International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-7 Issue-4, September 2018

Factors Influencing Purchase Intention towards Electric Vehicles in Bangkok Metropolis

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Abstract*: Electric Vehicles (EVs) is the modern vehicle technology with a rapid development which will alleviate the problems of energy, air pollution and global warming that are becoming more severe. This paper was aimed at the study the relationships between individual factors and factors influencing purchase intention toward EVs in Bangkok Metropolis. The questionnaires distributed to 50 respondents were collected by online survey in Bangkok Metropolis which descriptive data were analyzed and inferential information by used a statistic: means, percentage, standard deviation and chi-squared test. According to the results obtained of the questionnaires show that Infrastructure factor and Financial factor were very important with the averages of 4.60 and 4.50 respectively, and the factors that were fairly important were Performance, Government Support, Market Efficiency Awareness, Environmental Impact and Information Awareness with the averages of 0.47, 4.06, 4.02, 4.00 and 3.68 respectively from most to least. Furthermore, the correlations between the demographic variables and purchase intention towards EVs in the future shown that the variables of gender, age, occupation, education highest and monthly income are all no significantly different for purchase intention towards EVs in the future. The results of the present research can help the researchers to continue create a new model forecasting toward EVs adoption in the future.

***Index Terms*: Electric Vehicles, Factors influencing, Purchase intention.**

I. INTRODUCTION

During the past years, many countries all over the word began to attach more importance to a vehicle that uses electric energy that is called EV and there has been a relentless attempt to replace a car that uses fuel oil as the main energy for its mobility with EV in order to reduce the problems of energy [1], air pollution and global warming that are increasingly more severe. Announced in December 2015 and enforced in November 2016, the Paris Agreement set the objective of limiting the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial level [2]. Therefore, the worldwide growth of EV tends to rise. According to the report in "Bloomberg New Energy Finance (BNEF) by 2040", more than half of all new car sales will be electric. At the same time, EVs will account for a third of the automobiles on Earth. That's about 559 million vehicles. The International Energy Agency (IEA) forecasted that EV will replace the ICE (the internal combustion engine) in the near future [3].

EV's technology will grow very fast in the future because of the production costs that are quickly reduced due to the advancement of various research developments [4]. It is anticipated that EV's market share will be as high as 35% of the total world car sales value in 2025 and will rise to 48% in 2030. The number of total global stock EVs that shows trend rising continuously and expected to gain significant popularity over the next year onwards [3]. In 2016, even though the total global car sales were only 0.83% (inclusive of HEV) of the total sales of all vehicles or only 0.78 million cars, the growth rate was 42% compared with that of the previous year and it was approximately 10 times higher than the sales of (ICE) and HEV. The brands that are popular and have high total sales are Renault Zoe, TESLA Model S, Mitsubishi Outlander PHEV and Nissan Leaf, especially in the main markets like USA, Europe and Japan. However, in China, the EV market is the local EV brand that is domestically produced and sold, and this tremendously reflected the advanced development of EV industry. China is very successful in developing EV industry. In addition to the increased number of users, the number of manufacturers of EV and parts has also risen [5]. In 2017, Japan's Nissan car group announced their readiness for the sale of NEW Nissan LEAF EV in Thailand and 6 countries in Asia and Oceania such as Australia, Hong Kong, Malaysia, New Zealand, Singapore and South Korea. In Thailand, it is anticipated that the sale will begin in 2019.

In Thailand, EV is the trend which is increasingly talked about through the awareness from various domestic and overseas media in terms of the advanced competition of modern technology development, the improvement of performance efficiency to appropriately meet users' demand and the environmental friendliness. Thai EV began to go in the same direction as the world market. The report [8] found that in 2016 the accumulated number of registered EVs increased from the previous year at a high rate. The accumulated number of registered PHEVs and BEVs in the period from 2011 to 2016 increased by 32% and that of HEVs increased by 13%. This is opposite to the accumulated number of registered ICEs that has continuously fallen to 4%. However, the number of EVs in Thailand still has a low proportion compared with the whole accumulated number of registered cars at the end of 2016.

Revised Manuscript Received on 30 September 2018.
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The combined accumulated number of registered PHEVs and BEVs was only 132 cars whereas the accumulated number of registered HEVs in Thailand since 2010 has been 79,657 cars (49% of the total accumulated registered cars). The reason for this is that BEV is the new technology for Thai consumers, so they are not confident in the performance and the price is still high in accordance with the battery

cost (the battery cost is approximately 50% of the car price); besides, there are limited number of charging stations and there are also other factors concerning the interest to purchase them in the future. The Energy Policy and Planning Office [6] reported the situation in Thailand that the adoption of EV began in some areas but it was still limited to the organization level or was only the research for finding the way to develop various infrastructures such as the charging station and the EV test driving on the road. The real use of EV by the consumers or the people did not occur yet. The car manufacturers probably saw many limitations in importing EVs into the market in Thailand such as car import duties, the infrastructure of the charging station or the consumers' confidence in the performance of EV. Besides, there are many important factors that promote and encourage the consumers to make decision to use more EVs such as the price of EV in the global picture that tends to decrease in the future. There are encouragements to increase the number of charging stations to meet the number of the increased EVs in the future and promote the research and development of EV in the aspects of performance efficiency in response to the users' demand and safety. Consequently, in order to study these factors that will have an impact on the decision to purchase EVs, the researcher wanted to study the factors influencing purchase intention towards EVs in Thailand and would like to forecast the number of EVs in the future. These two questions are the main topics in this research which aims to make all related stockholders pay attention and give the joint support to push the real adoption of EV.

