Investigating Determinants of Electric Vehicle Adoption: Malaysian Experience

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ABSTRACT

The Malaysian government has been actively encouraging and advocating for the adoption of electric vehicles among its citizens to address the challenges of high energy consumption and pollution. Embracing increased usage of electric vehicles is crucial in mitigating issues related to carbon emissions, reducing dependence on traditional fuels, and enhancing economic sustainability. Despite the growing variety of electronic vehicles (EVs), they still constitute a relatively small proportion of the overall vehicle market. Several barriers hinder car owners from embracing EVs, including travel needs, charging infrastructure, individual socioeconomic characteristics, attitudinal factors, and environmental concerns. In this study, the researchers employed the Theory of Planned Behavior (TPB) model to establish a framework for understanding the impact of purchase intentions on electric vehicles (EVs). The model incorporated consumer intention (CI), perceived value (PV), and innovation. A questionnaire was distributed to potential customers, resulting in 277 valid survey responses. Structural Equation Modelling (SEM) using Partial Least Squares (PLS) was employed to analyse the factors influencing EV purchase intent. The study revealed that none of the tested factors had a negative impact, with most factors significantly contributing to positive outcomes in consumers' intent to purchase electric vehicles (EVs). The findings were discussed alongside policy recommendations and conclusions.

Keywords: Electric vehicle, Plug-in hybrid electric vehicles (PHEVs), Carbon emissions, customer intention, perceived value, innovation

INTRODUCTION

In terms of its influence and relationship to the future, the environmental problem of climate change is unlike any other. In the fields of reducing greenhouse gas emissions and adapting to climate change, technology is seen as one of the key elements of the answer. Furthermore, a tech-centric perspective and ecological modernization theory contend that adopting clean technology is essential to addressing environmental issues and lowering pollution levels in the environment (Gibbs, 2000).

These days, air pollution caused primarily by the transportation sector is a major global concern. According

to Xia and Yan (2022), issues arising from the transportation sector would result in energy scarcity and carbon emissions, and Malaysia is not immune to this issue. According to research, Malaysia, which has a population of 32 million, is among the ASEAN nations with the highest carbon dioxide emissions in 2019, with an estimated 253270 kilotons (Trading economic, 2022). Furthermore, the data indicates that Malaysia is placed 13th globally in terms of carbon emissions. The amount of carbon emissions (CO2) per person in our nation was 7.67 metric tons in 2019. This is an increase from 24,4410 tons in 2018 to 25,327,253,270-kilo in 2019, expanding at an average yearly rate of 3.49% (Trading economic, 2022). Consequently, the adoption of electric mobility systems has been aided by growing worries about the risks linked with peak oil and the environmental effects of the current road transport system.

Moreover, the presence of smart cities such as Cyberjaya and Putrajaya in Malaysia, which prioritize the reduction of carbon dioxide emissions, may also contribute to the necessity for EV adoption in the country. Therefore, there is a relationship between new technologies and smart cities that may have an impact on the process of mitigating pollution. Emerging technology has a wide range of uses, including improving mobility patterns, lifestyle enhancements, and the governance of transportation systems, in addition to increasing the energy efficiency of various modes of transportation (Paiva et al., 2021). In order to ensure that future generations have better lives, this endeavor is essential. Given the widespread belief that humans are largely responsible for climate change, we need a deeper comprehension of the variables influencing people's behavior in order to discourage environmentally harmful conduct. These days, electric cars have evolved into more ecologically friendly automobiles; in other words, EVs are currently regarded as eco-friendly goods that are renowned for their creativity in lowering pollution and environmental risks (Gulzari, Wang & Prybutok, 2022).

Innovation in something like an electric vehicle (EV) originates from gaining basic understanding about EVs and developing an attitude toward them. Customers would decide whether to accept or reject the introduction of any new technology pertaining to EVs while examining innovations in this area (Rogers, 1995). It's debatable, though, whether or not consumers will accept and ultimately buy an EV. This is due to the likelihood that individuals would have to modify their opinions and driving behaviors in order to embrace the concept of EVs. A few different types of electric vehicles (EVs) include plug-in hybrid electric vehicles (PHEVs), which draw their energy from either a battery or conventional fuel, BEVs (battery electric vehicles), which run on conventional fuel and have an electric drive system, and HEVs (hybrid electric vehicles) (Secinaro et al., 2022).

