THE INFLUENCE OF FACTORS AFFECTING INTENTIONS TO PURCHASE ELECTRIC VEHICLES (EVs) AMONG THAI CONSUMERS

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Abstract

To help prevent the phenomenon of global warming caused by the combustion of fossil fuels, this research aimed to investigate the viability of Electric Vehicles (EVs) as a solution to the problem of pollution from transportation in Thailand. Based on the Theory of Planned Behavior (TPB) formulated by Ajzen (Ajzen, 1985), the study utilized quantitative research methods to collect data from a sample group of people interested in EVs and modern automobile technology, all of whom had memberships in online social groups concerned with these technologies. Data were collected via a questionnaire survey with Cronbach's alpha values ranging from 0.892 to 0.933. Complete questionnaire responses were received from 312 respondents. Data were analyzed using SmartPLS software.

The findings of the study revealed that the constructed SEM had a high level of congruence with the empirical data. 49.8% of the variance in purchase intentions was explained by causal factors. Subjective norms (from the suggestions, use of EVs, agreement with the choice of using EVs, and satisfaction with the choice to use EVs, of family and close friends) were shown to have both direct and indirect effects on purchase intentions. In contrast, attitudes toward purchase behavior did not have any effect on purchase intentions. These results show that actual subjective norms depend on interpersonal influences at the highest level, followed by external influences, and personal innovativeness, respectively. The study suggests that the influences of close relationships with family and friends have an important role in the purchase intentions relating to EVs among Thai consumers. Additional interview results revealed that Thai people are aware of global warming and rising oil prices, bringing their attention to EVs as a potentially more viable option.

Keywords: Electric vehicles (EVs), Purchase intentions, Attitudes toward purchase behavior, and Subjective norms.

1. INTRODUCTION

Current levels of carbon dioxide emissions from fossil fuel combustion are rising worldwide. In Thailand, energy consumption has grown consistently at all levels of the economy from domestic to industrial use. The increased demand for energy has triggered the seeking of new energy sources to meet growing requirements; such sources may include energy from local or new excavations of coal, natural gas, and oil. The road transportation sector, in particular, has seen great increases in both consumption and demand. This can lead to stability of the natural resource base and an upgrading of the quality of the

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environment (Office of the National Economic and Social Development Council, 2022). Most automobiles currently used for travel in Thailand use internal combustion engines with fossil fuel as the main driving energy. Use of fuels from this group of energy resources adds large amounts of carbon dioxide to the atmosphere, causing environmental effects and worsening the global warming crisis. This problem is not the problem of any single country but remains a problem that every country in the world must try to solve (International Energy Agency, 2015).

Due to the severe problems caused by the use of fossil fuels, including various environmental impacts and rising global temperatures, the world has begun to recognize this problem. Thus, campaigns are being waged to reduce fossil fuel consumption and turn to renewable energy resources, to reduce carbon dioxide emissions. One possible solution is the use of EVs. The International Energy Agency (IEA) reported that governments in many countries are promoting EVs, causing global EV sales in 2018 to number more than 5.1 million vehicles, and an increased growth in comparison to prior years. Currently, the countries of the world are placing great importance on the environment. EVs are widely considered to be the vehicles that answer this question the most, providing an opportunity to reduce global warming, by reducing carbon dioxide emissions and other pollution in the atmosphere, as EVs have the potential to be environmentally-friendly.

In Malaysia, the most significant factors found to affect consumers' intentions to purchase hybrid cars were functional value (usefulness, ease of use, efficiency, innovation/technology) and conditional value (lifestyle, place of resident, age). On the other hand, symbolic value, including attitudes toward the product and subjective norms, failed to show a significant relationship with consumers' intentions to purchase hybrid cars (Chai Wen & Mohd Noor, 2015). Miranda and Delgado (2020) studied the determinants of electric car purchase intentions in Portugal (to determine the factors related to near future purchase intentions for EVs, and how this varies with pro-environmental lifestyles, the perceived symbolic value of EVs, and place of residence). The findings of the study indicated that the most positive relative causes relating to the purchase intentions for EVs were fuel cost increase, the proximity of convenient charging places, and battery lifetime perception. It was also found that interpersonal factors, age and lifestyle, knowledge, and the perceived symbolic value of EVs, in general, had a positive influence on consumers' choices regarding EVs. In India, some researchers studied the factors affecting drivers purchase intentions with the study focusing on utilitarian values in relation to customer attitudes and purchases of EVs, finding that the attitude toward the product and subjective norms both had a strong influence on purchase intentions (Issac, Mathew, and Sriram, 2022). It can be said that the intention to purchase EVs abroad was increased by the factors mentioned, i.e., usefulness, ease of use, efficiency, innovation and technology, lifestyle, attitude toward the product, and subjective norms. While EVs in Thailand are not widely popular, based on data from the Department of Land Transport (30 September 2020), 148,187 EVs are registered nationwide out of a total 40,467,665 vehicles. EVs registered in Thailand are divided into 2,088 fully electric vehicles and 146,099 hybrid vehicles. Collectively, these amount to only 0.45 percent of all vehicles, possibly because EV technology is new to Thailand and consumers remain concerned with the lack of coverage from service points or agencies in every area, causing consumers to be apprehensive when deciding to purchase an EV. This leads to the problem considered in this research, which considers if the factors of usefulness, ease of use, efficiency, innovation and technology, lifestyle, attitude toward EVs, and subjective norms, have a positive effect on intentions to purchase EVs among Thai consumers. In addition, the research considers what other factors are related to the intentions to purchase EVs among Thai consumers, and

how the number of EV users in Thailand can be increased.

Due to the aforementioned reasons, it is interesting to study the influence of the factors that are the main variables with effects on the purchasing intentions for EVs among Thai consumers, namely, perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influence, external influences, attitudes toward the intention behavior, and subjective norms, in order to provide data for entrepreneurs interested in selling EVs to consumers in the Bangkok area and surrounding provinces and to develop the EV infrastructure and offerings to meet most consumer needs.

Research Objective: To study and determine the influence of various factors over decisions to purchase EVs among Thai consumers. These factors are perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influence, external influences, attitudes toward purchase behavior, and subjective norms, in relation to the purchasing intentions for EVs among Thai consumers.

2. LITERATURE REVIEW

The framework underlying this study is the Theory of Planned Behavior (TPB) formulated by Ajzen (Ajzen, 1985). The TPB is proposed for the purpose of predicting and describing likely purchasing behavior. Intentions to carry out different behaviors (such as purchase intentions) can be predicted with high accuracy from attitudes towards the behavior, subjective norms, and the perceived behavior (Ajzen, 1991).

2.1 Perceived Usefulness

The Technology Acceptance Model was proposed by Fred Davis in 1989 (Mwiya, Chikumbi, Shikaputo, Kabala, Kaulung'ombe, and Siachinji, 2017). This theory was adapted from the Theory of Reasoned Action. It is the most widely used model for exploring user acceptance of technology. According to the research model, perceived usefulness refers to the expectations for enhanced technological work efficiency, including better accuracy and speed, and its effect on personal beliefs in using the technology (Davis, 1989). Perceived usefulness refers to the perceived benefits from using the technology with expressions of acceptance and intentions to use the technology stemming from its perceived usefulness (Lobpai and Tanittanakorn, 2016).

