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What Motivates Me to Adopt Electric Vehicle

[1]Azlina Mohd Hussain, [2]Nor Syamaliah Ngah, [3]Nor Suraya Aini

[1]Fakulti Undang-Undang, Universiti Teknologi MARA Cawangan Negeri Sembilan, Kampus Seremban, [2]Fakulti Sains Pentadbiran & Pengajian Polisi, Universiti Teknologi MARA Cawangan Negeri Sembilan, Kampus Seremban, [3]Kolej Komuniti Hulu Terengganu

Email: azlin072@uitm.edu.my, syamaliah@uitm.edu.my, cloudciksu@gmail.com

Corresponding Author Email: syamaliah@uitm.edu.my

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Abstract

The Malaysian government has been urging and promoting Malaysians to adopt electric vehicles to help reduce high energy consumption and pollution. Acceptance of increased electric vehicle usage will without doubt help in easing issues relating to carbon emission and extensive reliance on fuel and of course improve economic sustainability. Although the number of different types of electronic vehicles (EVs) is increasing, they still constitute only a small share of the total vehicle market. There are a number of barriers to car owners' adoption of an EV: travel needs, charging infrastructure, the individual car owner's socioeconomic characteristics, attitudinal factors, and environmental concerns. The theory of planned behavior (TPB) model was utilized in this study to construct a model of purchase intention impact mechanism for electric vehicles (EVs). It considered consumer attitude (AT), perceived value (PV), and lack of innovation. The questionnaire was administered to potential customers. A total of 277 valid survey responses were collected. The factors affecting EV buying intent were examined by Structural equation modeling (SEM) using PLS. According to the results, no factors tested negative, most of the factors were significant beneficial outcomes on consumers' intent to buy electric vehicles (EVs). These findings were discussed with policy recommendations and conclusion.

Keywords: Electric Vehicle, Plug-In Hybrid Electric Vehicles (PHEVs), Carbon Emissions, Attitude, Perceived Value, Innovation

Introduction

The issue of climate change is unlike any other environmental issue in comparison to its impact and correlation with the future. Technology is viewed as one of the important components of the solution to climate change in the areas of the abatement of greenhouse gas emissions and climate change adaptation. Additionally, according to ecological modernization theory and a tech-centric point of view, the move to clean technology is crucial for reducing environmental pollution and addressing environmental problems (Gibbs, 2000).

Nowadays, the major problems of air pollution from the transportation industries are becoming the main concern worldwide. The problems that arise from transportation industries will lead to energy scarcity and carbon emissions (Xia & Yan, 2022) and Malaysia is not exempted from facing this problem. The data has shown that in 2019, Malaysia with a total population of 32 million has become one of the ASEAN countries with the most carbon dioxide emission with approximately 253270-kilo tons (Trading economic, 2022). In addition, the data also proved that Malaysia is ranked 13th in the world ranking port on carbon emissions. In 2019, our country recorded an amount of 7.67 metric tons per capita of carbon emissions (CO2) and it has increased from 244410 tons in 2018 to 25327253270-kilo in 2019 which is growing at an average annual rate of 3.49% (Trading economic, 2022). As a result, rising concerns about the environmental effects of the existing road transport system as well as the risks associated with peak oil have encouraged the adoption of electric mobility systems.

Furthermore, the existence of smart cities in Malaysia like Cyberjaya and Putrajaya where the focus of the smart city is to reduce carbon dioxide emissions can also be the factor why Malaysia needs to implement EV. Thus, there is an interconnection between smart cities and emerging technologies where it can influence the pollution-mitigation process. Overall, there are various applications for emerging technology, not only in enhancing the energy efficiency of different transport modes but also in promoting lifestyle improvements, mobility habits, and transport system governance (Paiva et. al., 2021). This effort is crucial in promising future generations to experience a better quality of life.

Since it is perceived that we, as human beings play a large role in contributing to change in climates, we need a better understanding of factors that impact individual behaviors in curbing destructive actions which harm the environment. Nowadays, electric vehicles have developed into vehicles that are more environmentally friendly, that is EVs are now known as eco-friendly products that are known for their innovation in reducing environmental hazards and pollution (Gulzari et al., 2022).

Innovation in, such as an EV, stems from the attainment of initial knowledge in EV and forming a mindset towards it. Consumers when considering any innovation in respect of an EV would make decisions to either accept or refuse the implementation of any new technology regarding EVs (Rogers, 1995).