Due to the advancements in sustainable and innovative mobility technologies in recent years, the use of electric vehicles (EVs) has proven successful in reducing pollution in the transportation sector (Bakker & Trip, 2013). The extent to which customers embrace and accept EVs will determine how successful they are (Hwang et al., 2021). The public's acceptance of these new environmentally friendly EVs might only be impacted in circumstances when buyers question the application of cutting-edge technology due to their own ignorance and lack of expertise (Adu-Gyamfi, 2022). These are barely any of the factors influencing the uptake of electric vehicles. Energy-sustainable transportation innovations, such as electric vehicles (EVs), require some essential components to be effectively marketed and embraced. This study aims to explore the effects of independent variables on EV adoption in Malaysia, including consumer behavior, customer intent, and a lack of innovation convenience.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The implementation of electric vehicle (EV) usage presents a challenge in solving technological issues and changing consumer behavior (Wang et al., 2022). The theory of planned behavior (TPB) states that knowledge and experience are typically the driving forces behind the factors that may affect customers' behavioral intentions (Ajzen, 1991). Thus, the purpose of this study is to explain why customers make

purchases based on environmental considerations and to find a solution to the behavior of consumers even after technological issues have been resolved.

TPB contends that perceived behavior control (PBC) and individual intention determine behavior. Since its development nearly three decades ago, TPB has been used in numerous studies to describe the causes of pro-environmental behaviors, including waste recycling (Echegaray & Hansstein, 2017), low-carbon footprint products (Liu et al., 2022), energy efficiency, low carbon consumption (Jiang et al., 2019), and others. We have adjusted the TPB to reflect Malaysian users' adoption of EVs. Regarding Malaysian customers, we have redirected the study's focus to demonstrate how they have embraced electric vehicles (EVs) (Adnan, 2017). Furthermore, the TPB is a revision of reasoned action theory, which makes up for the original model's incapacity to address actions over which people have only a limited degree of choice and freedom (Tommasetti, 2018).

According to Sun et al. (2019), an electric vehicle (EV) is a car that has two energy sources: a diesel engine and a battery. In the auto business, electric vehicles are thought to be among the most cutting-edge innovations in recent years. In many countries, electric automobiles are becoming more and more expensive. Recently, automakers with more intriguing engineers have been producing an increasing number of higher-quality electric automobiles, and the Toyota Prius was declared the largest electric vehicle globally at the start of 2000 (Adnan et al., 2017). Despite the fact that fully electric cars were previously available, they did not gain popularity. Because of advancements in technology, increased battery capacity, and growing environmental concerns, electric vehicles may prove increasingly appropriate for use in transportation markets (Khazaei, 2019). These days, the electric vehicle (EV) is acknowledged as the most inventive and sustainable method of cutting carbon emissions worldwide (Gerardo et al., 2020).

Consumer intentions

According to Liu et al. (2021) customer intents can be defined as follows: consumers are more likely to purchase things that align with their interests because they are more informed. In other words, customers will have the purpose of purchasing the items if they already have plans to purchase the desired type of goods. Prior research has focused on variables affecting consumers' purchase intentions and ideal timing for electric vehicle purchases. The majority of researchers have examined the influence of socioeconomic factors, such as age, gender, household income, education level, occupation, and others, on EV purchasing intentions using the ordered choice model (Lane et al., 2018). In fact, there is a connection between customer intentions and EV uptake. Specifically, when it comes to the adoption of EVs, the customer's intentions and their experience are positively correlated, which may or may not encourage the customer to adapt to the EV (Li et al., 2017). These tests have demonstrated that consumers want to switch to electric vehicles (EVs) when they believe, for example, that driving a conventional fuel vehicle can harm the environment. For this reason, it's referred to as a positive experience that encourages the user to switch to an electric vehicle. Furthermore, socioeconomic factors have a favorable and negative impact on customers' purchase intentions. For instance, a person is more likely to intend to buy an electric vehicle (EV) if their income is higher. According to these studies, a customer's awareness of the cost and charging duration of electric vehicles (EVs), along with factors like education level, yearly earnings, the quantity of domestic cars on the road, and motivational viewpoints (Yong Zhang et al., 2011), can all have an impact on their intention to purchase an EV in the near future.