2.2 Perceived Ease of Use

Davis (1989) defines perceived convenience as there being little effort involved in using the technology including enhanced efficiency and usefulness (Davis, 1989). In the area of perceived ease of use, users expect to have convenience from using the technology without the need to make an effort; technology should not be complicated in order to be easily learned and understood (Park, 2010). Venkatesh and Davis (2000) found that perceived ease of use is an important factor in a customer's willingness to agree and act in terms of use. Rahmiati & Yuannita (2019) studied online shopping looking at the behavior of consumers towards e-commerce in Indonesia regarding the influence of trust, perceived usefulness, perceived ease of use, and attitudes, on purchase intentions. Their research results showed that perceived usefulness and perceived ease of use have a significant effect on purchase intentions.

2.3 Compatibility

Compatibility means that the technology or innovation has a mode of use suitable for the current work or lifestyle (Ramos-de-Luna, Montoro-Rios & Liebana-Cabanillas, 2015). Furthermore, Rogers (2003) stated that the compatibility of innovations is dependent on existing definitions, user needs, and past experiences. In addition, to gain customer acceptance, compatibility is a main factor related to attitude, while the report shows that

compatibility helps the users to develop positive attitudes (Daud, Rahman, and Mohamad, 2019). Meanwhile, Saragih and Alversia (2020) found that technology and innovation had a positive influence on users' attitudes toward a brand, as well as users' engagement behavior.

2.4 Personal Innovativeness

Personal innovativeness refers to a person's interest to experiment with a new technology and their ability to accept the consequences such as the risk from experimenting with the technology. It also includes the expectations regarding the likelihood of purchasing a new product before others (Slade, Dwivedi, Piercy & Williams, 2015). Loria and Rodhiah (2020) studied personal innovativeness, finding that subjective norms received a direct effect from personal experiences of new technology.

2.5 Interpersonal Influence

Interpersonal influence refers to the influence of other people or groups over changes in personal thoughts, feelings, attitudes or behavior (Saichao, 2017). The role of interpersonal influence originates from the effects on a user's decision-making instilled by other people, such as family members, close individuals and friends. In addition, a supervisor's authority or other colleagues can have influence over expressions of technology use (Venkatest, 2003). Yan & Karen (2015) examined the influence of relationships on interpersonal and subjective norms, suggesting that a strong relationship with interpersonal influence can increase the effect of subjective norms.

2.6 External Influence

External influence refers to the persuasion of a user to accept technology by external influences such as government agencies, media, and social influences. External influence may occur at multiple levels, while each level is associated with different processes in persuading users and in relation to the social influence over user behavior (Kelman, 1958). Artificial intelligence has been used to form government news that can affect personal behavior (Hasan and Suciarto, 2020; Liu and Liao, 2021) which is in accordance with Gultom et al. (2020) who studied the influences of external factors on attitudes and subjective norms and on citizen's intentions to use e-government services.

2.7 Attitude toward Purchase Behavior

Ajzen (1991) stated that attitude toward a behavior refers to the personal assessment of that particular behavior, which may be expressed positively or negatively. The attitude toward a behavior is dependent on the individual person holding that attitude. If a person thinks the behavior will receive positive responses, the person is more likely to have a positive attitude toward that behavior. On the contrary, if a behavior is expressed and receives negative responses, the person will have a negative attitude toward that behavior. When a person has a positive attitude toward a behavior, they will continue to express that behavior. The research study of Jui-Che Tu & Chun Yang (2019) showed that subjective norms had the greatest effect on a customer's purchase intentions, followed by attitude, also stating that users of EVs had a positive attitude towards purchase intentions. In addition, as consumers thought EVs were a product of new technology, they generally held positive attitudes towards purchase behavior.

2.8 Subjective Norms

Ajzen (1991) stated that subjective norms refer to the awareness that a person important to us expressed a behavior or wants us to perform that behavior, causing us to follow and mimic that person's behaviors. Social pressure to perform or abstain from participation in certain behaviors has also been mentioned (Abrahamse, 2009). Subjective norms from external perceptions

have effects on purchase behavior (Wang, 2017). The research study of Schmalfuß, Mühl, and Krems (2017) found that subjective norms had an effect on customers' purchase intentions after the customer had taken a test drive, while if a customer thought that the people important to them had presented their behavior to their group it would also be in a positive way. Al-Amin, Ambrose, Masud, and Azam (2016) found that subjective norms had a significant direct influence on the purchase intentions towards hydrogen fuel cell vehicles among Malaysian consumers.

2.9 Purchase Intentions

Zeithami, Beny & Parasuraman (1990) stated that purchase intentions refer to the expression of the desire to purchase a specific product first; this can indicate consumer purchasing behaviors. Howard (1989) stated that purchase intentions refer to a consumer's plan to purchase specific products within a period of time, such as product categories, reputations, product prices, and product quantity. Mowen & Minor (1998) added that purchase intentions refer to consumers' management in acquiring and using products with intentions to purchase generated in the search for information, making comparisons, and exchanges of opinions among consumers, regarding the product, and lead to acquisition of the desired product. From the above studies, it is concluded that purchase intentions have a direct effect on purchasing and use of EVs, as well as an indirect effect via subjective norms, and attitudes towards purchase behavior.

2.10 Development of the Conceptual Framework

Based on the literature review, subjective norms depend on personal innovativeness, interpersonal influences, and external influences (Ajzen, 1991; Abrahamse, 2009; Wang, 2017) while subjective norms also have a direct influence on attitudes toward behavior (Ajzen, 1991; Jui-Che Tu, & Chun Yang,2019), and purchase intentions toward EVs (Schmalfuß, Mühl, and Krems, 2017; Al-Amin, Ambrose, Masud, and Azam, 2016). Meanwhile, attitude toward purchase behavior is influenced by perceived usefulness, perceived ease of use, and compatibility (Rahmiati & Yuannita, 2019). A summary of the literature review regarding intentions to purchase EVs led to the creation of the following conceptual framework:

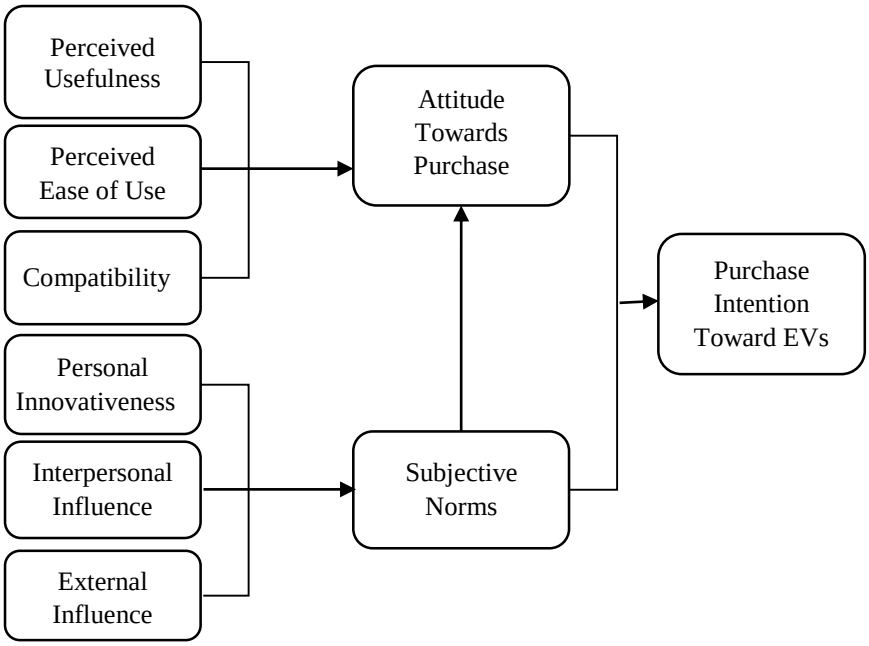

Figure 1.1 - Conceptual Framework

Figure 1.1 shows the structural equation model indicating the causal relationships between the exogenous variables and endogenous variables (recursive and linear additives). The measurement model is shown in Figure 1.2.