However for people to accept and finally purchase an EV is debatable. This is because the probability of people accepting the idea of EVs would require them to change their views and habits relating to vehicles. There are a few types of EV which are HEVs (hybrid electric vehicles), which are operated by conventional fuel and have an electric drive system, BEVs (battery electric vehicles), which entire energy originates from a battery and PHEVs (plug-in hybrid electric vehicles), whose energy comes from either a battery or conventional fuel (Secinaro et. al., 2022).

The usage of EVs has had success in contributing to the reduction of pollution in the transport sector due to the innovative and sustainable mobility technologies that have been advanced in recent years (Bakker & Trip, 2013). The success of EVs will be largely due to the degree to which EVs are welcomed and accepted by consumers (Hwang et al., 2021). The public's acceptance of these new eco-friendly EVs may only be affected in situations where purchasers doubt the usage of innovative technology because of the purchasers' own lack of knowledge and experience (Adu-Gyamfi, 2022). These are just a few of the elements that influence the adoption of EVs. There are a few key ingredients that must be present for energy-sustainable mobility technologies like EVs to be successfully promoted and adopted. The goal of this study

is to investigate the impact of independent variables, such as customer intent, consumer behavior, and a lack of innovation convenience, on the adoption of EVs in Malaysia.

Literature Review and Hypothesis Development

The challenge of implementing the usage of EVs lies in the resolution of technology-related problems and consumer-related behavior (Wang et. al., 2022). According to the theory of planned behavior (TPB), factors that may influence the behavioral intentions of consumers are generally driven by knowledge and experience (Ajzen's, 1991). Therefore, this study aims to resolve the persistence of consumer behavior even after the resolution of technical problems and to explain ecological-based purchases by consumers.

The argument of TPB is that behavior is the result of individual intention and perceived behavior control (PBC). According to Echegaray & Hansstein (2017), there are many studies that have utilized the use of TPB to describe the causes of pro-environmental behaviors such as waste recycling Echegaray & Hansstein (2017), low-carbon footprint products Liu et. al (2022) and energy efficiency, low carbon consumption Jiang et al (2019), and others since its development nearly three decades ago. We have modified the TPB to show the adoption of EVs among users in Malaysia. In the case of Malaysian users, we have resolved the direction of the study to show how Malaysian users have accepted EVs (Adnan, 2017). In addition, the TPB is a modification of reasoned action theory, which forces the original model's inability to deal with behavior over which humans have only partial freedom and choice (Tommasetti, 2018).

An Electric Vehicle (EV) is an automobile that uses two energy sources, a battery, and a diesel in comparison to energy sources (Sun et al., 2019). Electric cars are, in recent years, seen to be among the most advanced developments in the car industry. Electric cars are at an upmarket pace in several nations. More and more electric vehicles of better quality are being created recently by generating car makers with more fascinating engineers and Toyota Prius was recently announced as the internationally largest EV in the world in the beginning of 2000 (Adnan et al., 2017). Although complete electric vehicles were also offered a long time ago, nevertheless they did not become a popular choice. Electric vehicles can be more suitable in the transport markets by technical development, improving battery capacity, and emerging environmental issues, (Khazaei, 2019). Nowadays, the EV has been recognized as the most sustainable and innovative approach to reducing carbon emissions across the globe (Gerardo et al., 2020).

Consumer Intentions

Consumer intentions can be identified as the consumers being more informed and tend to buy the goods which are in line with their interests (Liu et .al., 2021). Meaning that if the consumers already have plans to buy the goods with the preferred type of goods, then the consumers will have the intention of buying it. Several previous studies have concentrated on factors influencing the purchasing intentions of customers and the preferred time to buy EVs. Most researchers have used the ordered choice model to analyze the impact of socioeconomic variables (Lane et. al., 2018) with respect to EV purchasing intentions such as age, gender, household income, education level, occupation, and others. Indeed, there is a relationship between the consumer's intentions with the adoption of EVs In particular, in the context of EV adoption, the customer's intents are also favorably connected with the experience of the consumer, which can discourage or inspire the customer's adaptation to the EV (Li et al., 2017). Such experiments have proven that when the consumer thinks, for

example, that it can damage the environment by driving conventional fuel vehicles, the consumer has the goal of adapting the EV. This is therefore called a favorable experience that can inspire the consumer to adopt the EV. Moreover, socioeconomic influences affect consumers' intention to purchase both positively and negatively. Taking as an example, the higher the income of the individual, the more likely the individual has the intention to purchase the EV. These studies identified that the awareness of a customer about the price and charging times of EVs (Junquera et al., 2016), level of education, annual profits, number of domestic cars, or motivation views Zhang et al (2011) influences the intention whether this consumer can buy an EV in the short amount of time.

