A Quantitative Analysis of Consumer Intentions to Adopt Electric Vehicles in Vietnam

Yi Hsu
Associate Professor
Department of Business Administration
National Formosa University, Huwei, Yunlin, Taiwan

Thi Bich Thuy Pham
Graduate Student
Department of Business Administration
National Formosa University, Huwei, Yunlin, Taiwan

Christian Hartauer
Graduate Student
Department of Business Administration
National Formosa University, Huwei, Yunlin, Taiwan

Widhi Jati Kusumah
Graduate Student
Department of Business Administration
National Formosa University, Huwei, Yunlin, Taiwan

Abstract

The objective of this study is to develop a structural model that can be used to explain consumer adoption intentions for electric automobiles in Vietnam. This research investigated the following independent variables: attitudes, subjective standards, perceived behavioral control, and personal moral norms, vehicle performance, purchase price, charging infrastructure, government incentives, environmental concern, and product knowledge. Between June 4, 2022 and August 30, 2022, we received 327 replies to our online survey. Before being included to the database, the collected surveys undergo a second screening. Due to the fact that all observable variables had identical values, eight replies were considered invalid. In the end, 319 replies satisfied the requirements of this research. This study used the Linear Structural Relation Model (LISREL) and the regression model to test hypotheses and create the research model. According to the data, R^2 is 0.626, Adjust R^2 is 0.614, and there is a perfect match in the LISREL model with X^2/df close to 0.000 and p-values close to 1.000. When testing hypotheses, both models yielded identical results: Only subjective needs, charging infrastructure, and product knowledge have no substantial effect on the adoption intentions of electric vehicles among consumers. Other independent variables strongly impact customers' adoption intentions for electric vehicles. This paper also contains recommendations for the electric vehicle industry, government, and future researchers.

Keywords: Attitude, Subjective Norms, Perceived Behavioral Control, Personal Moral Norms, Vehicle Performance, Purchase Price, Charging Infrastructure, Government Incentives, Environmental Concern, Product Knowledge, Consumer Intentions, Regression, LISREL

Introduction

Research background

Vietnam's air pollution is caused by the transportation sector's rising alarming energy consumption. The increasing depletion of fossil fuels, the issue of environmental contamination, and the prospect of a worldwide ecological disaster have been and continue to pose the greatest challenge to mankind (Le, Nguyen & Do, 2021). According to the annual Air Quality Index (AQI) study, Vietnam ranks third in Southeast Asia and is one of the world's 36 most polluted countries (AQI, 2021). Notably, the quantity of dust in Hanoi and Ho Chi Minh City is continually increasing, causing the air quality index to remain frighteningly high over the WHO's normal emission limit (AQI, 2021). In addition, Vietnam's EPI is only slightly higher than Myanmar's and marginally lower than the regional average of the eleven Southeast Asian nations (40,4) (EfD, 2020).

The economical growth of Vietnam is significantly influenced. Air pollution is a "silent killer" when 92 percent of the world's population lives in a location with air quality below WHO limits (WHO, 2016). Vietnam is the sixth most susceptible nation in the world to climate change (UNICEF, 2020).

Over 74% of the population is impacted by climate change, with a disproportionate impact on the poorest people, who lack the resources to recover from substantial losses caused by natural disasters (UNICEF, 2020). More than 60,000 Vietnamese have died from air pollution-related ailments, such as cardiovascular disease, stroke, lung cancer, chronic obstructive pulmonary disease, and pneumonia (WHO, 2018). Vietnam presents a significant challenge in terms of balancing consumption and environmental quality. Many cities experience issues with air pollution and energy consumption due to their populations of above 98 million (Worldometer, 2022), 2.71 million new motorbikes, and 296.634 autos (BVSC, 2021). Electric vehicle markets in developing Asian countries such as Vietnam are extremely promising (Le et al., 2021). Since public transportation is necessary in Vietnam, personal vehicles are the primary mode of transportation due to their compatibility with current traffic infrastructure and the majority of people's habits. Vietnam, like many other countries, has environmental protection and sustainable development concerns (Nguyen, Nguyen & Hoang, 2019; Nguyen, Nguyen, Nguyen, Trinh, Tran & Cao, 2020). Vietnam is making substantial efforts to address climate change in a number of ways, including the adoption of electric cars to replace gasoline-powered vehicles. More than 1,000 hybrid and plug-in hybrid electric vehicles were on the road in 2021 (VR, 2022), and COP26 participants pledged to support global measures to tackle climate change (UNDP, 2021). However, the outcomes were not as anticipated, and this conversion remains susceptible to various internal difficulties.

Research purpose

Numerous studies on the adoption of electric vehicles have concentrated on industrialized and western countries, with much too little attention devoted to Southeast Asian countries, notably Vietnam, which has one of the region's most polluted cities. Vietnam is the poorer Southeast Asian country, having a GDP per capita that is much lower than the GDP per capita of other Southeast Asian nations previously evaluated (WorldBank, 2021). In developing Asian nations such as Vietnam, adoption rates of electric vehicles are often low (Statista, 2021; VR, 2022). Numerous research suggests that different nations have unique challenges when it comes to adopting new commodities, owing to each country's unique culture, demographics, and social structure. Electric vehicles are a novel concept in Vietnam; also, electric vehicles are an interesting subject to explore in terms of environmental and energy issues, as this may assist to increase consumer acceptability of electric vehicles, which in turn helps to increase purchasing intention. As a result, it is prudent to examine components from a certain country. The purpose of this study is to develop a structural model that can be used to explain consumer intentions to adopt electric vehicles in Vietnam.

Research structure

The following chapters summarize the findings of this study. The first chapter will provide an overview of the research, outlining the study's aims and context. The second chapter will offer some basic background material on the theoretical foundations for the goal of electrifying cars. The second chapter will offer some basic background material on the theoretical foundations for the goal of adopting electric cars. The third chapter will discuss the methodology that was used in this investigation. This chapter details the research process, from data collection to data analysis. The most critical aspect of the study is determining; chapter four will provide data analysis and appraisal based on real outcomes related to the theoretical framework. The last chapter will review the preceding sections, including academic and managerial implications, limitations, and recommendations for more research on electric cars in Vietnam.

Literature Review

Theory of Planned Behavior (TPB)

The theory of planned behavior (TPB) is an enlarged version of the reasoned action theory (TRA) (Ajzen, 1991). TPB is required by the TRA's limits in dealing with activities over which people have only limited volitional control. The theory of planned behavior (TPB) was distinguished from the theory of spontaneous behavior (TRA) by the addition of a new independent variable - perceived behavioral control. Ajzen & Fishbein (2000) assert that TPB makes three conceptually independent assumptions about intention: attitude toward the conduct, subjective standards, and perceived behavioral control. TPB makes the generally accepted and commonly utilized assumption that behavior may be anticipated or explained by intentions to do that activity.