Figure 1.2 illustrates the measurement model. Part A consisted of 9 latent variables (Perceived Usefulness, Perceived Ease of Use, Compatibility, Personal Innovativeness, Interpersonal Influence, External Influence, Subjective Norms, Attitude Toward Purchase Behavior, and Purchase Intention Toward EVs) with each latent variable having specific observed variables (yellow symbol were the questions in a questionnaire). All details are shown in Table 1.

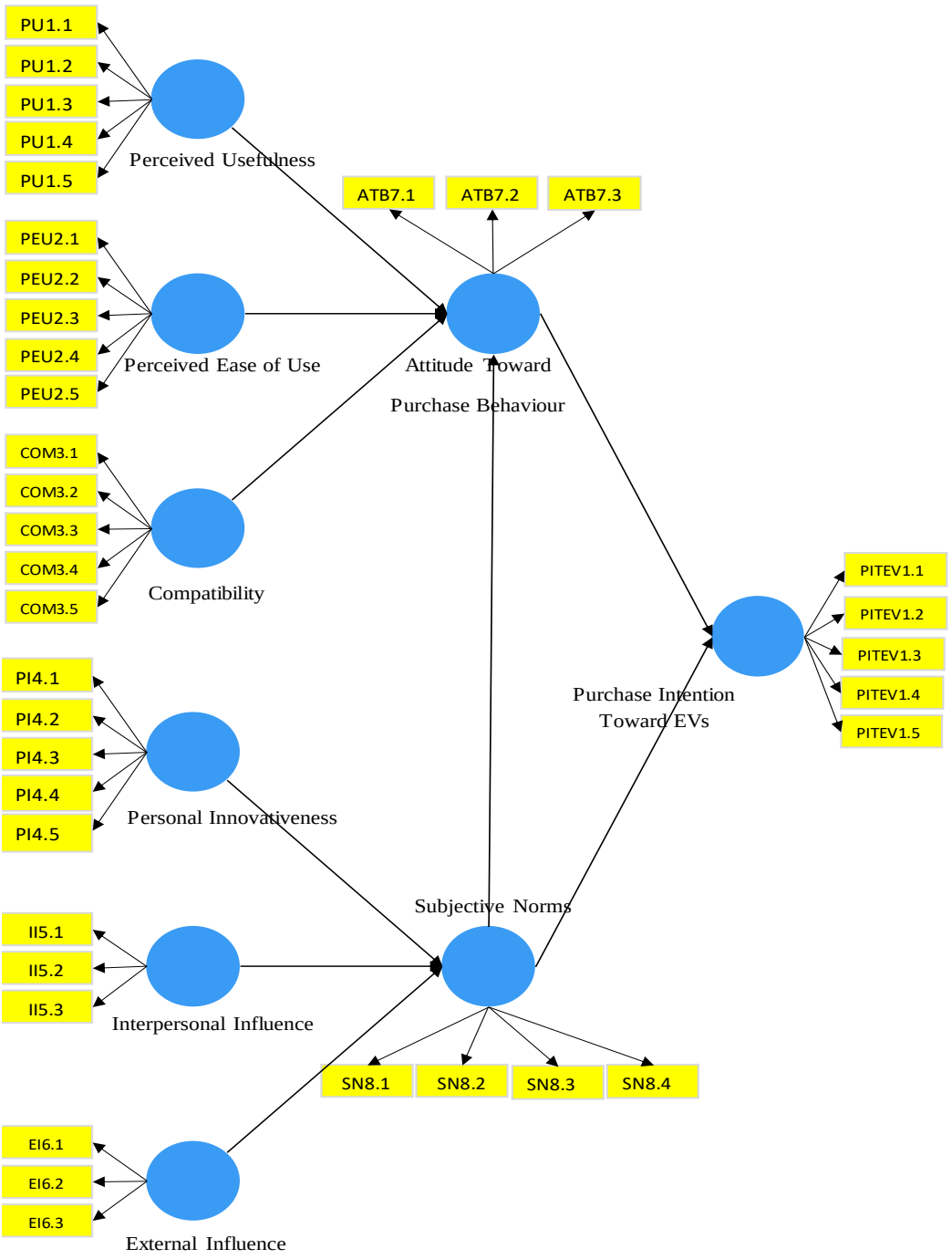

Figure 1.2 – Full Measurement Model of the Conceptual Framework

Table 1- Latent Variables and Measurement Variables in Conceptual Framework

Latent Variable	Measurement Variable (in questionnaire) Do you agree with the following?	Symbol
Perceived Usefulness	• EVs will help to reduce air pollution.	PU1.1
	• EVs will improve your quality of life.	PU1.2
	• EVs will increase your travel efficiency.	PU1.3
	• EVs will help you to be safer while traveling.	PU1.4
	• EVs will save you more money.	PU1.5
Perceived Ease of Use	• It's easy to use EVs.	PEU2.1
	• It's easy for someone to use EVs to learn to drive.	PEU2.2
	• It's easy to charge an EV.	PEU2.3
	• It's easy to find an electric power station for charging.	PEU2.4
	• There are enough electric power stations for charging.	PEU2.5
Compatibility	• EVs fit your lifestyle.	COM3.1
	• EVs are compatible with your daily needs.	COM3.2
	• EVs are perfect for your family.	COM3.3
	• EVs are suitable for traveling.	COM3.4
	• EVs are perfectly suited to solving the energy problem.	COM3.5
Personal Innovativeness	• You're always looking for new technologies.	PI4.1
	• You're the first to talk about new technologies.	PI4.2
	• You don't hesitate to experiment with new technologies.	PI4.3
	• You love experimenting with new technologies.	
	• If you have free time, you will search for new technologies.	PI4.4
		PI4.5
Interpersonal Influence	• Your family will support you if you buy an EV.	II5.1
	• Those closest to you think that buying an electric car is a good idea.	II5.2
	• Those closest to you have influenced your choices regarding EVs.	II5.3
External Influence	• You have read or viewed news that using EVs is a way to solve global warming.	EI6.1
	• Information from various media has led you to try out EVs.	EI6.2
	• Social media shows positive thinking towards EVs.	EI6.3
Attitude Toward Purchase Behavior	• The concept of using EVs is positive in relation to air pollution and cost savings.	ATB7.1
	• Using an electric car will be a pleasant experience.	ATB7.2
	• Using EVs instead of fuel cars would be better idea.	ATB7.3
Subjective Norms	• Those close to you advised you to buy EVs.	SN8.1
	• If your friends use EVs, it will be easier for you to make the decision to buy an EV.	SN8.2
	• Those close to you will agree with you, if you choose to purchase an EV.	SN8.3
		SN8.4
	• Those close to you will be satisfied if you choose to purchase an EV.	
Purchase Intentions Toward EVs	• When you have the ability to purchase an EV, you will choose to buy one.	PITEV1.1
	• You intend to buy an EV instead of a car of another power source.	PITEV1.2
		PITEV1.3
	• You may buy an EVs within 3 years.	PITEV1.4
	• You may buy an EV as a second car.	PITEV1.5
	• You intend to continue to purchase EVs in the future.	