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

Perceive value and the adoption of Electric Vehicles

The evaluation of events is mainly focused on the human value systems. Perceived value (PV) can be viewed as a core component of purchasing behavior. This principle is related to the total evaluation of the extent to which the customer has been pleased with the goods and services offered (Asadi et. al., 2021). According to Hassan (2015), perceived value plays a major role in the decision-making process of consumers to purchase goods of high perceived value. In addition, several researchers in the field of perceived value theory have shown that this aspect specifically impacts individuals' ability to use public transport Lai & Chen (2011), mobile health facilities Deng et al (2014), and wearable equipment, Yang et. al (2016) as well as electro-mobility vehicles (Jiang, 2016). Few consumer behavior research related to the use of novel technology recognized the contribution of attitude (ATT) as the key mediating factor between perceived worth and desire to implement (Kim et al., 2019). A significant amount of research has shown that consumer attitudes and the intention to adopt new technologies are positively linked, particularly in the case of electro-mobility (EM) vehicles (Zhang, Bai & Shang, 2018).

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

Lacking innovation convenience with the adoption of Electric Vehicles

Various financial incentive programs (FIPs), including direct sales discounts and preferential tax policies, are offered to lower purchase costs and enable more customers to follow EVs (Brenna & Foiadelli, 2020). Apart from the prices that become the major obstacles among Malaysian to adopt EVs, the other obstacle to consumer withdrawal from the purchase of EVs is their recharging infrastructure (Lin & Wu, 2018). Investment in recharging infrastructure incurred a lot of costs and it makes consumers think twice before consuming it (Peterson & Michalek, 2013). In previous studies have been made, it showed that the convenience of recharging infrastructure is significant for EV adoption by consumers (Smith, 2019). The governments should involve deeper in the market preparation and the provision of infrastructure for EV recharging (Muzir et. al., 2022). This effort could help these emerging new technologies to sustain and also can open the eyes of many parties to join the partnership such as electric utility companies (Rajendran et. al., 2021). The partnership between electric utility companies and EV technology can be seen as a business opportunity

and their involvement in the automobile industry might put the electric vehicle industry at an advantage (Yıldız et al., 2019).

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

Methodology

The structured questionnaire consists of four parts with a total of 44 total questions. The first part asks about the intention to purchase an EV (DV; referred to as EV adoption from here on). The five items in the Likert scale were adopted from Adnan (2017). The second part asks about the vehicle attributes that the respondents valued most (or least) when considering purchases in the forms of mobility, such as speed and acceleration, design and style, fuel economy and financial savings, and technological reliability which was adopted from (Adnan, 2017). This part also asked five questions specifically about the importance of EV attributes, including charging availability, driving range, battery life, charging time, and V2G capability. The third part of the survey asked respondents about the lack of innovation pertaining to the usage of EVs. The three items instruments were adopted from Nigel Berkeley (2018) The final part of the survey includes demographics such as age, gender, income, number of children, living location (i.e., rural or non-rural), country, and so on. All measures except for socio-demographics, EV driving experience, and sustainability activities were estimated by participants' responses to the items with a 5-point Likert-type scale

In order to collect information, a survey was created using Google Forms and disseminated online via Facebook covering a span of more than one month. According to Hair et al (2019), the sample size should be determined based on the power of the analysis, which is determined by the number of predictors included in the research. For a study with an 80 percent power, a medium effect size, and a p-value of 0.05, Gefen et al (2011) determined that the minimum sample size necessary was just under 84 individuals. Given that a total of 402 respondents completed questionnaires that were returned to the researcher for processing, the sample size for this study did not pose an issue.

Results

The total respondents of this study were 277 respondents, representing 158 or 57% of male respondents and 119 or 43% coming from female respondents. Most of the respondents of this study were at the age of 50 years old and above that represented 90 respondents out of 277 total respondents and covered up about 32.5% of the total samples. This survey was followed by the age groups of 40 to 49 years which covered 24.9% of the sample (n=69), and both 18 to 29 years old and 30 to 39 years old have the same number of respondents which is 21.3% of the sample (n=59). Next is the highest academic qualification where most of the respondents are the undergraduate status with 60 respondents with 21.7% the next higher behind undergraduate is the SPM qualification with 20.9% of the respondents (n=58) and the least high academic qualifications is STPM where only 19 respondents or 6.9% residents stop until STPM qualifications. The next demographic profile is the monthly income earned by the respondents and most of the respondents are having an income of more than RM3000 in a month with a total of 159 respondents which is 57.4% and only 118 respondents represent only 42.6% that is the monthly income is less or equal than RM3000. Lastly is the job scope where 151 of the respondents which is 54.5% are in a management and professional group while the support services group is only 126 respondents or 45.5% of the total respondents.