TPB's advantages have been shown empirically. It has undoubtedly become one of the most widely accepted theories in social psychology, having been utilized to predict consumer behavior across a range of study perspectives. Additionally, TPB can broaden the standard since it is not generic; rather, it is adapted to the unique objectives of each research (Wang, Fan, Zhao, Yang,& Fu, 2016). Mohamed, Higgins, Ferguson & Kanaroglou (2016) used the theory of planned behavior (TPB) to describe the behavior of electric automobiles in Canada. As a result, this study uses TPB to examine Vietnamese consumers' use of environmentally-friendly electric vehicles.

Singh, Singh & Vaibhav (2020) stated that demographic, situational, contextual, and psychological aspects all play a significant influence in determining the desire to embrace electric vehicles. Psychological considerations are critical among these four elements because they have a direct impact on adoption intentions and the potential to modulate the effects of other aspects(Lai, Liu, Sun, Zhang,& Xu, 2015). Additionally, prior research has shown that a range of psychological variables impact buyers' aspirations to purchase electric automobiles. As a consequence, several studies have been conducted that rely heavily on the theoretical extension of the TPB model to explain why consumers' intentions to adopt electric cars may vary owing to changes in attitudes, subjective standards, perceived behavioral control, and personal moral norms.

Attitude

The attitude of the client toward adoption is critical in describing human behavior. The issue of how to quantify attitude is equally intriguing. As described by (Ajzen, 1991), attitude refers to a person's judgment or appraisal of an action in terms of their predisposition to react positively or negatively. This may be regarded as the more the desire to do certain activities that impact a product's or service's adoption, the higher the product's or service's positive assessment (Ajzen, 1991).

Although the notion of green consumerism dates all the way back to the 1960s (Kim, Yeo, Sohn, Rha, Choi, Choi,& Shin, 2012; Straughan & Roberts, 1999), it has lately garnered a great deal of attention (Haws, Winterich & Naylor, 2014; Leonidou, Katsikeas & Morgan, 2013; Peloza, White & Shang, 2013). Numerous research on the attitude-behavior interaction in the context of green goods have been undertaken. Singh et al., (2020) combined earlier research to demonstrate that consumers' intentions cannot be accurately measured or anticipated without taking their attitudes into account. Additionally, a poll of Taiwanese customers' buying intentions for ecologically friendly automobiles revealed. According to (Dutta & Hwang, 2021), people have a favorable attitude toward acquiring electric automobiles due to their ecological trust. As a consequence, customer views strongly influence their willingness to embrace electric automobiles. As a result, the following hypothesis is formed.

H1: In Vietnam, consumer attitudes toward electric vehicles are positively influenced on consumer intentions to adopt them.

Subjective norms

Subjective norms are associated with the perception of social pressure when doing a certain activity. It suggests that the stronger the social pressure exerted by the government and the social environment, both of which are significant, the greater the likelihood of an individual participating in specific behaviors (Ajzen, 1991). If your family expects you to be a physician, lawyer, or businessman, the pressure to comply becomes a motivator. To study this aspect, begin by identifying significant social influencers in society, such as parents, more reputable individuals, and friends.

Asadi, Nilashi, Samad, Abdullah, Mahmoud, Alkinani & Yadegaridehkordi (2021)explored subjective norms that impact behavioral intention since customers' expectations play a significant role in their decision-making. By the end of 2021,Dutta & Hwang (2021)demonstrated that subjective norms are crucial for the construction and development of positive intention, which enables consumers under social pressure to conform to others' expectations. As a result, the following theory is advanced:

H2: Subjective standards have a positive effect on customer inclinations to purchase electric automobiles in Vietnam.

Perceived behavioral control

Perceived behavioral control refers to how easy or difficult it is for a person to do an activity. This factor evaluates people's judgments of the difficulty or convenience they perceive while adopting or employing a technology, product, or service based on their prior experiences (Ajzen, 1991). This implies that the more confident a person is in his or her capacity to manage specific conditions, as shown by resource availability and opportunity, the greater the perceived ability to regulate certain behaviors (Ajzen, 1991).

Additionally, Dutta & Hwang (2021) indicated that customers with better behavioral control are more likely to embrace a green product such as an electric car than those with less behavioral control. Additionally, Gunawan Redi, Santosa, Maghfiroh, Pandayaswargo,& Kurniawan (2022) recognized that persons with a high degree of financial control may be better equipped to purchase and use electric automobiles in the future. As a result, the following hypothesis is formed:

H3: In Vietnam, perceived behavioral control has a positive effect on customer intentions to embrace electric vehicles.

Personal moral norms

Personal standards are feelings of moral obligation to engage in pro-social behavior that is consistent with one's own views (Biel & Thøgersen, 2007). Personal norms have a significant influence on behavioral intentions.

When personal standards are activated, a personal moral obligation is created that compels the individual to do pro-environmental acts (Schwartz, 1977). For example, according to a research by He, Zhan & Hu (2018), personal moral values have a significant role in customers intents to embrace electric automobiles. Additionally, Jansson (2011)found that adopters of alternative fuel vehicles had higher personal standards than non-adopters. The inclusion of moral standards explains unequivocally why the behavioral intention model exhibits more variety (Armitage & Conner, 2001; Wang et al., 2016). As a result, the following hypothesis is formed:

H4: In Vietnam, personal moral standards have a positive effect on customer inclinations to embrace electric automobiles.

Vehicle performance

Technophiles, or those with a strong interest in technology, are particularly impacted by new technologies (Abbasi, Johl, Shaari, Moughal, Mazhar, Musarat, Rafiq, Farooqi,& Borovkov, 2021). They are likely to be early adopters of electric cars because they feel they perform better than conventional automobiles (Egbue & Long, 2012). Additionally, Egbue & Long (2012) noted that in a study of prospective consumers' electric car intent, performance characteristics such as vehicle safety, reliability, and range were identified as a barrier to adoption. Dutta & Hwang (2021) concluded that vehicle performance, notably driving range, safety, and reliability, are critical factors in determining whether or not to purchase an electric car.

According to Thananusak, Rakthin, Tavewatanaphan,& Punnakitikashem (2017), Thais put a high premium on the performance of electric cars while paying little attention to its infrastructure and economic benefits. Thananusak et al., (2017) add to the evidence that Thais value electric vehicle performance in terms of speed and acceleration, as well as driving range per charge, safety, and reliability. Thais are especially concerned about the safety of electric cars in Thailand's congested traffic. They are concerned that their EV would run out of juice in a heavily populated area such as Bangkok. When it rains, if the electrical circuits and systems of electric vehicles can tolerate the wet, or whether an EV can drive over puddles. Vietnam is very equivalent to Thailand in terms of climate and socioeconomic circumstances; consequently, it can be believed that the performance of electric cars indicates the desire to adopt electric vehicles in Vietnam. As a result, the following hypothesis is formed:

H5: Vehicle performance has a positive effect on customer inclinations in Vietnam to embrace electric automobiles.