2.11 Hypothesis

A conceptual framework of the relationships between the variables was constructed from the findings of the literature review. This led to the research hypothesis that subjective norms and attitudes towards purchase behavior have direct effects on purchasing intentions towards EVs among Thai consumers.

3. METHODOLOGY

3.1 Population

This study was conducted among Thais aged 18 years and over, as this population represents those who considered legally as adults, meaning that they have reached the age of majority and can be considered as voluntary providers of information (Office of the Royal Society, 2022; MU-CIRB, 2022). Ipsos (2020) study and research of the EV industry in Thailand found that the Thai people have an interest in modern automobile technology with membership in online social groups concerned with technology, Thai automobiles, EVs and alternative energy automobile propulsion technology, as well as other related areas.

3.2 The Sample

Furr (2008), Hopkins (2002), and Becker (2000) have studied of the relationships between variables, and the effect size of the relationships between variables. For the effect size to be reported in the study results, when the population is unknown, the appropriate sample size for testing the statistical correlations must be calculated. For this study which aims to find the relations between the independent and dependent variables, the G*Power 3.1.9.7 computer program was used to calculate an appropriate sample size for an effect size of $F^2 = 0.3$ (medium sample size, α=0.05, $\alpha/ß = 0.8 = (0.05/0.05)$ ß=0.05 or power = 0.2 = (1-ß, 1-0.2=0.8). Accordingly, a minimum sample size of 282 subjects was determined (Cohen, 1977). The final number of completed returned questionnaires was 312 respondents and is thus sufficient for the purposes of the study.

3.3 Research Instruments

The instrument used in this study was a questionnaire divided into four parts, as follows:

Part 1 contained questions concerned with the demographic characteristics of the respondents namely gender, marital status, age, monthly income, educational attainment, and occupation. This section of the questionnaire had six questions with multiple-choice responses. Part 2 contained questions on the respondents' opinions regarding the influence of factors affecting their EV purchase intentions. These questions covered the concepts of perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influence, and external influence. Responses were given on a rating scale with opinions divided into five levels (Serirat et al., 1998) and a class interval formula used for response analysis (Hirunkitti, 2009; Page 98). Part 3 contained questions on opinions concerning EV purchase intentions and the same response style and analysis as Part 2. Part 4 contained questions on the respondents' opinions with regard to additional recommendations or other factors expected to have an effect on EV purchase intentions. In order to improve EV provision and technology, this part used open-ended questions.

3.4 Data Analysis

After receiving data from the questionnaires, the data were tested and processed statistically using the SmartPLS3.0 computer program.

3.5 Descriptive Statistics Analysis

Demographic data of the questionnaire respondents was analyzed via frequency distribution and percentage statistics.

3.6 Structural Model Assessment

In the structural model assessment, multicollinearity of predictive components was tested and required to have no correlations with statistical significance. Accordingly, the variance inflation factor (VIF) should be no less than 5.00 (Hair et al., 2011).

1) Evaluation of the measurement model consisted of indicator reliability testing, where composite reliability must be higher than 0.7 (Hair et al., 2014), and Cronbach's alpha coefficient must be higher than 0.7 to indicate high reliability (Hair et al., 2011; Hair Jr et al., 2013; Wong, 2013; Hair et al., 2014). Concurrently, outer loadings should be no less than 0.70. If outer loadings are lower than 0.70, the observation variable or indicator should be excluded from the measurement (Hair et al., 2014). In convergent validity testing, the AVE must be no less than 0.5 to indicate that the latent variables are able to explain the variance of the indicator variables by more than 50 percent (Hair Jr et al., 2013). In discriminant validity testing, √AVE must be 0.7 or higher, while each latent variable should have a value higher than the AVE of the latent variables and the square root of the other variables, consistent with the Fornell-Larcker criterion, including cross loadings. Each indicator should have loading with latent variables where the associated indicator is higher than the other latent variables (Henseler & Sarstedt, 2013). It is best to have loadings no less than 0.70, while they must be no lower than 0.50 (Lee et al., 2011).

2) The inner model evaluation consisted of calculation of the coefficient determinants. Hair et al. (2014) specified that R^2 should be no less than 0.25 in order for the independent variables to be able to explain variance in the dependent variables. Measurements from cross-validated redundancy (Q^2) should be above zero. A Q^2 higher than or equal to 0.02 means that correlations are at a low level, while a Q^2 of more than or equal to 0.15 means that correlations are at a medium level, and a Q^2 of more than or equal to 0.35 means that correlations are at a high level (Hair et al., 2014). Analysis of effects on predictive accuracy (effect size or f^2) require an f^2 of more than 0.02. An f^2 of more than or equal to 0.02 indicates a low effect size while an f^2 of more than or equal to 0.15 indicates a medium effect size, and an f^2 of more than or equal to 0.35 indicates a high effect size (Hair et al., 2014). In analysis of the direct effects, indirect effects, and total effects, was conducted via calculation of the path coefficients (ß), where each path coefficient should be no less than 0.10 with a statistical significance of t least 0.05.

3) In hypothesis testing (path coefficients and significance levels) with a bootstrapping process, two-tailed hypothesis testing can be used with inner model path coefficients having significance at 0.05 or $p < 0.05$, whereby t-statistics above the critical value of 1.96 indicate that path coefficients support the hypothesis (Helm et al., 2010; Henseler & Sarstedt, 2013; Hair et al., 2014).

4. RESEARCH FINDINGS

4.1 Descriptive Statistics Analysis Results

From the total of 312 questionnaire respondents 198 were female (63.5%), while 114 were male (36.5%). The majority of respondents (270 respondents, or 89.5%) were single, while 42 were married (13.5%). Most of the respondents were aged 31-40 years, with a mean monthly income of 30,000 – 50,000 baht. Most of the sample had attained education at the master's degree level (232 respondents, or 66%), while a minority had attained education at the bachelor's degree level (34%). The majority of respondents worked as private company employees (196 respondents, or 62.8%), while a minority were business owners (54 respondents, or 17.3%). The entire sample were interested in EVs.

