraints represent sufficient proof for convergent validity. Discriminant validity refers to how empirically diverse a construct is from other constructs in the structural model (Hair et al., 2019). In PLS-SEM, the heterotrait-monotrait (HTMT) ratio should be calculated to prove discriminant validity (Henseler et al., 2015). In this case, all the values in the analysis are much below the recommended value of the HTMT ratio, which is less than 0.9 (Henseler et al., 2015), represented in Table 3.

Table 3 Discriminant validity – HTMT ratio

	AW	*CI*	*EC*	*PBC*	*SN*
AW					
CI	0.056				
EC	0.648	0.031			
PBC	0.223	0.057	0.268		
SN	0.079	0.049	0.078	0.046	
WA	0.882	0.078	0.630	0.318	0.145

4.1.2 Structural model

Once the measurement model is acceptable, the next is to assess the structural model in PLS-SEM (Hair et al., 2019). The coefficient of determination (R^2) measurement, as well as the level and significance of the path coefficients, are the major evaluation criteria for the structural model. The major target construct's R^2 should be high because the purpose of the prediction-oriented PLS-SEM technique is to explain the endogenous latent variable's variance (Hair et al., 2011). Collinearity must be checked before examining structural relationships to ensure that it does not influence the regression results (Hair et al., 2019). The variance inflation factor (VIF) is often used to determine formative indicator collinearity. VIF scores of 5 or higher indicate serious concerns with collinearity between indicators of formatively measured constructs (Hair et al., 2019). Here the VIF values of all the constructs are less than 5, indicating no trouble caused by collinearity. The model fit can be assessed with the help of standardised root mean square residual (SRMR) and normed fit index (NFI). The results confirm the model fit, as the SRMR value is 0.058 and the NFI value is 0.83. The SRMR value is less than the threshold value of 0.08 (Henseler et al., 2016a), and the NFI value is greater than 0.8 (Hu and Bentler, 1998), indicating a satisfactory fit to the structural model.

If collinearity is not an issue, the next step is to look at the endogenous construct's R^2 value (Hair et al., 2019). As this research focuses on the behavioural side of marketing, the R^2 value interpretation as per the rule of thumb is 0.75, 0.50, and 0.25, which are defined as substantial, moderate, and weak, respectively (Hair et al., 2011; Henseler et al., 2009). In this model, the R^2 value obtained by running the PLS algorithm is 0.606, and the adjusted R^2 value is 0.601. The coefficient of determination indicates that environmental concern, product awareness, subjective norms, perceived behavioural control, and consumer innovativeness of an individual is responsible for 60.6% of willingness to adopt three-wheeler EVs. Here the R^2 value lies between 0.75 and 0.5, indicating the model is above moderate and near substantial.

Bootstrapping in PLS gives the model's total effects, including path coefficients, mean, standard deviation, t-statistics, and p-value. The bootstrap sample allows the calculated coefficients in PLS-SEM to be verified for their significance (Henseler et al., 2009). This bootstrapping is to be used for hypothesis testing based on different criteria. The hypothesis will be valid when the path coefficient becomes positive, the t-statistic value should be more than 1.96, and the p-value should be less than 0.05. The path relationship is significant at 10%, 5%, and 1% significance levels, respectively, when the t-value was more than 1.65, 1.96, and 2.57.

Table 4 Results of structural model analysis

Factors	*Path coefficients*	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	*P values*	*Remarks*
Awareness of EV → Willingness to adopt EVs	0.580	0.576	0.038	15.246	0.000	Supported
Consumer innovativeness → Willingness to Adopt EVs	0.093	0.089	0.044	2.095	0.037	Supported
Environmental concern → Willingness to adopt EVs	0.211	0.210	0.038	5.624	0.000	Supported
Perceived behavioural control → Willingness to adopt EVs	0.117	0.115	0.035	3.332	0.001	Supported
Subjective norms → Willingness to adopt EVs	0.115	0.118	0.034	3.401	0.001	Supported

Table 4 depicts the path coefficient, t-statistics, and p-value; from the table, it is clear that all the hypotheses considered for the analysis have been supported. So, an individual's environmental concern, awareness, subjective norms, perceived behavioural control, and consumer innovativeness is significant factors in adopting a three-wheeled EV.