Purchase price

The price at which you sell a product has a significant impact on consumer behavior. Consumers are worried about current product pricing and want to purchase items at a lower price (Balle, 2019), they also routinely review their product and service experiences in terms of the money they spend (Varki & Colgate, 2001). Additionally, when consumers make purchasing choices, they compare the prices of alternative energy cars to conventional automobiles (Dumortier, Siddiki, Carley, Cisney, Krause, Lane, Rupp,& Graham, 2015). Simultaneously, targeted reductions in operating and maintenance costs aided consumers' decision to switch to electric cars. While Zeng, Luo, Zhang,& Liu (2020) argue that the greater cost of electric automobiles is mostly due to the high cost of battery packs. Shetty, Shetty, Rodrigues, Naik, Maddodi, Malarout,& Sooriyaperakasam (2020) argue that the cost of backup power is a significant barrier to vehicle adoption. Additionally, according to a Dutta & Hwang study conducted in 2021, electric car consumers perceive that eco-friendly automobiles are more expensive than conventional ICE vehicles. As a result, the following hypothesis is formed:

H6: In Vietnam, purchase price has a beneficial effect on customer inclinations to embrace electric vehicles.

Charging infrastructure

The problem of charging infrastructure and batteries is one of the most significant impediments to EV adoption at the moment (Eccarius & Lu, 2020). Due to poor performance, consumers are worried about the availability of charging infrastructure. For instance, clients may have charging difficulties at all locations due to incompatibility with all infrastructure (Hardman, Shiu, & Steinberger-Wilckens, 2016), or they may encounter charging difficulties in apartment complexes (Maghfiroh, Pandyaswargo,& Onoda, 2021). According to a study performed in India by (Jayasingh, Girija,& Arunkumar, 2021), it is difficult for owners of petrol two-wheelers to transfer to electric two-wheelers if the charging method is complex, takes a long time, and the availability of charging stations is unknown. As a result, the following hypothesis is formed:

H7: In Vietnam, charging infrastructure has a positive influence on customer intentions to embrace electric cars.

Government incentives

According to Xue, Zhou, Wu, Wu,& Xu (2021), a variety of government financial and non-financial policies,

including economic reimbursements, tax exemptions (VAT, vehicle registration fees, annual road tax, preferential lending program, and free parking, have a favorable effect on the global electric vehicle market share.

However, Wang, Tang, & Pan (2019) demonstrate that, although financial incentives and information support policies have a large impact on EV intention, they are not as potent as convenience policy measures in influencing customer purchase choices. Similarly, a research done in Malaysia by Sang & Bekhet (2015) found that government incentives have a significant role in the decision to embrace electric vehicles. Electric vehicles are still considered a technical development in Nepal. If not implemented effectively, electric car rules have been shown to act as a barrier to acquiring electric vehicles. As a result, the Nepalese government is being pressed to deploy a variety of measures, such as public awareness campaigns and tax rebates, to aid in the adoption of electric cars (Adhikari, Ghimire, Kim, Aryal,& Khadka, 2020). As a result, the following hypothesis is formed:

H8: In Vietnam, government incentives have a positive influence on customer aspirations to embrace electric vehicles.

Environmental concern

Environmental concern denotes an awareness of and readiness to handle environmental challenges on a broad scale (Schuitema, Anable, Skippon,& Kinnear, 2013). Individuals who are more concerned about the have a powerful incentive to alter their current behavior in favor of more environmentally friendly behavior (Malik & Yadav, 2021; Poortinga, Steg,& Vlek, 2004). Additional evidence indicates that environmental concerns impact Macau's demand for electric goods (Lai et al., 2015). Hartmann, Eisend, Apaolaza,& D'Souza (2017) also conducted a meta-analysis to examine the relationship between environmental concerns and environmentally friendly behavior, determining that the mean coefficient value between environmental concerns and environmentally friendly behavior is between 0.23 and 0.35.

Environmental concerns have been shown to have a significant influence on the purchase of a new commodity. According to Afroz, Rahman, Masud, Akhtar, & Duasa (2015), environmentally concerned buyers are more inclined to acquire electric automobiles. This is in line with Kimcontend that expanding the electric vehicles market necessitates targeting consumer groups that are open to environmental innovations and have a proclivity to respond to environmental issues. As a result, the following hypothesis is formed:

H9: Environmental concern has a positive effect on customer intentions in Vietnam to use electric automobiles.

Product knowledge

Throughout the consumer research process, product knowledge has received much attention(Chang, 2004). According to the researchers, a consumer's degree of product knowledge influences their product selection (Cheng, Ouyang & Liu, 2020; Lin & Chen, 2006). Market failure may occur when consumers lack adequate understanding about a product. According to Higueras-Castillo, Liébana-Cabanillas, Muñoz-Leiva & García-Maroto (2019), a lack of consumer awareness has a harmful effect on electric car acceptance. As according to Higueras-Castillo et al., (2019)'s survey results, over 70% of participants rated their knowledge factors between 1 and 4. On the other hand, Cheng et al., (2020) believes that providing consumers with as much information as possible does not necessarily have a beneficial influence on their behavioral intentions. As a consequence, it is vital to provide reliable information to help in the transition to commodities such as electric automobiles.

H10: In Vietnam, product knowledge has a positive influence on customer intentions to use electric automobiles
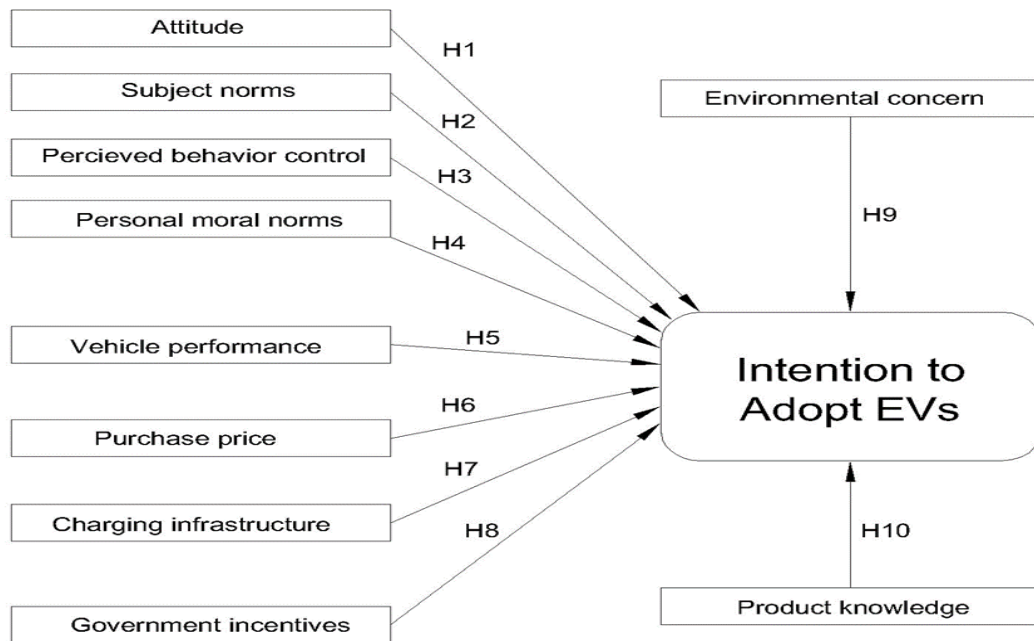
Figure 2.1 Structural model of consumer intentions to adopt electric vehicles in Vietnam.