4.2 Structural Model Assessment Results

In the reliability testing of questionnaires, testing requires the

instruments or questionnaires to have the same results regardless of the number of tests or situational differences. Table 1 shows the results of the composite reliability and Cronbach's alpha coefficient values for the model assessment in the first and last round of measurements, which found that both values were above 0.7 for all latent variables (Hair et al., 2011; Hair Jr et al., 2013; Wong, 2013; Hair et al., 2014). Thus, all latent variables used in this study can be considered reliable.

Assessment of the model by testing the reliability of the observed variables or questions was conducted to determine if each question relating to each specific latent variable was measuring the same topic. In this study as shown in figure2, assessment was found to have been repeated twice to eliminate observed variables or questions which were not measuring the respective latent variable. Question exclusion was based on having an outer loading below 0.7 (Hair et al., 2014). As can be seen in Table 1, elimination results from the first iteration of the model assessment were PU1.4, PU1.5, PEU2.2, PEU2.4, PEU2.5, COM3.5, PI4.1 and II5.3 as their outer loadings were lower than 0.7, indicating the questions PU1.4, PU1.5, PEU2.2, PEU2.4, PEU2.5, COM3.5, PI4.1 and II5.3 were not useful in measuring perceived usefulness, perceived ease of use, compatibility, personal innovativeness, and interpersonal influence. After excluding questions PU1.4, PU1.5, PEU2.2, PEU2.4,

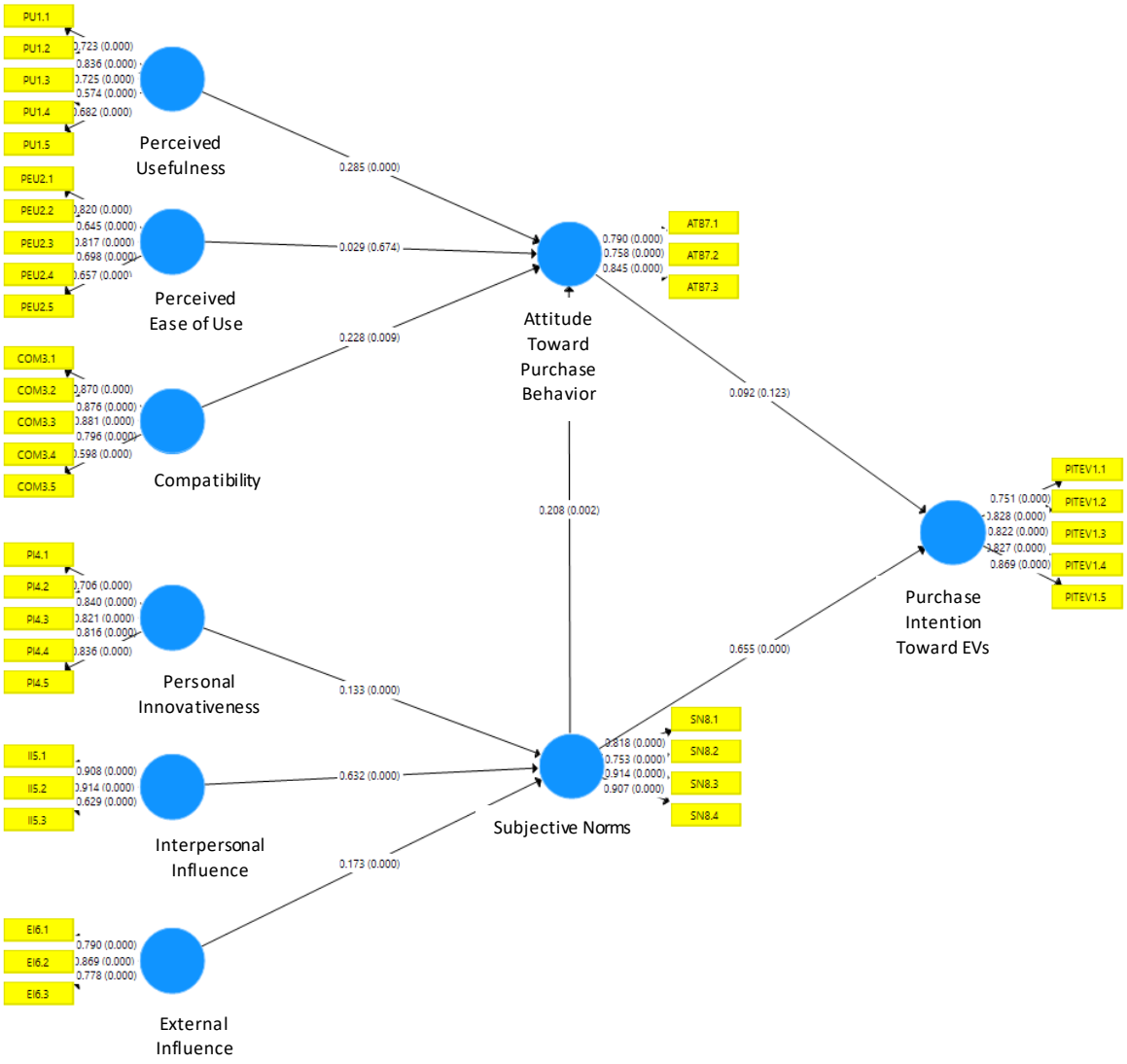

Figure 2 – Model of EV Purchase Intentions in Thailand (First Model)

PEU2.5, COM3.5, PI4.1 and II5.3, the final iteration of the model's assessment was used without excluding any questions as each question now had an outer loading above 0.7 (Hair et al., 2014), indicating that the questions for each latent variable could be used to measure the topics related to that latent variable. In addition, all eight latent variables had higher average variance extracted than the criteria of 0.5 with statistical significance at p = 0.000, indicating that all latent variables had adequate convergent validity. This meant that the latent variables were able to explain or measure the indicator variables with reliability and could be written as shown in Table 2.

Results from reliability testing and factor loading of the model of EV purchase intentions in Thailand showed outer loadings lower than 0.7 in certain variables. Therefore, these variables were excluded from the model, causing the final iteration of the model of EV purchase intentions in Thailand to be as shown in Figure 3.

Figure 3 shows the final iteration of the model of EV purchase intentions in Thailand (the final iteration had better quality than the first iteration), which is based on consideration of outer loading values, the Cronbach's alpha coefficient, composite reliability, and average variance extracted (AVE) as shown in Table 1.