H1: There is a significant relationship between consumer intention and the adoption of Electric Vehicles

Perceive value and the adoption of Electric Vehicles

Human value systems are the primary focus of event evaluation. One could consider perceived value (PV) to be a fundamental aspect of consumer behavior. This idea has to do with assessing how satisfied a client is

overall with the products and services they have received. (Asadi and others, 2021). Perceived value, according to Hassan (2015), is a significant factor in consumers' decisions to buy things with a high perceived value. Furthermore, a number of studies in the field of perceived value theory have demonstrated that this particular factor has an impact on people's capacity to use mobile health facilities (Deng et al., 2014), wearable technology (Yang et al., 2016), public transportation (Lai & Chen, 2011), and electromobility vehicles (Jiang, 2016). Numerous studies have demonstrated a beneficial relationship between consumer attitudes and the intention to adopt new technologies, especially when it comes to electro-mobility (EM) vehicles (Zhang, Bai & Shang, 2018).

H2: There is a significant relationship between perceived value and adoption of Electric Vehicles.

Innovation and the adoption of Electric Vehicles.

To reduce purchasing costs and encourage more customers to adopt EVs, a variety of financial incentive programs (FIPs) are available, such as advantageous tax laws and direct sales discounts (Brenna & Foiadelli, 2020). In addition to cost, which is one of the main barriers preventing Malaysians from adopting EVs, the infrastructure for recharging EVs is another barrier preventing consumers from buying EVs (Lin & Wu, 2018). The expenditures associated with investing in infrastructure for recharging make customers reconsider their consumption habits (Peterson & Michalek, 2013). Prior research has demonstrated that customer adoption of electric vehicles (EVs) is significantly influenced by the convenience of the infrastructure for recharging them (Smith, 2019). Governments ought to be more actively involved in setting up the infrastructure and preparing the market for EV recharging (Muzir et al.,2022). This initiative may aid in the sustainability of these cutting-edge new technologies and encourage other stakeholders, such electric utility corporations, to become partners (Rajendran et al., 2021). Electric utility companies and EV technology can work together as a business opportunity, and the electric vehicle industry may benefit from their involvement in the automotive industry (Yıldız, Olcaytu & Sen, 2019).

H3: There is a significant relationship between the innovation and the adoption of Electric Vehicles