Research Methodology

Variable Operationalization and Distributions

This research proposes as independent variables attitude, subjective norms, perceived behavioral control, personal moral norms, automobile performance, purchase price, charging infrastructure, government incentives, and product knowledge. These independent variables influence the dependent variable, which is the desire to embrace electric cars.

Table 3.1 Variable Operationalization

Factors	Variables	Definition	Author (year)
Psychological factors	Attitude	Customers' intents cannot be accurately evaluated or forecasted without taking their attitudes into account.	Singh et al., (2020)
	Subjective norms	Subjective norm is essential for the construction and development of positive intention, which enables consumers under social pressure to seek to conform to the expectations of others.	Dutta & Hwang (2021)
	Perceived behavioral control	Those with stronger behavioral control are more inclined to embrace environmentally friendly products, such as electric automobiles, than those with poorer behavioral control.	Dutta & Hwang (2021)
	Personal norms	Personal norms are feelings of moral obligation to engage in pro-social behavior consistent with one's own views.	(Biel & Thogersen, 2007)
Situational factors	Vehicle performance	When considering whether or not to purchase an electric car, vehicle performance, including driving range, safety, and reliability, are crucial factors.	Dutta & Hwang (2021)
	Purchase price	When making purchasing decision, consumers compare the expenses of alternative energy cars to those of conventional automobiles.	Dumortier et al., (2015)

	Environmental concern	Environmental concern refers to a broad understanding of environmental concerns and a desire to address them.	Schuitema et al., (2013)
Contextual factors	Charging infrastructure	Currently, charging infrastructure is one of the greatest obstacles to EV adoption.	Eccarius & Lu (2020)
	Government incentives	Various government financial and non-financial measures, including economic reimbursements, tax exemptions (VAT, car registration fees, yearly road tax, preferred making loans plan, and free parking), have had a positive impact on the global electric vehicle market share.	Xue et al., (2021)
	Product knowledge	The extent of consumer product knowledge influences their product selection.	Cheng et al., (2019)

Data Collection and Questionnaire

Based on available literature, the questionnaire has sections. Both portions of the questionnaire questions were designed to be closely related to the model in order to collect the most exact data necessary to accept or reject the proposed model's testing hypothesis. The first segment consists of 45 questions about buyers' attitudes toward electric cars and their intentions to purchase. In the last step of the questionnaire, we arrange 9 demographic questions and 45 questions directly connected to consumer desire to adopt electric cars for multi-dimensional analysis in order to learn more about the problem and assess the quality of the collected data. All scale components were evaluated using five-point Likert scales ranging from (5) strong agreement to (1) severe disagreement (Harpe, 2015). In addition, the questionnaire was first constructed in English to guarantee the coherence and consistency of the questions (Appendix I), and was then translated into Vietnamese to make it more suitable for Vietnamese people. Some questions were eliminated based on the best version's reliability and validity, and the pretest was modified once more before the final official questionnaire was sent and a large-scale survey was conducted.

Online survey research was conducted to acquire insight into customer adoption intentions for electric cars in Vietnam and to validate the suggested conceptual model. Due to time and resource constraints, a non-probability sampling technique using a convenience sample method was adopted to gather data in Vietnam (Nguyen, 2021). The respondents are Vietnamese adults who have experience with or are considering purchasing a car. Google Forms were used to administer structured and coded online questionnaires to two significant Vietnamese automotive groups in order to collect data for the research. Otofun in Hanoi has around 157,000 members, whilst Otosaigon in Ho Chi Minh City has over 149,000 members. We hope that individuals from these regions will not only have a sophisticated grasp of autos and electric vehicles, but may also be potential electric vehicle purchasers. Consistent with past research on the buying intentions for electric vehicles in Vietnam (Nguyen, 2021). In addition, to augment the research data, we distributed a Google Form to anybody interested in electric vehicle research.
Data Analysis

Descriptive Statistics

To adequately synthesize data, descriptive statistics explain the connections between variables in a population. According to Kaur, Stoltzfus, and Yellapu (2018), descriptive statistics are an essential component of initial dataset analysis while doing research, since they provide a framework for comparing variables using inferential statistical tests. Therefore, independent examination of source data is essential to achieve the study goals and is regarded as acceptable research practice (Huebner, Vach,& le Cessie, 2016).

In this research, the descriptive statistical approach is used to characterize the acceptance of electric automobiles by Vietnamese customers based on questionnaire responses, as well as the fundamental features of the gathered data, including gender, age group, income, home type, location. Consequently, we get straightforward summaries of the sample and the scales. In conjunction with basic graphical analysis, this study provides the foundation of all quantitative data analysis. In order to describe and comprehend the distribution features of a raw data table, the frequency distribution and other sample characteristics must first be tabulated and computed.

Regression Analysis

Regression analysis is a powerful and widely used quantitative research method for determining the relationship between variables (Karamagi, 2021). The beta coefficient (β), t-value, p-value, and R^2 in regression analysis indicate how well a model can predict the acquired data and whether or not the hypotheses should be accepted. The bigger the adjusted R^2 score, the more accurate the model's predictions (Garza-Ulloa, 2018). If the P-value is less than 0.05, the regression model is appropriate for inquiry; variables with a p-value more than 0.05 should be excluded (Garza-Ulloa, 2018). Moreover, the variable with the largest beta coefficient (β) is the most important variable (Garza-Ulloa, 2018). In this study, regression analysis is used to evaluate the research model in order to determine how the degree influences the variables. Linear Structural Relational Model (LISREL)

LISREL is a software that may be used for statistical analysis, factor analysis, and structural equation model calculation (Schumacker, 2004). The LISREL method is typically used for evaluating covariance matrices and applying correlation and covariance to observable data (Xia & Yang, 2019). In addition, LISREL, such as the chi-square test (X^2/df) closer to zero indicating a better fit (Suhr, 2006), goodness of fit index (GFI) > 0.90 indicating a good model fit (Finch, 2020), and root mean square error of approximation (RMSEA) 0.08 indicating a reasonable fit, can be used to assess the model's fit (Hu & Bentler, 1999). Moreover, when using LISREL testing to determine the t-value, if the t-value is greater than 1.96 or greater than -1.96, the association between the two variables is significant. Recent research has used the LISREL model in a variety of domains, such as the relevance of social capital on knowledge management (Rezaei, Jafari-Sadeghi, and Bresciani, 2020), and the investigation of customers' perceptions and actions on corporate social responsibility (Hsu & Bui, 2022). Therefore, the LISREL approach should be used as the last step of method testing to determine if the model hypotheses are valid and how many numbers they support or do not support.