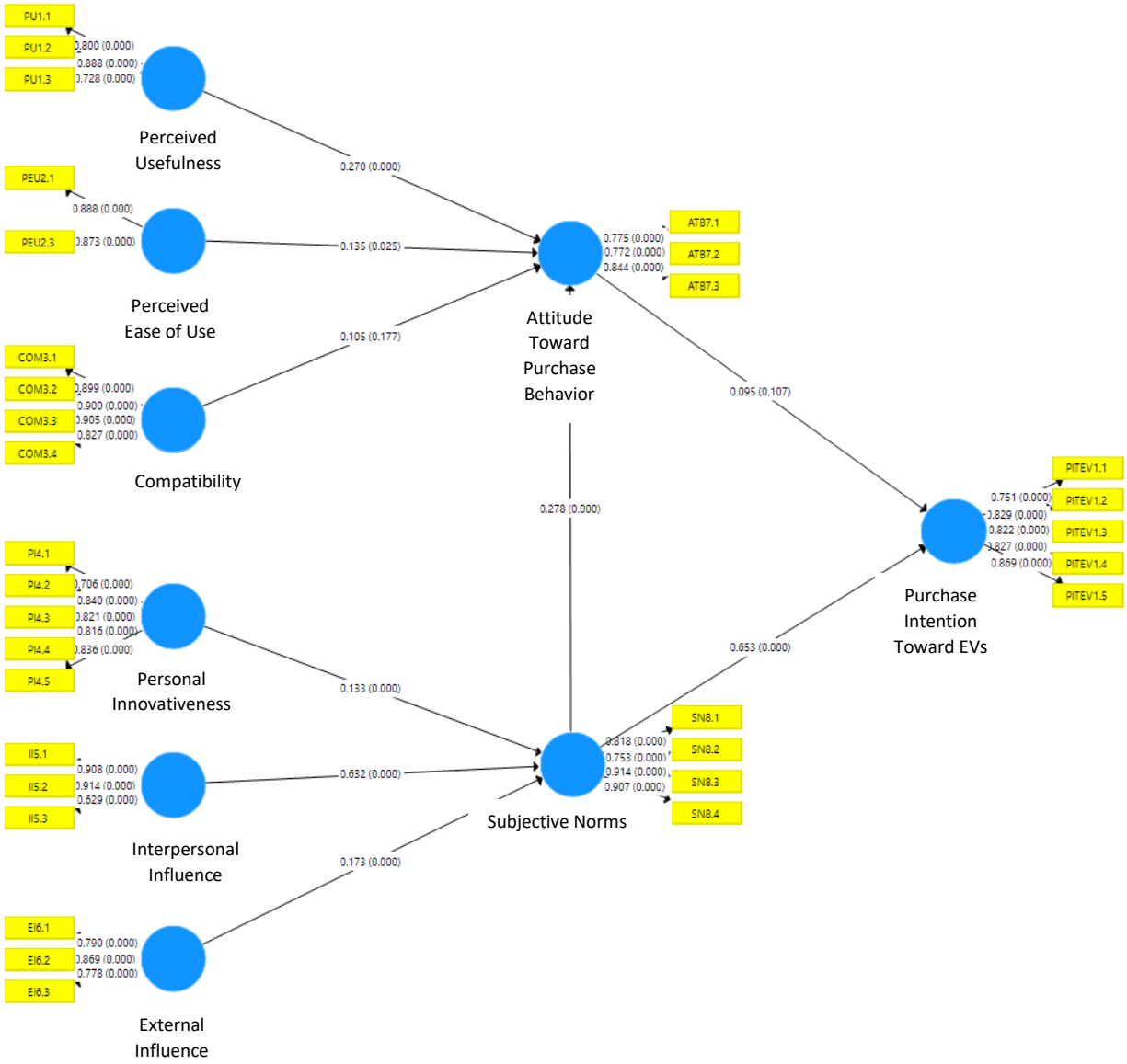

Figure 3 – Model of EV Purchase Intentions in Thailand (First Iteration)

Table 2 – Results from Reliability and Outer Loading Tests of the Statistical Instruments

Latent variables	The First Iteration					The Final Iteration			
	indicator variables	Outer Loadings	Alpha	CR	AVE	Outer Loadings	Alpha	CR	AVE
Perceived Usefulness	PU1.1	0.723	0.761	0.836	0.508	0.800	0.738	0.849	0.653
	PU.1.2	0.836				0.888			
	PU1.3	0.725				0.728			
	PU1.4	0.574				deleted			
	PU1.5	0.682				deleted			
Perceived ease of use	PEU2.1	0.820	0.786	0.850	0.535	0.888	0.710	0.873	0.775
	PEU2.2	0.645				deleted			
	PEU2.3	0.817				0.873			
	PEU2.4	0.698				deleted			
	PEU2.5	0.657				deleted			
Compatibility	COM3.1	0.870	0.864	0.904	0.658	0.899	0.905	0.934	0.780
	COM3.2	0.876				0.900			
	COM3.3	0.881				0.905			
	COM3.4	0.796				0.827			
	COM3.5	0.598				deleted			
Personal Innovative-ness	PI4.1	0.706	0.864	0.902	0.649	0.706	0.864	0.902	0.649
	PI4.2	0.840				0.840			
	PI4.3	0.821				0.821			
	PI4.4	0.816				0.816			
	PI4.5	0.836				0.836			
Interpersonal Influence	II5.1	0.908	0.768	0.864	0.685	0.908	0.768	0.864	0.685
	II5.2	0.914				0.914			
	II5.3	0.709				0.709			
External Influence	EI6.1	0.790	0.748	0.854	0.661	0.790	0.748	0.854	0.661
	EI6.2	0.869				0.869			
	EI6.3	0.778				0.778			
Attitude Towards Purchase Behavior	ATB7.1	0.790	0.715	0.840	0.637	0.775	0.715	0.840	0.636
	ATB7.2	0.758				0.772			
	ATB7.3	0.845				0.844			
Subjective Norms	SN8.1	0.818	0.870	0.912	0.724	0.818	0.870	0.912	0.724
	SN8.2	0.753				0.753			
	SN8.3	0.914				0.914			
	SN8.4	0.907				0.907			
Purchase intention toward EVs	PITEV1.1	0.751	0.878	0.911	0.673	0.751	0.878	0.911	0.673
	PITEV1.2	0.829				0.829			
	PITEV1.3	0.822				0.822			
	PITEV1.4	0.827				0.827			
	PITEV1.5	0.869				0.869			

As seen in Table 2, the Final Model was found to have all outer loadings, Cronbach's alpha coefficients and composite reliability values within the recommended criteria (not lower than 0.5-0.7) (Henseler & Sarstedt, 2013; Lee et al., 2011). Thus, all latent variables used in the study were reliable. Furthermore, average variance extracted (AVE) was able to determine that all latent variables had convergent validity and were able to explain or measure the indicator variables with reliability.

According to Table 3, the square root of the average variance extracted between the

latent variables and other latent variables showed that the √AVE of each latent variable had a value over 0.7 and that the average variance extracted from the same latent variable was higher than the correlations with the other latent variables (Henseler & Sarstedt, 2013).

Discriminant validity analysis using cross loading criteria produced loadings for the observed variables which were higher than the criterion of more than or equal to 0.7 (Henseler & Sarstedt, 2013). When correlations between the loadings of the observed variables of those of the latent variable and other latent variables in the model were considered, the correlations were found to be at a low level. Thus, all nine latent variables had discriminant validity consistent with cross loading criteria.

As shown in Table 4, calculation of determinant coefficients indicated that attitudes towards purchase behavior, subjective norms, and EV purchase intentions, had determinant coefficients of 0.364-0.638. In addition, measurements from the cross-validated redundancy (Q^2) confirmed the quality of the structural equation with fit indices and cross-validated redundancy (Q^2) above zero (0.221 – 0.484) and over 0.15 indicating a medium level (Hair et al., 2014). Overall, the quality of the structural equation was correlated at a medium-to-high level.

4.3 Structural Model Analysis

The structural model analysis aimed to study the influence of factors over purchase intentions in relation to EVs among Thai consumers. The analysis results are shown in Table 5.