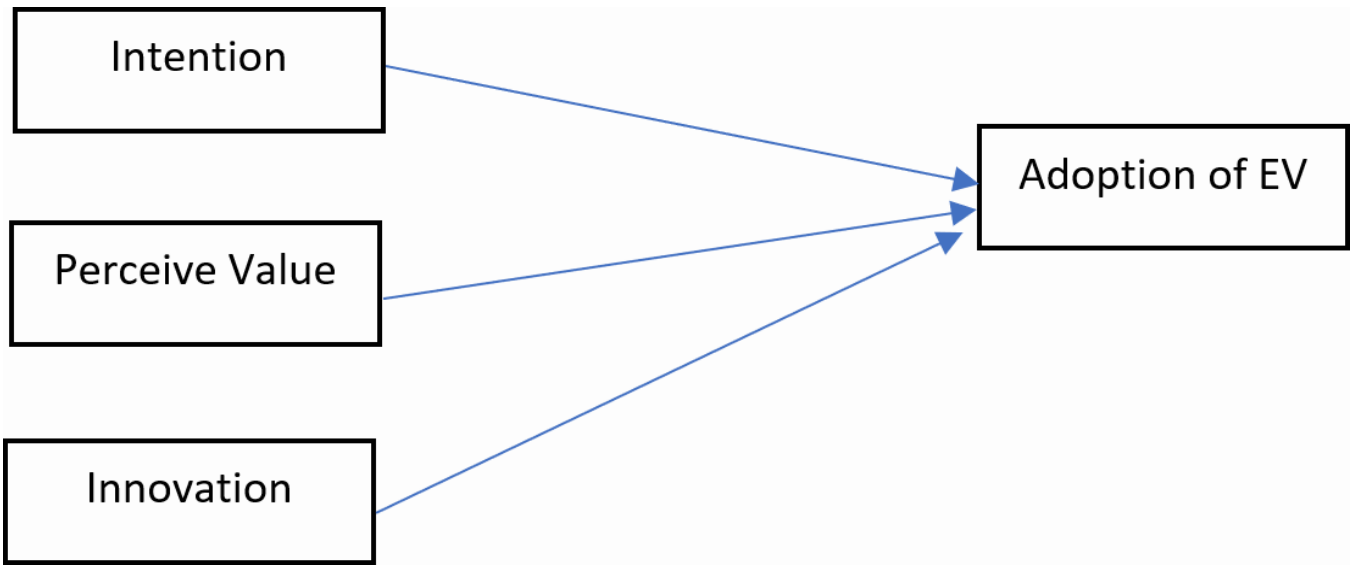

Figure 1: Research Framework

METHODOLOGY

There are 44 questions in all across the four sections of the structured questionnaire. The first section inquires about the desire to buy an electric vehicle (DV; henceforth referred to as EV adoption). The Likert

scale's five items were taken from Adnan (2017). The second section, which was adapted from Adnan (2017), inquires about the characteristics of the vehicles that the respondents valued most (or least) while contemplating purchases related to mobility, such as speed and acceleration, design and style, fuel economy and cost savings, and technological reliability. Additionally, five questions about the significance of EV attributes—such as charging accessibility, driving range, battery life, charging time, and V2G capability—were posed in this section. Respondents were given questions about the lack of innovation inEV usage in the third section of the study. 2018 saw the adoption of the three instruments from Nigel Berkeley. Demographic information on age, gender, income, number of children, country, and place of residence is included in the survey's last section. With the exception of sociodemographics, EV driving experience, and sustainability activities, all measures were calculated using the participants' 5-point Likert- type scale responses to the items.

A survey was made with Google Forms and distributed online via Facebook over the course of more than a month in order to gather data. Hair et al. (2019) state that the number of predictors included in the research determines the power of the analysis, which in turn determines the sample size. Gefen et al. (2011) found that a study with an 80 percent power, a medium effect size, and a p-value of 0.05 needed a sample size of less than 84 people. The sample size for this study was adequate, as 402 respondents completed the questionnaires and submitted them to the researcher for processing.

RESULTS

The study contained a total of 277 respondents, of which 158 (or 57% of the sample) identified as male and 119 (or 43%) as female. The age group of 50 years and older comprised the majority of participants in this research, comprising 90 out of 277 respondents or approximately 32.5% of the total samples. The age group of 40 to 49 years comprised 24.9% of the sample (n=69) in response to this survey. The age groups of 30 to 39 years and 18 to 29 years had an equal number of respondents (21.3% of the sample, n=59). The subsequent highest academic qualification is SPM, held by 20.9% of the respondents (n=58), with undergraduate status representing the majority of respondents (60 individuals, or 21.7%). STPM is the lowest level of academic qualification, with only 19 respondents or 6.9% of the residents having completed it. The following demographic profile pertains to the respondents' monthly income. A majority of the respondents (159 individuals, or 57.4%) reported an income exceeding RM3000 per month. Conversely, only 118 respondents, or 42.6%, indicated that their monthly income was equivalent to or less than RM3000. In conclusion, regarding the job scope, it is noteworthy that 126 respondents (or 45.5% of the total) are in the support services group, whereas 151 respondents (or 54.5% of the total) belong to the management and professional group.