Result

Demographic Statistics

From June 4, 2022, through August 30, 2022, we received 327 replies to an online survey. Before putting the collected surveys into the database, they are re-screened. Due to the fact that all observable variables had the same value, eight replies were ruled unsuccessful. In the end, 319 replies satisfied the requirements of the present research. Table 4.1 illustrates how the demographic parameters of the collected data vary amongst respondents. Listed below are the specific survey findings. 166 male respondents account for 52.04% of the total 319 responses, while 153 female respondents account for 47.96%. Only 3.7% (12 samples) of respondents are above the age of 50, with the remainder predominantly consisting of young individuals. Single respondents outnumber married, divorced, and widowed respondents by a margin of 59.87% (191 samples) to 35.42% (113 samples), 4.08% (13 samples), and 0.63% (2 samples), respectively. Regarding occupation, we determined that office workers made up the large majority with 42.32% (135 samples). Only 3.77 percent (12 samples) of respondents possess a doctoral or professional degree, whereas 59.87% (191 samples) hold a bachelor's degree. Less than USD $300 accounted for up to 19.75% (63 samples), USD $301 to USD $650 accounted for the largest proportion (35.74%) (114 samples), USD $651 to USD $1000 accounted for 20.69% (66 samples), USD $1001 to USD $1300 accounted for 10.66% (34 samples), and more than USD $1300 accounted for 13.16%. (42 samples). The percentage of urban respondents was 83.70% (267 samples), which was more than four times that of rural residents (16.3%) (52 samples). The current database reveals that respondents with the housing type (townhome) comprise the largest proportion at 33.23% (106 samples), while condos comprise the smallest proportion at 25.39% (81 samples), followed by apartments and single-family houses at 27.90% (89 samples) and 25.39% (81 samples), respectively. When asked whether they plan to buy an electric car, 58.62% (187 samples) said that they most likely will.

Table 4.1 Demographic Profile of the Participants (N=319)

Demographic	Variables	Freq.	(%)
Gender	Male	166	52.04
	Female	153	47.96
Age	From 18 to 30	227	71.16
	From 31 to 40	60	18.81
	From 41 to 50	20	6.27
	From 51 to 60	9	2.82
	Older than 60	3	0.94
Marital status	Single	191	59.87
	Married	113	35.42
	Divorced	13	4.08

	Widow	2	0.63
Occupation	Student	54	16.93
	Office worker	135	42.32
	Civil servant	37	11.6
	Self-employed	48	15.05
	Homemaker	6	1.88
	Retired	4	1.25
	Other	35	10.97
Education	High school diploma	64	20.06
	Bachelor's degree	191	59.87
	Master's degree	52	16.3
	Doctoral or professional degree	12	3.77
Average monthly income	Less than USD $300	63	19.75
	From USD $301 to USD $650	114	35.74
	From USD $651 to USD $1000	66	20.69
	From USD $1001 to USD $1300	34	10.66
	More than USD $1300	42	13.16
Area	City	267	83.7
	Countryside	52	16.3
Housing type	Townhome	106	33.23
	Apartment	89	27.9
	Condos	43	13.48
	Single-Family House	81	25.39
Going to get an electric vehicle	Not Likely	128	40.13
	Likely	187	58.62
	I just had an electric car	4	1.25

Regression Analysis and LISREL Testing

Regression Analysis

Conduct a regression analysis on 319 responses to determine how the weights of Attitude (AT), Subjective norms (SN), Perceived behavioral control (PB), Personal moral norms (PM), Vehicle performance (VP), Purchase price (PR), Environmental concern (EC), Charging infrastructure (CI), Government incentives (GI), and Product knowledge (PI) impact customers' willingness to use vehicles in Vietnam. The outputs of the regression model are given in Table 4.2.

Table 4.2   Regression Model

Model Summary				
	R	R²	Adjusted R^2	p-value
Eq.	0.791	0.626	0.614	0.000
		Coefficients (β)	t-value	p-value
Dependent variable IA	(Constant)	-0.238	-1.270	0.205
	AT	0.168	4.776	0.000
	SN	0.001	0.040	0.968
	PB	0.108	3.295	0.001
	PM	0.073	2.208	0.028
	VP	0.214	4.982	0.000
	PR	0.090	2.301	0.022
	CI	0.089	1.844	0.066

	GI	0.200	3.860	0.000
	EC	0.146	3.097	0.002
	PK	0.047	1.231	0.219

Consider table 4.2, where the regression equation has $R^2 = 0.626$, Adjusted $R^2 = 0.614$, and p-value = 0.000; hence, the established regression equation is generally applicable. The equation for regression is derived as follows:

IA=	-2.380	+ 0.168 x AT	+ 0.001 x SN	+ 0.108 x PB	+ 0.073 x PM	+ 0.214 x VP
	(-1.270)	(4.776)	(0.040)	(3.295)	(2.208)	(4.982)
	(0.205)	(0.000)	(0.968)	(0.001)	(0.028)	(0.000)
		+ 0.090 x PR	+ 0.089 x CI	+ 0.200 x GI	+ 0.146 x EC	+ 0.047 x PK
		(2.301)	(1.844)	(3.860)	(3.097)	(1.231)
		(0.022)	(0.066)	(0.000)	(0.002)	(0.219)

Analyzing the regression data, we found that Subjective norms (β = 0.168, p-value = 0.968), Charging infrastructure (β = 0.089, p-value = 0.066), and Product knowledge (β = 0.047, p-value = 0.219) had no influence on consumers' propensity to use automobiles in Vietnam. Consequently, H_2, H_7, and H_{10} are unsupported. On the other hand, willingness to utilize electric cars was positively influenced by attitude, perceived behavioral control, personal moral standards, vehicle performance, purchase price, environmental concern, charging infrastructure, and government incentives (β > 0 and p-value 0.05).

Table 4.3 Hypotheses Testing - Regression.

Independent variables	Dependent variables	Hypotheses	Coefficient (β)	p-value	Supported (Yes/No)
AT	IA	H1	0.168	0.000	Yes
SN	IA	H2	0.001	0.968	No
PB	IA	H3	0.108	0.001	Yes
PM	IA	H4	0.073	0.028	Yes
VP	IA	H5	0.214	0.000	Yes
PR	IA	H6	0.090	0.022	Yes
CI	IA	H7	0.089	0.066	No
GI	IA	H8	0.200	0.000	Yes
EC	IA	H9	0.146	0.002	Yes
PK	IA	H10	0.047	0.219	No
* Supported: Yes (β>0, P<0.05)					

LISREL testing

4.2.2.1   Covariance matrix

Table 4.4   Covariance Matrix of the Measure Variables.