According to Table 5, subjective norms were the only factor that had both direct and indirect effects on purchase intentions in

Table 3 - Discriminant Validity Through the Square Root of AVE with Fornell-Larcker Criterion

Latent variables	Attitude Toward Purchase Behavior	Compatibility	External Influence	Interpersonal Influence	Perceived ease of use	Personal Innovativeness	Purchase intention toward EVs	Perceived Usefulness	Subjective Norms
ATB	**0.798**								
COM	0.496	**0.883**							
EI	0.580	0.595	**0.813**						
II	0.503	0.683	0.573	**0.934**					
PEU	0.384	0.482	0.408	0.434	**0.880**				
PI	0.391	0.455	0.430	0.498	0.353	**0.842**			
PITEV	0.431	0.605	0.560	0.653	0.377	0.539	**0.820**		
PU	0.479	0.522	0.401	0.335	0.323	0.198	0.415	**0.808**	
SN	0.510	0.667	0.601	0.810	0.388	0.500	0.701	0.411	**0.851**

Remarks: Numerical values in the main diagonal are √AVE.

Table 4 – Coefficient Determinant (R Square)

Variables	R square	R square Adjusted	Determinant Coefficient Validity	Q^2	Structural Equation Quality Correlation Level
Attitude toward Purchase Behavior	0.364	0.356	Medium	0.221	Medium
Subjective Norms	0.683	0.681	High	0.484	High
EVs Purchase Intentions	0.498	0.496	Medium	0.327	High

relation to EVs among Thai consumers, where the direct effect from subjective norms yielded analysis values of ß=0.653, p=0.000, and the indirect effect from subjective norms yielded analysis values of ß=0.026, p=0.000, causing the total effect from subjective norms to be ß=0.679, p=0.000.

Furthermore, the factor with the greatest indirect effect on purchase intentions in relation to EVs among Thai consumers, was found to be interpersonal influences (ß=0.429, p=0.000), followed by external influences (ß=0.118, p=0.000), both of which caused effects via subjective norms.

Attitudes towards purchase behavior were directly affected by subjective norms (ß=0.278, p=0.000) while subjective norms had the most direct effect from interpersonal influences (ß=0.632, p=0.000), followed by external influences (ß=0.173, p=0.000) and personal innovativeness (ß=0.133, p=0.000), respectively.

Attitudes towards purchase behavior had the greatest direct effect from perceived usefulness (ß=0.270, p<0.001), followed by perceived ease of use (ß=0.135, p=0.022), respectively. Additionally, attitudes toward purchase behavior had the greatest indirect effect from interpersonal influences (ß=0.176, p=0.000), followed by external influences (ß=0.0488, p=0.000) and personal innovativeness (ß=0.037, p=0.000), respectively, leading to the conclusions in relation to the hypotheses shown in Table 6.

According to the hypotheses of this study, attitudes towards purchase behavior and subjective norms have a direct effect on purchase intentions in relation to EVs among

Table 5 – Results of the Direct Effect (DE), Indirect Effect (IE) and Total Effect (TE) Analysis Between the Independent Variables and Dependent Variables

Relationship between factors	Attitudes Toward Purchase Behavior			Subjective Norms			Purchase intention toward EVs		
	DE	IE	TE	DE	IE	TE	DE	IE	DE
Perceived Usefulness	0.270***	0	0.270***				0	0.026***	0.026***
Perceived ease of use	0.135*	0	0.135*				0	0.013***	0.013***
Compatibility	0.105	0	0.105				0	0.010***	0.010***
Personal Innovativeness	0	0.037***	0.037***	0.133***	0	0.133***	0	0.090***	0.090***
Interpersonal Influences	0	0.176***	0.176***	0.632***	0	0.632***	0	0.429***	0.429***
External Influences	0	0.048***	0.048***	0.173***	0	0.173***	0	0.118***	0.118***
Attitudes Towards Purchase Behavior							0.095	0	0.095
Subjective Norms	0.278***	0	0.278***				0.653***	0.026***	0.679***

Remarks: *p < .05; *** p < .001; ns = no statistical significance.

Table 6 – Summary of Hypothesis Test Results

Analysis assumption	Assumption test result
Attitude Towards Purchase Behavior--> Purchase intention toward EVs	Unsupported
Subjective Norms--> Purchase intention toward EVs	Supported

Thai consumers. The hypothesis test results showed only that subjective norms have a direct effect on purchase intentions regarding EVs among Thai consumers. This is shown in the Figure 4 Path Coefficients, which display the correlations and direct effects of attitudes towards purchase behavior and subjective norms relating to purchase intentions for EVs among Thai consumers.

According to Figure 4, if there is a need to boost the purchase intentions for EVs among Thai consumers, support must be given to subjective norms, consisting of recommendations, and the approval and satisfaction from close acquaintances such as close relatives and friends, when customers want to purchase EVs, as this will make customers more likely to decide to purchase EVs. Subjective norms have the most direct effect and also have indirect effects on EV purchase decisions with statistical significance at the 0.001 level.

In addition, deep interviews were conducted with 17 people with interest in EVs in the "ASEAN Sustainable Energy Week" and "Electric Vehicle Asia 2022" at Queen Sirikit National Convention Center on September 14, 2022. This event was key to guiding the industry movement, especially regarding energy sources affected by the energy crisis, economic crisis, and the problems caused by rising energy prices, environmental change, inflation, and the pandemic. One objective from the event was

Figure 4 - Path Coefficients

to find a common solution for related business practices. Questions asked "Why do the current issues affect purchase intentions for EVs?" and "What factors affect your desire to buy an EV?"

Regarding the respondent's opinions regarding the relationship between purchase intentions for EVs and the energy crisis, most Thai consumers showed awareness of the energy transition towards carbon neutral as well as the acceptance of current consumer demand for EVs, while they were also worried about environmental issues. The Thai government has stated that they support Thailand in becoming a center of EV production in the region (EV Hub) (EVs Tax fee reduction policy). Everyone commented that global warming and rising oil prices are important factors in the purchase intentions for EVs. Many people were concerned about global warming. Therefore, there is a big problem in the world which they can try to help reduce by using clean energy; EVs were considered the number 1 way to reduce greenhouse gas emissions.

However, many interviewees were concerned about the availability of EV charging stations, as well as spare parts and maintenance; these were seen as significant problems which require solutions as all of this infrastructure is very new to Thailand. Whenever actions EV Entrepreneurs can take to reduce consumer concerns, such as long-lasting quality assurance for EVs, provision of quality maintenance services with suitable prices, safety for life and property all times when using an EV, or provision of a sufficient number of charging stations throughout Thailand, as well as in gas stations will raise EVs to becoming the first choice of Thai consumers.

Thai consumers are aware of global warming and the oil price situation, such that electric energy is seen as an alternative clean energy to reduce global warming and the financial viability of transport. EVs can be used to solve both of these concerns perfectly; this can make the purchase intention to buy EVs easier as family and friends offer support and encouragement.