The Smart Partial Least Squares (PLS) technique was used to test the hypotheses and determine their validity. A two-stage approach was used as proposed by (Hair et al., 2019). It consists of two models: a measurement model and a structural model, which are used in conjunction with one another. A valid measurement model must demonstrate two properties, namely convergent validity and discriminant validity, in order for the model to be regarded as valid, according to (Hair et al., 2019). Specifically, the loading must be more than 0.708, the average variance explained (AVE) must be greater than 0.5, and the Composite Reliability (CR) must be better than 0.7 in order to achieve convergence validity (Hair et al., 2019). Because all of the loadings, as well as the AAVE and CCR for this study, were more than the threshold values, convergent validity did not appear to be a difficulty in this examination, as previously indicated.

Following that, the discriminant validity was assessed using the heterotrait-monotrait test (HTMT). In this investigation, the values of HTMT are lower than the needed threshold value of 0.9, which was proposed by (Franke and Sarstedt, 2019). As a result, the discriminant validity of the test in this study was not a problem.

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 CONVENIENCE	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 life easier	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 CONVENIENCE	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 (β = 0.750, p < 0.001), PV -> EVA (β = 0.702, p < 0.001), and IC -> EVA (β = 0.620, p < 0.001), it is clear that the variables indicating the CI, PV, and IC have favorable impacts. As a result, the study's hypotheses H1, H2, and H3 are supported. 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

The blindfolding approach was used to examine the coefficient of determination (R2), predictive relevance (Q2), and effect size in this study (f2). The R2 values of 0.583 for CI, 0.492 for PV, and 0.698 for IC imply that CI explains 58.3 percent of the EVA variation, while PV explains 49.2 percent. IC accounts for 69.8 percent of the variation in EVA. When it comes to predictive significance, a value of Q2 greater than 0 shows that the model is highly predictive. Hair (2017), among other things. The study discovered that Q2 is 1.265, 0.501, and 0.196 for the CI, PV, and IC, respectively, using the blindfolding approach, showing that the model has strong predictive potential for the study's subject matter.
Finally, the f2 effect size was calculated. Effect sizes of 0.35, 0.15, and 0.02 are considered large, medium, and small, respectively, according to (Cohen, 1988). With a value of 0.128, CI was determined to have a modest influence size on the EVA. On EVA, the PV has a medium impact size (a value of 0.167). The IC, on the other hand, has a small effect (0.090) on EVA.

Managerial Implications
The adoption of EVs in Malaysia is greatly influenced by a pro-environment stance (Adnan et al., 2016). Due to their low emissions and high mileage, EVs also have notable visions. Therefore, in order to encourage local consumers to embrace electric vehicles, vendors might

use fuel efficient as well as environmentally friendly automobiles as one of the advertising strategies in their marketing. In order to educate consumers on the advantages and key features of electric vehicles, they also need to create a more informative promotion for advertising purposes. To draw in customers, manufacturers should introduce more electric automobiles as part of their product plan. Features like a simple operation, fuel efficiency, and good quality in terms of dependability and longevity are essential for electric vehicles. In Malaysia, the entire cost of a hybrid/EV was almost 30% higher than a non-hybrid EV. Automobile makers must suggest more cheap electric automobiles in order to avoid overpricing. This is so because the majority of customers want to pay a more reasonable and acceptable price. One of the things that affect hybrid EV adoption in Malaysia is government incentives. The legal authorities should make sure to provide incentives for EV buyers based on the findings. Additionally, the local government may offer special incentives, such as a low corporate tax rate and no tax on industrial facilities for a period of five to ten years.

Discussion and Conclusion

The motivation for the conduct of this study is to raise awareness on environmental pollution and the strategic measures that need to be identified and executed to reduce pollution. Therefore the use of EV is highly recommended as one of the methods in creating safe and healthy environment.

This research study has given a comprehensive review of the literature concerning the factors influencing the adoption of EVs. Based on the delivered literature, we found that this study bridges the gap and forecasts the studies based on the EV penetration rates of consumer behavior toward EV adoption. For this, a set of scenarios that suit most of today's market conditions was assumed to develop three stages as major modeling techniques used in the literature on EV marketplace forecasting are agent-based models, consumer choice models, and diffusion and time series models. EV adoption forecasts within the sale of vehicles in Malaysia. To this end, this paper first presents a review of the published forecasts of EVs, which includes a classification especially in the Malaysian transportation sector, the reduction of carbon dioxide emissions being kept in view, the EV has been considered the best alternative.