	AT	SN	PB	PM	VP	PR	CI	GI	EC	PK	IA
AT	0.637										
SN	0.253	0.882									
PB	0.242	0.395	0.789								
PM	0.177	0.191	0.160	0.641							
VP	0.167	0.245	0.226	0.175	0.535						
PR	0.157	0.169	0.208	0.161	0.283	0.557					
CI	0.197	0.201	0.182	0.166	0.225	0.226	0.414				
GI	0.196	0.274	0.278	0.180	0.265	0.207	0.231	0.439			
EC	0.214	0.192	0.213	0.113	0.209	0.171	0.199	0.226	0.408		
PK	0.128	0.329	0.281	0.126	0.263	0.133	0.205	0.308	0.188	0.646	
IA	0.301	0.284	0.330	0.224	0.333	0.269	0.259	0.316	0.265	0.270	0.537

The covariance matrix illustrating the linear relationship between variables is shown in Table 4.4. All of the values in the matrix are positive, suggesting that the relationship between the variables is both expanding and linear.

4.2.2.2   Goodness of Fit Testing

Table 4.5   Goodness of Fit Statistics Measurement

| Fit measures	Reference values	Model value
x2/df	<3.00	0.000
p-value	>0.05	1.000
RMSEA	<0.08	0.000

The findings of Table 4.5 indicate that when LISREL is used to evaluate the model's fit, Chisquare ($\chi 2/df$) = 0.00, RMSEA = 0.000, and p-values = 1.00 are all very significant. The results demonstrated that the model is complete and that the fit is excellent.

4.2.2.3   Hypotheses Testing

All hypotheses, with the exception of, H_2, H_7, and H_{10} are supported. H_2 (Est. = -0.01, t-value = 0.34), H_7 (Est. = 0.08, t-value= 1.55), and H_{10} (Est. = 0.04, t-value = 0.95) were not statistically significant; therefore,H_2, H_7, and H_{10} were not supported. In contrast, H_1 (Est. = 0.18, t-value = 4.94), H_3 (Est. = 0.12, t-value = 3.33), H_4 (Est. = 0.07, t-value = 2.14, H_5 (Est. = 0.24, t-value = 5.15), H_6 (Est. = 0.08, t-value = 2.00), H_8 (Est. = 0.22, t-value = 3.77), H_9 (Est. = 0.15, t-value = 2.90) all are supported. The LISREL results are depicted in Tables 4.6 and Figures 4.1.

Table 4.6   Hypotheses Testing - LISREL.

Independent variables	Dependent variables	Hypotheses	Estimate value	T-value	Supported (Yes/No)
AT	IA	H_1	0.18	4.94	Yes
SN	IA	H_2	-0.01	-0.34	No
PB	IA	H_3	0.12	3.33	Yes
PM	IA	H_4	0.07	2.14	Yes
VP	IA	H_5	0.24	5.15	Yes
PR	IA	H_6	0.08	2.00	Yes
CI	IA	H_7	0.08	1.55	No
GI	IA	H_8	0.22	3.77	Yes
EC	IA	H_9	0.15	2.90	Yes
PK	IA	H_{10}	0.04	0.95	No
* Supported: Yes (Est. > 0, |t-value| ≥ 1.96)					
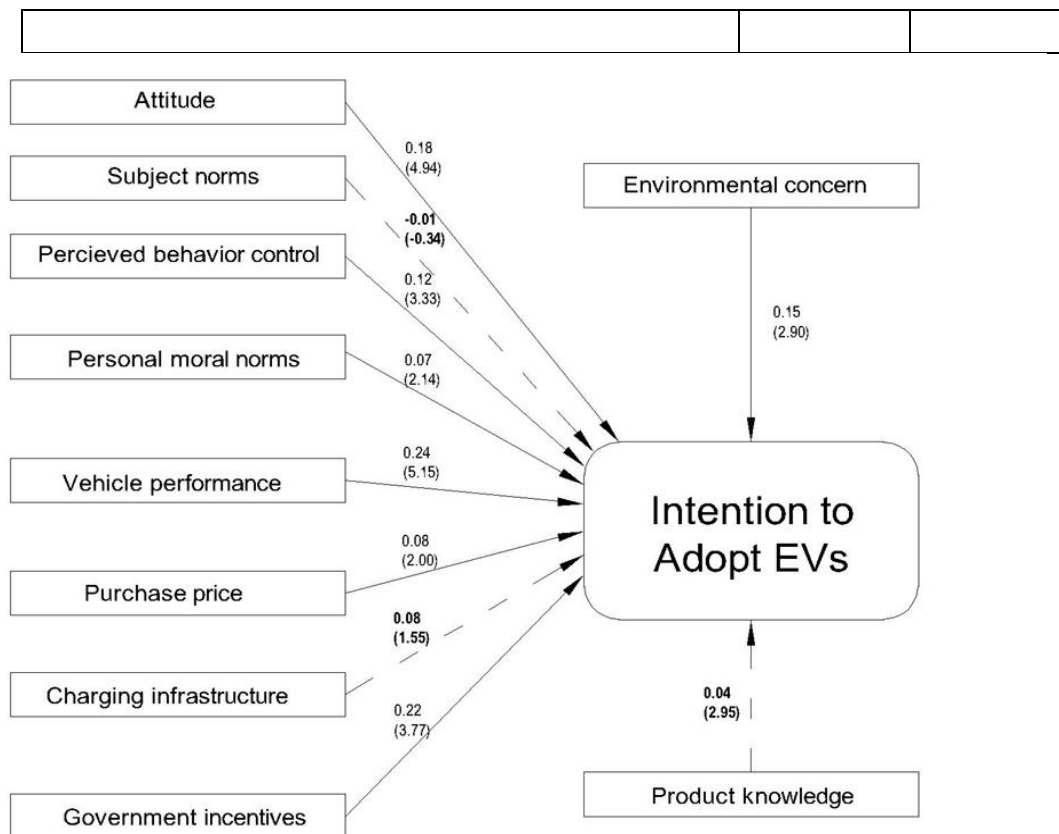
Figures 4.1   Hypotheses testing - LISREL.

Comparison of the Regression analysis and LISREL Model

A linear model was used in regression analysis to indicate the amount of influence of 10 independent variables and a dependent variable. In the regression model, the corrected R^2 value is 0.614. It may be determined that 61.4% of the independent factors in the research model contribute to the value of the dependent variable, with the rest due to the influence of variables outside the model or random error. In addition, the residual (estimate's standard error) is 0.455%, indicating a disparity of 45.5% between the observed and computed values. LISREL is a highly handy tool for aiding with the design of different connections. With Chi-square and RMSEA values near to zero and a p-value larger than 0.05, the LISREL model indicators in this research satisfy the requirements. Consequently, the results demonstrated that the model is accurate.