The hypotheses were tested and their validity was established using the Smart Partial Least Squares (PLS) technique. The two-stage method that Hair et al. (2019) suggested was applied. It is composed of two models that work in tandem with one another: the measurement model and the structural model. According to Hair et al. (2019), convergent validity and discriminant validity are the two characteristics that a measurement model must exhibit in order to be considered valid. Convergence validity is specifically achieved when the loading is larger than 0.708, the average variance explained (AVE) is greater than 0.5, and the Composite Reliability (CR) is better than 0.7 (Hair et al., 2019). Given that every loading, as previously said, convergent validity did not seem to be a problem in this evaluation because both the AVE and CR for this study were higher than the threshold values.

The heterotrait-monotrait test (HTMT) was then used to evaluate the discriminant validity. The HTMT values in this study are below the recommended threshold value of 0.9, as suggested by Franke and Sarstedt (2019). Consequently, there was no issue with the test's discriminant validity in this investigation.

Table 1 Measurement Model

Constructs		Items	Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Consumer Intention	CI1:I intend to purchase EVs because it is environmentally friendly.	CI1	0.768	0.764	0.746	0.515
	CI2: I intend to purchase an EV car even though it is more expensive than a conventional car	CI2	0.872			
	CI3: I intend to purchase EV over a conventional car when their product qualities are similar.	CI3	0.814			
	CI4: I feel that I will play a great part in helping the environment when I drive EV	CI4	0.763			
	CI5: I feel more comfortable if I drive a hybrid car rather than a conventional car	CI5	0.744			
Perceive Value	PV1: I think the price of PHEV/EV is important to me and I can afford it when I decide to adopt	CB1	0.787	0.888	0.920	0.506
	PV2: I think the maintenance and repair of PHEV/EV is important to me when I decide to adopt	CB2	0.825			
	PV3: I think I can find where to buy PHEV/EV if I wanted to buy	CB3	0.852			
Innovation	IC1: I think charging an electric car in a public space is easy.	IC1	0.846	0.835	0.816	0.690
	IC2: I believe that there is room for improvement of charging facilities at the nearest future	IC2	0.801			
	IC3: I think our charging facilities are enough	IC3	0.725			
Electric Vehicle Adoption	EVA1: I believe that innovation gives me more control over my daily life.	EVA1	0.840	0.830	0.804	0.523

	EVA2: I believe that adopting EV makes my lifeeasier	EVA 2	0.752			
	EVA3: I am enjoying figuring out how to use EV.	EVA 3	0.712			
	EVA4: I feel like I am overly dependent on EV.	EVA 4	0.712			

Next, the discriminant validity was measured by the heterotrait-monotrait (HTMT). Table 2 depicts the values of HTMT are lower than the required threshold value of 0.9 as suggested by Franke & Sarstedt (2019). Hence, the discriminant validity was not an issue in this study.

Table 2 Discriminant Validity (HTMT Criterion)

Variables	Waste Separation Behaviour	Attitude	Perceive Behavioral Control	Subjective Norms
Electric Vehicle Adoption	**0.832**			
Consumer Intention	0.570	**0.825**		
Perceive Value	0.713	0.325	**0.710**	
Innovation	0.187	0.210	0.188	**0.721**
Mean	5.780	3.780	6.012	3.978
Standard Deviation	0.710	1.290	0.732	0.768

A bootstrapping approach with 5000 resampling was used to evaluate the hypotheses. All of the purpose hypotheses are validated by the data for the direct effect. With CI -> EVA ($\beta = 0.750$, $p < 0.001$), PV -> EVA ($\beta = 0.702$, $p < 0.001$), and IC -> EVA ($\beta = 0.620$, $p < 0.001$), it is clear that the variables indicatingthe CI, PV, and IC have favorable impacts. As a result, the study's hypotheses H1, H2, and H3 aresupported. The study's findings are shown in Table 1.