However, based on the comparison carried out by past researchers (DiPietro et al., 2013; Ho et. al., 2022; Kim et. al., 2022), it is quite clear that the addition of the personal moral norms has upgraded the explained variance which is less than the expected one. In this research, the impact of personal moral norms was the minimum compared to the measured values in the international studies. In Malaysia, the main reason is that communism is leading on numerous sides of day-to-day life, which is not very effective (Laoonual, 2013; Furnham & Gunter, 2015) arguments leads to societal stress amongst consumers and expresses a vital role towards changing consumer behavior. The influence of SN leads to individual moral norms. Moreover, the researchers mentioned above further explain the effect of eco-friendly concerns on the components of the extended TPB structure as well as the intention towards the EV adoption. As an associated impact, the investigation outhouses a bright understanding on the specific theme of the adoption of the EV where Knowledge sharing, Response, and Interaction play an important role in our research of environmental sustainability. The intention towards adoption is affected by environmental concern, indirectly, and its effect is positively related to attitude, perceived value and innovation convenience. However, the collective outcome of Knowledge sharing, Response and Interaction plays as a moderator which has a direct effect on the consumer’s intention and the actual adoption of EVs. The elements of the extended

TPB model, in part, arbitrates the effects of a consumer's eco-friendly concern on his/her intention towards adoption.

Moreover, it is also important to highlight that the environmental concern and adoption intention are not directly proportional. In fact, the intention of adoption depends on the impacts of eco-friendly concern and the parts of the extended TPB model. This literature review is very useful and comprehensive. The finding of the relevant information is useful for governments and vehicle dealers. This research has concluded that consumer attitude towards adopting EVs is positive when impacted by environmental concerns. In other words, if the consumer has more concern towards the environment, they will have more attraction towards adopting EVs.

In general, with respect to the marketing angle, a vehicle seller shows and launches EVs; by this, they enhance the popularity of the brand as well as the consumer's environmental concern and emphasizes the awareness of eco-friendly environmental benefits towards the adoption of EVs. Consumers giving importance to societal pressure or other pressures inserted by people or primary adopters are one of the most significant factors of their intentions towards adoption. By supporting the research, we will stand a chance of developing this further with the theoretical frameworks of emotions in psychology, consumer behavior, and ethics. Whereas, there is a need for proper communication memoranda. Instruction and strategies can generate explicit intellectual and emotive replies in consumers and, therefore, affect their choices and behaviors. Accepting the reasoning and emotional reactions can assist marketing authorities and lawful agencies to collaborate in their communication, instruction, and strategies to be able to overcome more obstacles towards the adoption of the EV. The assessment of the EV of these participants and initial adopters bears a vital impact on the customer's adoption intention. So, the Government sector and sellers should come forward in order to enhance the early adopters' evaluation of their EV. Though, there is a major initiative that has been carried out by the policy maker such as EV Club and the Word-of-Mouth (WOM) marketing policy that may be the two vital and dominant methods for the increment of SN that consumers observed. Hence, this paper tries to fill the gap by proposing a conceptual framework by tailoring the sustainability of the environmental concern.

The proposed conceptual framework has theorized the significant relationship amongst the variables towards the proper adoption of EVs as well as environmental sustainability and opens a new path for future research to empirically prove the hypothetical relationship amongst the variables. It is needless to say that there are a few limitations in this review study. The domain of preference as well as attitude studies is a huge one, and the authors here only studied the findings that explicitly related to the EV. Furthermore, we have tried to summarize the complex and extensive literature in a brief way, which has not permitted an exhaustive assessment of all the current arguments. However, our dedicated study regarding consumers' preferences and attitudes towards EVs has sorted out numerous prevailing gaps in information whilst recognizing a number of encouraging procedural avenues and approaches for the upcoming research thrust. The prevailing doubts regarding the improvement of the attitudes towards fuel cells as well as hydrogen-powered vehicles in the upcoming years seem to warrant a continued research effort in this field.

This study makes an important contribution by highlighting the criticality of taking care of the earth from an EV usage perspective. Against this background, the underlying factors uncovered here have bridged a significant knowledge gap to gain a better understanding of the critical problems undermining EV adoption and potentially enable the country to devise

long-term strategic measures to enhance the operation of EV. Thence, to steer an EV transformation, the fusion of people, system, and tools are needed to improve EV adoption rates so that pollution can be reduced.

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