5. CONCLUSION

This study considered if the factors of usefulness, ease of use, efficiency, innovation and technology, lifestyle, attitudes towards purchase behavior, and subjective norms, have positive effects on the intention to purchase an EV among Thai consumers. However, the results showed that the only factor with a strong positive direct effect on the purchase intentions for EVs among Thai consumers was subjective norms, while interpersonal influences had a direct effect on subjective norms in accordance with Yan & Karen (2015). The strong relationship with interpersonal influences can increase the subjective norms. However interpersonal influences had a strong indirect effect on EV purchase intentions, in line with the research study of Chen, Zhang, Shao, Gao, and Xu (2022) who found a relationship between the interpersonal interaction factor and purchase intentions also offering a description of key buyer-seller interpersonal interaction factors. This reflects that Thai people are subjected to interpersonal influences from family members who provide support if a person needs to purchase an EV; how the subjects' close acquaintances think that purchasing EVs was a good idea and how people close to the subjects have effects on their EV purchasing decisions. This caused the subjects to have more intentions to purchase EVs when they have the ability, while they also develop intentions to purchase EVs rather than vehicles that use other types of energy due to subjective norms, such as people close to them advising them to purchase EVs. Furthermore, the subjects will be more likely to decide to purchase EVs if their friends use EVs. This is consistent with the concept of Schmalfuß, Mühl and Krems (2017) who found that direct experience with battery electric vehicles (BEVs) matters when evaluating vehicle attributes, attitudes and purchase intentions; they found a significant effect from subjective norms on purchase intentions. Al-Amin, Ambrose, Masud, and Azam (2016) studied peoples purchase intentions towards hydrogen fuel cell

vehicles. This experiential enquiry in Malaysia, reported a strong relationship between subjective norms and purchase intentions.

External influences had a direct effect on subjective norms and an indirect effect on EV purchase intentions. This reflects how people living in Bangkok and surrounding provinces are influenced by external influences such as information from other media, causing the respondents to want to experiment with using EVs; information gained from online media (Facebook, Twitter, other) is expressed as positive confidence in EVs. Furthermore, respondents had watched news reports stating that EV use is a method for managing air pollution, causing them to be more likely to purchase EVs in the near future (in three years). People may purchase EVs as a second vehicle and continue to purchase EVs in the future due to subjective norms such as approval and satisfaction from people close to them who use EVs. This was consistent with Gultom et al. (2020) who studied the influence of attitudes and subjective norms on citizens' intentions to use e-government in Indonesia. A person's decision to purchase products to satisfy colleagues by purchasing product brands preferred by friends in order to gain acceptance from a group, or purchase brand name products, were influenced by family member preferences. Furthermore, the findings were consistent with Ajzen's concept (1991) of the theory of planned behavior (TPB) which explains that consumers will express behaviors if they are positive behaviors or intentions, and if people important to consumers' lives such as family members or close friends, approve of expressing that behavior.

Perceived ease of use, personal innovativeness, compatibility, and perceived usefulness, had direct effects on attitudes towards purchase behavior, reflecting how people in the Bangkok area and surrounding provinces acknowledge that the use of EVs will reduce air pollution, improve quality of life, and traveling efficiency. Respondents thought that EVs can be used easily, recharged easily, and that EVs are suitable for lifestyles, daily needs, family needs, and travel needs. Furthermore, after receiving news and information about new technology, the respondents expressed that they would search for further information about the technology and would usually be the first people to speak about new technologies without hesitating to use or experiment with new technologies. This causes their attitudes toward EV purchases to be higher than ordinary people as they think that use of EVs will have positive effects on pollution management and expenses, and that the use of EVs will be a satisfactory experience, while replacing gasoline vehicles with EVs is a good idea. This is consistent with the concept of Sueprasertsit, C. (2011) who found attitude to be caused by perceived usefulness, perceived ease of use, personal innovativeness, and compatibility. If users perceive a technology to be useful and easily used, they will have a positive attitude toward that technology with direct effects on their intentions to use the technology. After having the intention to use that technology, users will feel that they should use the technology.

Attitudes towards purchase behavior had no effect on EV purchase intentions. This reflects how people in the Bangkok area and surrounding provinces thinking that using EVs has positive effects on air pollution management and expenses, that using EVs will be a satisfactory experience, and that using EVs to replace gasoline vehicles is a good idea, does not affect their intentions to purchase EVs when they have the ability to do so, to use EVs to replace vehicles which use other types of energy, or to purchase EVs in the near future (in three years). This was not consistent with the findings of Jui-Che Tu and Chun Yang (2019) who found that attitudes towards purchase behavior have an effect on EV purchase intentions, and subjective norms. Furthermore, the respondents had positive attitudes toward EVs purchases. Consumers believed EVs to be a forward-looking technological product with driving and traveling expenses similar to ordinary vehicles. These opinions and factors were positively correlated with consumer attitudes

toward EVs purchases.

6. RECOMMENDATIONS

Based on the findings, the following recommendations are proposed for business owners, and Thai consumers who want to purchase EVs, as well as for future studies.

6.1 Recommendations for Business Owners

1) Investors must give priority to subjective norms, meaning that they should provide news and information for ordinary people, particularly those expected to become EV customers in the future, such as by advertising information or knowledge about EVs via online social media, large roadside billboards, and television advertisements, targeting closely related groups of colleagues, school friends, and groups of friends with interest in EVs, under the promotion of awareness of global warming and the energy issue.

2) If business owners want to promote EV products, they should select people with significant influence over the contemporary Thai population as presenters, as these people are followed by many people in every activity and people usually follow when influential people use a product.

3) If business owners want to save resources and have limited time, attitudes towards purchase behaviors should be excluded from consideration or considered last as the findings indicate that they have no statistically significant influence over purchase intentions in relation to EVs among Thai consumers.

4) EVs have only recently come to Thailand. It is no surprise that Thai consumers have a significantly lower level of perceived usefulness and perceived ease of use than other factors. If all entrepreneurs promote EVs in relation to the environmental issue, this will have the influence of improving attitudes towards purchase behavior for EVs and opportunities for purchase intentions for EVs among Thai consumers.

6.2 Recommendations for Future Studies

1) Apart from perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influence, external influence, attitudes toward purchase behavior, and subjective norms, other factors with effects on EVs purchase intentions should be included. For example, population factors, brand value, automobile selection behavior, purchase decision-making processes, and marketing mix factors (7Ps) should be included as variables for predicting EVs purchase intentions.

2) This study was a quantitative study. Therefore, academics interested in studying the issues related to this research should conduct in-depth qualitative research to learn more about the causes and effects or other factors in order to discover new factors with potential effects on EV purchase intentions. Especially when consumers make purchase intentions that take into account environmental issues and rising oil prices.

3) A suggestion for future research, is that it should consider factors relating to environmental issues or climate change; these must be taken into the main factors in the conceptual framework as in the open-ended questionnaire it was found that some respondents' are concerned with the likelihood of extreme weather from global warming. In future studies, this should be treated as one of the reasons for intentions to purchase EVs among Thai consumers.

4) The research results indicated that Thai people listen to product information from close friends and family more than their own self-study. This point deserves to be studied in depth, in order to determine the root cause.

5) The impact of environment issues in affecting intentions to purchase EVs wasn't discussed deeply in this article. In similar studies, environmental issues should be taken as a focus in the study, including how much they affect intentions to purchase EVs among Thai consumers.

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