In terms of supporting or not supporting concepts, the similarities between the two methodologies are apparent when we compare them. H2, H7, and H10 are not accepted, but the other hypotheses are. The LISREL model performs better in terms of structural validity and residual than the regression model. As a consequence, the LISREL model was selected as the best and most appropriate way to serve as the foundation for the proposition and debate.

Conclusion and Discussion

Summary of Results

The primary objective of this study is to identify the factors that impact Vietnamese individuals' tendency to purchase electric vehicles. More than half of the participants (58.6%) are likely to become prospective buyers of electric vehicles in the near future, according to the data. The results of both the regression analysis and the LISREL model indicate that H_1, H_3, H_4, H_5, H_6, H_8, and H_9 are consistent with the assumptions. H_2, H_7, and H_{10} cannot exist. Thus, attitude (AT), perceived behavioral control (PB), personal moral norms (PM), vehicle performance (VP), purchase price (PR), government incentives (GI), and environmental concern (EC) provide substantial support, as opposed to subjective norms (SN), charging infrastructure (CI), and product knowledge (PK). Overall, vehicle performance is the most influential factor in the adoption of electric vehicles, followed by government incentives, attitude, environmental concern, perceived behavioral control, purchase price, and personal moral standard. The hypothesis results are shown in the following table.

Table 5.1   The Hypothesis Results

Hypotheses	Supported (Yes/No)
H_1: In Vietnam, consumer attitudes toward electric vehicles are positively influenced on consumer intentions to adopt them.	Yes
H_2: Subjective standards have a positive effect on customer inclinations to purchase electric automobiles in Vietnam.	No
H_3: In Vietnam, perceived behavioral control has a positive effect on customer intentions to embrace electric vehicles.	Yes
H_4: In Vietnam, personal moral standards have a positive effect on customer inclinations to embrace electric automobiles.	Yes
H_5: Vehicle performance has a positive effect on customer inclinations in Vietnam to embrace electric automobiles.	Yes
H_6: In Vietnam, purchase price has a beneficial effect on customer inclinations to embrace electric vehicles.	Yes
H_7: In Vietnam, charging infrastructure has a positive influence on customer intentions to embrace electric cars.	No
H_8: In Vietnam, government incentives have a positive influence on customer aspirations to embrace electric vehicles.	Yes
H_9: Environmental concern has a positive effect on customer intentions in Vietnam to use electric automobiles.	Yes
H_{10}: In Vietnam, product knowledge has a positive influence on customer intentions to use electric automobiles.	No

Discussion

As explained below, the results of our empirical investigation showed a number of significant conclusions that are consistent with previous findings, but also highly unexpected.

Our results indicate that buyers with a high level of environmental skepticism are inclined to purchase electric automobiles. In addition, this result is consistent with other earlier investigations by Asadi et al., (2021), Dutta & Hwang (2021), and Huang & Ge (2019). Thus, it seems that attitude has a positive influence on customer intentions to embrace electric cars in Vietnam.

While analyzing the collected data in Vietnam, we were unable to demonstrate the influence of subjective standards on consumers' propensity to use electric vehicles. It may be because the individuals in the present research are very young, ranging in age from 18 to 30 (71.2%), and social circles have minimal influence on their reported intention. Our results are consistent with prior study by Huang & Ge(2019)in Beijing, which found that subjective standards had no positive influence on customer intentions to embrace electric cars. In this scenario, it is possible to conclude that, in terms of creative thinking, social pressures on young people in Asia are not as severe as they formerly were. In this research, it was discovered that perceived behavioral control had a significant effect on consumers' pro-environmental behavior intentions. Furthermore, these findings corroborate previous research on the pro-environmental consumer behavior intention in various circumstances (Dutta & Hwang, 2021; Gunawan et al., 2022). People are more likely to purchase electric cars when they are confident in their choice and have the financial means to do so, according to them.

Though personal moral standards were shown to have a very little influence on prospective customers' intentions to purchase electric cars, they nonetheless played a substantial role in the adoption of electric vehicles. These results are consistent with those of He et al., (2018), and Wang et al., (2016). It is acknowledged that socio-psychological elements have a significant impact on an individual's obligation to engage in environmentally responsible conduct.

Consequently, attitudes, perceived behavior control, and personal moral norms are the most influential influences on consumers' purchasing intentions.

Similar to the findings of Thananusak et al., (2017), and Dutta & Hwang (2021), it seems that prospective buyers in Vietnam are highly driven by high-performance electric car goods. Vietnamese citizens, like Thais, put a high importance on the performance of electric vehicles. It should be mentioned that performance is the first and most essential consideration for prospective customers interested in purchasing an electric vehicle. When determining whether or not to adopt an electric car, performance aspects, notably driving range, safety, and reliability, and distinctiveness are crucial considerations.

According to the results of an empirical study conducted in Vietnam, the majority of respondents felt that the price, replacement battery, and maintenance costs of an electric car should pose a substantial obstacle to their adoption. These findings are consistent with those of Dutta & Hwang (2021), Shetty et al., (2020), and Zeng et al., (2020). 38% of the participants are not frightened to pay a price that is greater than the average automotive price in comparison to other Asian countries, despite the fact that Viet people believe the buying price of electric cars to be excessive (Deloitte, 2021). It was a fad in Vietnam for a group of early adopters to pay a booking fee of around 440 U.S. dollars to display electric car reservation tickets on social media (Reporting ASEAN, 2022). In examining the Vietnamese market, there is no exception to the buying price of adopting electric cars. The entire impacts of the desire for performance cars on the willingness to pay the premium price for electric vehicles and the intention to acquire electric vehicles in Vietnam were identical to those evaluated in prior research conducted in Thailand (Thananusak et al., 2017). According to this concept, firms are encouraged to fund the development of distinctive feature-performance automobiles to attract early adopters with a strong interest in technology who are willing to pay a premium for new technologies.

Unlike Dutta & Hwang (2021), and Jayasingh et al., (2021), there is no evidence of the influence of charging infrastructure on the adoption intention of electric vehicles in Vietnam. In instance, these results contradict a 2019 poll performed by Statista in Vietnam, which revealed that 65.28% of respondents believe a shortage of charging stations prevents them from considering purchasing an electric vehicle (Statista, 2019a). This means that consumer attitudes toward electric vehicles will be positive provided the requisite charging infrastructure is available. The only provinces in Vietnam where charging infrastructure is being constructed are Hanoi, Da Nang, and Quang Nam (Schröder, Iwasaki & Kobayashi, 2021)

In Vietnam, a lack of public charging infrastructure continues to impede the uptake of electric vehicles. With just 1086 charge stations in 2016, Vietnam's electric car infrastructure is glaringly inadequate (Schröder et al., 2021). Owners of electric scooters in Vietnam may represent the most potential use case for accelerating the electric vehicle transition, but many are uninformed of charging infrastructure and confused about it. Because electric scooters may be charged using any standard outlet, specialist charging infrastructure is not required (Schröder et al., 2021). In addition, the primary reason may be because some people assume that if they drive a short distance, they can charge their electric vehicles using solar panels on their roofs (Reporting ASEAN, 2022).
Thus, the charging station will have no effect on their decisions.