4.2 Importance-performance map analysis

According to Ringle and Sarstedt (2016), importance-performance map analysis (IPMA) is a tool to determine those elements having low performance yet are extremely important for the target structures. In PLS-SEM, IPMA is a reliable and efficient analysis that extends the standard path coefficient estimates in a more practical approach. Using the latent variables score, IPMA helps to broaden the conclusions of the conventional PLS-SEM (Hair et al., 2014). The IPMA contrasts total effects that represent the importance of predecessor constructs in forming a target construct with an average latent variable score that represents their performance (Fornell et al., 1996; Martilla and James, 1977). PLS-SEM studies based on IPMA findings offer valuable insight into the role of antecedent constructs and their implications for managerial decisions (Grønholdt et al., 2015; Höck et al., 2010). The IPMA is carried out here to understand and interpret each construct in terms of its performance and importance. Figure 3 demonstrates the IPMA with a performance at the y-axis and importance at the x-axis. Table 5 gives the exact values for willingness to adopt and the total effect of IPMA analysis.

The map shows that construct awareness of EV has the highest importance (0.543) and moderately fair performance. Awareness of EV is the main factor that can make the highest difference in willingness to adopt. Even though the current performance (51.599) is moderate, the knowledge or awareness of the vehicle and technology can undoubtedly increase the performance and thus the willingness to adopt. The increase in the

performance of awareness of EVs by one unit can increase the willingness to adopt EVs by the value of 0.543. Awareness about EVs, their technology, and their advantages can be acquired by developing a better marketing strategy and the cooperation of different agencies, including government bodies. The environmental concern follows the awareness of EV importance. The performance of environmental concern (47.195) is comparatively less and has an importance of 0.216. So, manufacturers must address the consumer's concern about the environment, and they should be able to convert this concern into the willingness to adopt a three-wheeled EV. Even though subjective norms are not that important compared to awareness and environmental concern, its performance is fair. Perceived behavioural control also has importance similar to subjective norms but less in performance. In this study, consumer innovativeness seems low in importance and performance compared to other constructs, but it is a significant factor in adopting a three-wheeled EV.

Figure 3 Importance-performance map (see online version for colours)