Table 3 Hypothesis testing

Relationships	Standardized Beta	S.E.	*t*-value	BCI LL	BCI UL	f^2	Q^2	VIF	Decision
Consumer Intention – **Electric Vehicle Adoption**	0.750	0.050	4.025	0.056	0.276	0.128	1.265	1.028	Supported
Perceive Value – **Electric Vehicle Adoption**	0.702	0.056	4.142	0.136	0.317	0.090	0.501	1.226	Supported
Innovation Convenience – **Electric Vehicle Adoption**	0.620	0.054	2.051	0.066	0.466	0.167	0.196	1.846	Supported

In this study, the coefficient of determination (R2), predictive relevance (Q2), and effect size (f2) were

assessed using the blindfolding method. The R2 values for PV (0.492), CI (0.584), and IC (0.698) indicate that CI accounts for 58.3 percent of the variation in EVA, whereas PV explains 49.2 percent. CI is responsible for 69.8% of the variance in EVA. In terms of predictive significance, a model is considered highly predictive when the value of Q2 is greater than zero. Hair (2017), among additional works. The blindfolding method revealed that the Q2 values for the CI, PV, and IC are 1.265, 0.501, and 0.196, respectively, indicating that the model has a high predictive capacity for the subject matter of the study.

The f2 effect size was subsequently computed. Cohen (1988) classifies effect sizes of 0.35, 0.15, and 0.02 as large, medium, and minor, respectively. Based on the calculated value of 0.128, the CI was found to have a moderate impact on the EVA. PV exerts a moderate impact on EVA, as indicated by its value of 0.167. In contrast, the IC exerts a negligible impact (0.090) on EVA.

Managerial implications

A pro-environmental posture has a significant impact on the adoption of electric vehicles in Malaysia (Adnan et al., 2016). Notable visions are associated with EVs on account of their low emissions and high mileage. Hence, as a promotional tactic to stimulate local consumers' adoption of electric vehicles, purveyors may incorporate fuel-efficient and eco-friendly automobiles into their advertising campaigns. To further enlighten consumers regarding the benefits and essential characteristics of electric vehicles, it is imperative that an informative promotional campaign be developed for advertising objectives. As part of their product strategy, automakers should incorporate more electric vehicles to attract consumers. Elements such as user-friendliness, fuel economy, reliability, and durability are critical qualities for electric vehicles. The total price of a hybrid/EV in Malaysia was nearly 30 percent greater than that of a non-hybrid EV. Automobile manufacturers must propose a greater number of affordable electric vehicles to prevent price escalations. This is due to the fact that the majority of consumers prefer to pay a price that is more reasonable and acceptable. Government incentives are one factor influencing the usage of hybrid electric vehicles in Malaysia. On the basis of the findings, the legal authorities should ensure that incentives are provided to EV purchasers. Furthermore, special incentives, such as a reduced corporate tax rate and an exemption from tax on industrial facilities for a duration of five to ten years, may be extended by the local government.

DISCUSSION AND CONCLUSION

This research is being conducted to increase public consciousness regarding environmental pollution and the strategic measures that must be identified and implemented to mitigate the issue. Hence, electric vehicle (EV) usage is strongly advocated as a means of establishing a secure and conducive environment.

This research study has conducted an exhaustive literature review about the determinants that impact the adoption of electric vehicles. We determined, based on the provided literature, that this study bridges the divide and predicts future research regarding consumer behaviour toward EV adoption based on EV penetration rates. For this purpose, it was assumed that a set of scenarios representative of the majority of current market conditions could be utilised to develop three phases of models, with diffusion and time series models, agent-based models, and consumer choice models being the most prevalent in the literature on EV marketplace forecasting. Predictions of EV adoption in Malaysian vehicle sales. To accomplish this, the paper begins with a review of previously published EV forecasts, which includes a classification of EVs as the best alternative, particularly in the Malaysian transportation sector, where carbon dioxide emissions reduction is a primary concern.

On the contrary, previous studies' comparisons (DiPietro et al., 2013; Ho et al., 2022; Kim et al., 2022) indicate unequivocally that the inclusion of personal moral standards has increased the explained variance, albeit to a lesser extent than anticipated. The influence of individual moral standards was found to be