Government incentives increase the likelihood of adopting electric vehicles. These findings are consistent with the findings of Adhikari et al., (2020), Gunawan et al., (2022), and Xue et al., (2021). The Vietnamese government has just recently begun to examine and investigate the issue of electric transportation. The government has issued an order waiving electric car registration payments from March 2022 to February 2027 (Thuvienphapluat, 2022). Consequently, according to government incentives, people who feel the government is actively pursuing different incentives are more likely to embrace electric automobiles.

Environmental concerns have a positive influence on the purchase of electric vehicles, according to the conclusions of this research. Even though environmental concerns are not believed to have a significant impact, this finding closely aligns with the credible sources of Statista (2019b) with 92.74 percent of Vietnamese participants believing that the environmentally friendly nature of an electric vehicle is the primary reason to choose an electric vehicle over a conventional vehicle in 2019. The higher the concern for the environment, the bigger the demand for electric automobiles. Therefore, the Vietnamese populace might accept the notion of boosting transportation as a means of improving air quality. This may be a strength that the Vietnamese government and automakers may use to develop and expand the electric car sector.

Lastly, product knowledge has no positive influence on consumers' intentions to purchase electric vehicles. In this study, consumers have product knowledge about electric vehicles when they read electric vehicle newspapers, magazines, and forums, or when they have opportunity to engage with electric automobiles. These results are corroborated by the studies of Higueras-Castillo et al., (2019), and (Cheng et al., 2020). In addition, according to some credible records, the majority of Vietnamese believe there is a lack of knowledge regarding electric automobiles or that they are not acclimated to using new technology products such as electric vehicles (Le et al., 2021). In Vietnam, until November 2021, VinFast, a local manufacturer, successfully introduced two electric car models, VF e35 and VF e36. As a result, the Vietnamese public paid more attention to electric vehicles.

A lack of consumer product knowledge seems to have a negative impact on the spread of electric automobiles.

Theoretical contribution

There is presently a dearth of electric vehicle research focusing on the Vietnamese market. Therefore, this work may facilitate a substantial scholarly contribution in this area. First, this study expanded earlier research and supplemented references by offering a better knowledge of the desire to adopt an electric car and the extended TPB version studies from the standpoint of a Vietnamese consumer. Second, this study was conducted in Vietnam utilizing data gathered through an online survey. By comparing regression analysis to LISREL, this study provides a novel method for evaluating the research model.

Practical implications

This study's findings may be utilized to design a more effective plan to aid the Vietnamese electric car industry, the government, and especially managers and marketers.

Consistent with prior research, Vietnamese consumers place a high value on car performance, notably safety and driving range (Dutta & Hwang, 2021; Thananusak et al., 2017). People in Vietnam are concerned about the safety performance of electric cars under Vietnam's traffic conditions. They are especially concerned that their electric vehicle may run out of juice during rush hour in Hanoi and Ho Chi Minh City. Whether an EV can be driven in a climate with substantial annual rainfall and a tropical climate depends on the vehicle's longevity. In the meanwhile, information on electric car performance should not only be emphasized and transmitted to customers through the Internet, but it should also be delivered completely, openly, and honestly, without being exaggerated or presented in a manner that confuses the public (Cheng et al., 2020). Educating the general public on the significance of environmental effect, energy conservation, and electric cars, and providing customers with a better understanding of them. Moreover, the virtual procedures for purchasing electric vehicles are increasing rapidly (Deloitte, 2022). This shows that mass media have a significant impact on prospective consumers' adoption of electric vehicles. Therefore, electric vehicle makers must strengthen their collaboration with content producers in order to raise public awareness of electric cars. Aside from this, many individuals prefer in-person transactions (Deloitte, 2022). Most people prefer purchasing a vehicle from an authorized dealer. When thousands of customers lined up to test drive the VF 8 in Hanoi (Vietnamnet, 2022), waiting efforts were not met due to the overwhelming number of test drivers. Electric car manufacturers should organize electric car events in multiple locations to provide potential customers with more driving experience.

In addition, preparations should be made to conduct electric vehicle competitions at three of the top technological institutions in Vietnam, namely Hanoi University of Science and Technology, Ho Chi Minh University of Technology, and Da Nang University of Science and Technology. Giving instructors and students the chance to test-drive electric vehicles to get practical experience.

Therefore, optimism may provide further important knowledge and produce competent engineers for electric car industries in the future, or it may become a customer of electric vehicles.

The study's findings have practical implications that are particularly relevant for the execution of government policies. The government has the ability to establish purposeful policies that encourage citizens to switch from conventional to electric vehicles. In practice, the Vietnamese government has devised incentives to promote the use of electric vehicles, but national regulations remain limited and unpredictable (Schröder et al., 2021). Authorities may implement national policies such as encouraging electric car sales, tax exemptions and incentives (Kumar & Alok, 2020), reducing peak hour limits, eliminating parking fees, and permitting driving in bus-only lanes based on the experiences of other nations (Xue et al., 2021). Authorities in Hanoi and Ho Chi Minh City, Vietnam, need to consider allowing electric cars on the BRT route. Therefore, electric license plates may be green and have EV letters in front to differentiate them from other vehicle types. Residents who drive an electric vehicle may get preferential treatment as a result of legislative initiatives implemented across the nation, which might stimulate the growth of the Vietnamese electric vehicle market.

Although the data reveal that charging infrastructures have little effect on the buying intentions of Vietnamese consumers. To increase the use of electric cars, authorities must reevaluate their approach for achieving the total cost of ownership requirements and extend the charging network coverage. To increase public charging networks, Vietnam may also consider encouraging OEMs and charging network vendors to form stronger commercial relationships.

Limitations and Further Research

In addition to the acknowledged contributions of this research, there are a few shortcomings that must be addressed. First, in developing nations such as Vietnam, the presence of electric cars is still limited, and business and consumer understanding of these vehicles is poor. This may pave the way for future research on electric vehicles and related management and marketing strategies in Vietnam.

The second problem of the research is that it only examines the consumer's intentions and not their actions. Although there is a clear relationship between the goal and the action, this relationship may be affected by a number of circumstances. Future study is advised on the elements that influence customer behavior or the link between consumer intent and behavior. Lastly, since Vietnam's geographical location covers several cultural and economic regions, regional consumption patterns vary. This is also a limitation of the future problem that must be addressed. This limitation opens a new route for future study into the numerous cultural aspects of electric vehicle adoption in Vietnam.

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