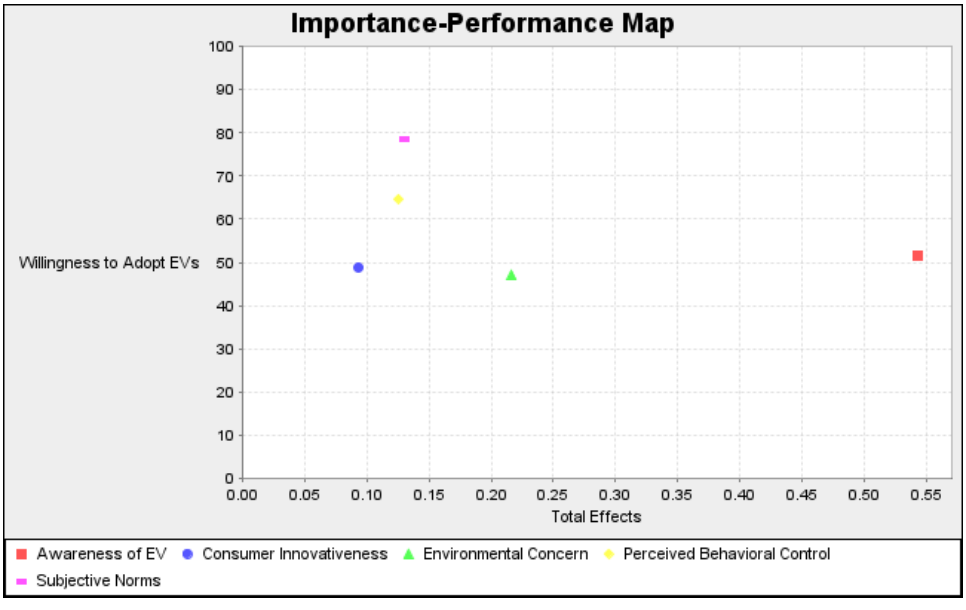


Table 5 Importance-performance map analysis statistics

Construct	*Importance*	*Performance*
Awareness of EV	0.543	51.599
Consumer innovativeness	0.093	48.847
Environmental concern	0.216	47.195
Perceived behavioural control	0.125	64.749
Subjective norms	0.130	78.608

5 Discussions

The study reveals psychological factors affecting the adoption of three-wheeler EVs, and a model has been developed. Existing vehicle users that are electric auto-rickshaw drivers are the respondents of this research. The one who used a product is the best to give the review and express their feeling towards the product. The PLS-SEM results indicate that all the factors considered for the study are significant in adoption. The analysis was carried out in two steps, and the IPMA gives the most significant parameter in adoption. The measurement model analysis and structural model analysis provide meaningful results to the study. The coefficient of determination indicates that environmental concern, product awareness, subjective norms, perceived behavioural control, and consumer innovativeness of an individual is responsible for 60.6% of willingness to adopt three-wheeler EVs.

Awareness of EVs is the major factor affecting the adoption of three-wheeler EVs. The awareness of a product can lead to faster adoption. Marketers must be cautious about making their target consumers aware of the EV and its specialities. In this case, the marketing communication has to be done effectively to make the public aware of its features, advantages, policies, government subsidies, different costs, charging infrastructure, charging time, technical features, etc. The findings from the study support the notion that environmental concerns significantly impact the adoption of three-wheeler EVs. Previous research has also found significantly positive links between environmental concerns and attitudes toward EVs (Dash, 2021) and their adoption intention (Cui et al., 2021). Environmental concern is the second most important of all constructs, and performance has to be increased. The manufacturers, government bodies, and other agencies promoting EVs have to conduct more campaigns on the green behaviour of the product. The environment-friendly nature of the product, as well as the importance of protecting the environment, must be made aware to the public.

Subjective norm is also a significant factor in willingness to adopt three-wheeler EVs. Society and peer groups of an individual can influence purchasing decisions. Several previous studies have mentioned the importance of subjective norms either toward a willingness to adopt (Asadi et al., 2021; Xu et al., 2019) or the consumer's attitude toward EVs (Dash, 2021). An individual's behaviour always relies on the society in they live, and his decisions also can be based on people who are influential and important to him. So, the subjective norm must be considered carefully because human behaviours emerge in a social setting. Perceived behavioural control is another significant factor that affects the willingness to adopt three-wheeler EVs. From the study, it is seen that its performance is 64.749, which is satisfactory. Manufacturers and different agencies must be aware of consumers' ability to exercise control over the opportunities and resources needed to acquire EVs. Adnan et al. (2018) state that perceived behavioural control can consist of perception of availability, awareness to use, technology, and the capacity to adapt behaviour. In this study, the perceived behavioural control is related to availability, different costs, and infrastructure. So, the government, as well as manufacturers, should give their focus on consumers' behavioural control. The infrastructure development in India is still on its way, so the government and manufacturers must take necessary actions to improve facilities.

Similarly, the factors that affect consumers' behavioural control must be addressed to make the adoption faster. Consumer innovativeness is also a significant factor in this

study, even though the importance is less than other constructs. The performance of this construct is weak compared to other constructs. Different studies considered consumer innovativeness for their model, some of which were significant (Jansson, 2011). The innovativeness of consumers depends on the innovative characteristics of the product. At present, some of the characteristics of a three-wheeler EV are good enough to attract its audience. But this characteristic of consumer demands timely updates and improvements in technology.