minimal in this investigation when compared to the values assessed in international studies. The primary reason for the prevalence of communism in Malaysia is that it dominates many aspects of daily life. However, this approach has proven to be ineffective (Laoonual, 2013; Furnham & Gunter, 2015), causing societal tension among consumers and playing a crucial role in influencing consumer behaviour. The impact of SN results in the formation of personal ethical standards. Furthermore, the aforementioned researchers elaborate on the impact of environmentally favourable considerations on the elements of the extended TPB framework and the inclination towards electric vehicle (EV) adoption. The investigation yields a profound comprehension of the particular subject matter concerning the adoption of electric vehicles (EVs), in which knowledge exchange, response, and interaction are crucial components in our environmental sustainability research. Environmental concern exerts an indirect influence on the intention to adopt, and this influence is positively correlated with attitude, perceived value, and convenience of innovation. However, the moderating effect of the collective consequence of knowledge sharing, response, and interaction directly influences the consumer's intention to adopt electric vehicles (EVs) and their actual adoption. A portion of the extended TPB model's components mediate the relationship between an individual's intention to adopt and the impact of that concern on the environment.

Moreover, it is crucial to emphasise that there is no direct proportionality between environmental concern and intention to adopt. Indeed, the intention to adopt is contingent upon the effects of environmentally conscious concern and the components comprising the extended TPB model. This literature review is extremely comprehensive and beneficial. The acquisition of pertinent data holds practical value for both governmental entities and automotive retailers. Environmental concerns have a positive effect on consumer attitudes towards the adoption of electric vehicles, according to the findings of this study. In other words, consumers will be more inclined to employ electric vehicles if they have a greater concern for the environment.

Typically, from a marketing standpoint, a vehicle vendor showcases and introduces electric vehicles (EVs); in doing so, they augment the brand's prominence and the consumer's environmental consciousness, while also raising awareness regarding the environmentally favourable advantages associated with EV adoption. The degree to which consumers value societal pressure or other pressures imposed by individuals or primary adopters is a critical determinant in determining their adoption intentions. By endorsing the research, there is an opportunity to further develop this in relation to the ethical, consumer behaviour, and psychological frameworks of emotions.

On the contrary, effective communication memoranda are required. Consumer choices and behaviours may be influenced as a result of explicit intellectual and emotional responses elicited in response to instruction and strategies. By embracing rational and affective responses, regulatory bodies and marketing authorities can enhance their ability to cooperate in terms of instruction, communication, and strategies aimed at surmounting further barriers to the widespread adoption of electric vehicles. The evaluation of the electric vehicle (EV) by these participants and early adopters significantly influences the customer's intention to adopt. Therefore, the vendors' and government sector's participation is required to improve the early adopters' assessment of their EV. However, the policymaker has implemented significant initiatives, including the EV Club and the Word-of-Mouth (WOM) marketing policy, which appear to be the two most important and dominant methods for the increase in SN as perceived by consumers. As a result, this paper attempts to address the deficiency by presenting a conceptual framework that customises the sustainability of environmental issues.

The significant relationship between the variables pertaining to the appropriate adoption of electric vehicles (EVs) and environmental sustainability has been theorised within the proposed conceptual framework. This framework also provides a novel avenue for future research to empirically validate the hypothesised relationship between the variables. It is unnecessary to mention that this review study has a few limitations.

The field of preference and attitude research is vast, and the authors in this article examined only those findings that were directly relevant to the EV. Moreover, in our endeavour to succinctly summarise the intricate and vast body of literature, we have been unable to conduct an exhaustive evaluation of every current argument. Nonetheless, our exhaustive investigation into the preferences and attitudes of consumers towards electric vehicles has filled in a number of existing knowledge voids and identified a number of promising procedural avenues and approaches for future research. Persisting scepticism regarding the potential for improved public perception of fuel cells and hydrogen-powered vehicles in the coming years appears to justify further investigation in this domain.

This study contributes significantly by emphasising the critical nature of environmental stewardship in the context of electric vehicle (EV) usage. In light of the foregoing, the fundamental elements revealed in this article have filled a substantial knowledge void, facilitating a more comprehensive comprehension of the pivotal challenges impeding the adoption of electric vehicles and possibly empowering the nation to formulate enduring strategic initiatives to improve the functioning of EVs. As a result, in order to facilitate an EV transition, it is necessary to integrate systems, personnel, and resources in order to increase EV adoption rates and thereby reduce pollution.

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