6 Conclusions

This study aimed to find the psychological factors affecting the adoption of three-wheeler EVs in India. With the help of the literature and a qualitative survey, a set of factors was identified, and a model was proposed. To validate the model, PLS-SEM was used with the help of SmartPLS. The model is validated, and a conceptual model is created with all the factors considered for the study that significantly impact three-wheeler EV adoption. The respondents of this study were three-wheeler EV users, giving a more refined set of outcomes. Environmental concern, product awareness, subjective norms, perceived behavioural control, and consumer innovativeness is significant in the willingness to adopt three-wheeler EVs. With the help of IPMA, it is found that awareness of EV is the most important factor, followed by environmental concern. The study also gives an insight into the behaviour of Indian three-wheeler users. With this model, manufacturers and government bodies can make suitable plans for the faster adoption of three-wheeler EVs.

The practical implication of this study is relevant and will be effective since the number of three-wheeler users in India are high and also due to its public transport usage. The three-wheelers are common in rural as well as urban areas of India. The awareness of EVs is the most vital factor identified in the study. So, manufacturers, marketers, governments, and other agencies should focus more on this factor. This awareness of EVs will help increase the adoption rate of three-wheeler and other segments. Different marketing communication tools are used to improve the knowledge of EVs. While planning to make people aware of EVs, companies should consider that most of the targeted audience will be conventional three-wheeler vehicle drivers. The heterogeneity and Indian cultural differences must be considered while performing suitable actions. The socio-demographic characteristics are given in the study, which can be used for making marketing plans. People should be aware of EV technology, how it works, how it can be charged, whether it's a plug-in type or battery swapping type, about battery, relative expenditures, maintenance, costs incurred, infrastructure, state, and central government policies and subsidies on EV, other technology associated, availability, durability, etc. Governments can play a good role in making people aware of EVs. So, making people aware of three-wheeler EV's will be beneficial in their adoption as well as for other segments too. The worse side of the internal combustion engine is also to be conveyed effectively.

From this study, it is clear that e-rickshaw users are considering the green behaviour and environmental benefits of EVs. This element should be treated wisely because it is important to stick to EV's environment-friendly nature. Marketers should focus more on this factor and design suitable plans to enrich the environmental concern of people. Society, family, peer groups, friends, etc., are always influential in decision-making.

Along with developing consumer knowledge of three-wheeler EVs, society should also be aware of their benefits. Campaigns, test drives, marketing communication tools, etc., have to be used tactically to make everyone aware of EVs' benefits. This will help the Indian market of three-wheeler EVs. Governments can make their contributions to make people aware of government support for EV adoption. Manufacturers and marketers must ensure the availability and accessibility of three-wheeler EVs. The manufacturers have to give their focus on updates and new technical assistance. Three-wheeler EV consumers are searching for innovative technologies, and these innovative consumers should always be attracted to EVs. If technologies can reduce human efforts, consumers will certainly start adopting them. Continuous improvement in the three-wheeler segment of EVs is expected to attract more consumers and also the existing consumers. Considering these consumer psychological factors, manufacturers, marketers, agencies, and government bodies can make suitable plans and procedures to improve the adoption rate of three-wheeler EVs in India.

This research gives an insight into factors affecting the adoption of three-wheeler EVs and the hierarchy of significance. Although this study makes different contributions, there are a few limitations to the study which can be a guide for future studies. The study was restricted to the views of 405 respondents in Patna, Bihar, India. The response of non-users is not included in this study, so further studies can be carried out on potential buyers. This study considered a set of factors identified as important from literature and qualitative study, and thorough investigation may be conducted on the factors which were ignored or omitted during the initial stage of research. The heterogeneity of consumers makes it possible to validate the model in different countries, considering the nation's speciality. This study focused only on the three-wheeler segment; further research can also be extended to other segments.

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