II. LITERATURE REVIEW

According to the previous researches, the factors influencing purchase intention towards EVs were the studies in many dimensions such as the study of the survey, dept-interviews of experts and academicians directly related to EV. From the study of the pilot project in the prototype city, the study of the examples of the successful countries and many overseas related researches, we could see that there are studies in a broad circle, mainly in the developed countries with the real adoption of EV. Recently, Nissan-commissioned study [7] titled "Future of Electric Vehicles in Southeast Asia" the research result show that 37% of the users in Southeast Asia are ready to choose EV as their next car; simultaneously, 44% of Thai users are ready to use EV as their next car. The data from the research revealed that the interested people are the age group of under 40 and the family with 4-5 members. These are the people who are interested in technology and modern cars, and they are not interested in vintage cars. Many related factors that have an influence on the intention to purchase EV are analyzed. Because all factors have related direct and indirect influences, the research found that there are the gap and a lot of interests. Reference [8] shows used a large-scale survey of 44, 931 drivers in USA and he found that highly educated and higher-income consumers were more willing to purchase EVs. Reference [9] shows carried out a web-based survey of 3,029 US residents and found that age and education, green consumption and expectations of gasoline prices were important influences. Moreover, the driving range, charging time to full power, cost of energy consumption, pollution emissions, and relative speed and specific attribute had a more critical impact on the consumer's intention to pay than the individual's demographic characteristics. Reference [10] shows conducted a survey and found that fiscal policy and related preferential policy were the main motivations for their purchase. The high purchase price of an EV is a significant obstacle to widespread EV diffusion [11]. Reference [12] shows study examined the factors that influence an individual's intention towards the adoption of full electric vehicles and found that the perception of economic benefit is one of the key factors influencing the adoption of full electric vehicles. Recently, research on consumer attitudes reviewed the literature on consumer preference for electric vehicle in 2016 [13]. Reference [14] shows classified and summarized the influencing factors of consumer preferences such as psychological factor, socioeconomic variable, social influence and mobility condition. The interesting research [15] used a survey on the questionnaires of 1,057 Chinese online consumers and found that the charging infrastructure is also an influence on consumers' preferences. The reference [16] shows that examined the attitudes of Shanghai residents towards electric vehicle found that the respondents in each of the three groups preferred electric vehicles with a longer driving range, a shorter charging time, a faster maximum speed, lower pollution emission, lower fuel cost, and a lower price.

The government's support policy is important because it encourages the people to use more EVs. The Electric Vehicles Initiative (EVI) is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide. EVI members include Canada, Chile, China, Finland, France, Germany, India, Japan, Mexico, the Netherlands, New Zealand, Norway, Portugal, Sweden, the United Kingdom and the United States. Its policy is to push the adoption of EVs in the country. USA, China, Japan, Spain, the Netherlands and Sweden gave financial support to persuade people to purchase and use EVs. Germany, Denmark and India gave the support by reducing car tax and road tax. Some countries like Finland, France and Italy gave financial support to reduce electricity price directly and indirectly. Regarding the infrastructure support, the government of each country attached importance to the infrastructure. Denmark, Finland, USA, Spain, the Netherlands, France and Japan gave support to EV charging stations in order to increase the number of the charging stations in response to the use of EVs. Germany and India supported the infrastructure by setting a national policy and establishing the model region so that it will be expanded to other cities.

Because of these policies, people began to use more EVs. In addition, there are researches that support the policy-related factors; for example [17] studied the analysis of factors affecting the deployment of Electric Vehicles. The research results found that there is no single effective policy tool or the circumstances of the countries for electric vehicle supply. Therefore, there should be the mixed policies on the deployment of EV.

However, some researches had a different perspective such as the research [18] which argued that the environmental performance of electric vehicles was a stronger predictor than price and driving range; confidence and the environmental properties of EVs are more important than their general attributes.

Based on the review of related researches, the monitoring and the analysis of the situation in Thailand in the past period until now, the factors influencing purchase intention towards EVs in Bangkok Metropolis are summarized 7 factors as follows: Financial, Performance, Infrastructure, Market efficiency awareness, Information awareness, Environmental Impact and Government support.

III. OBJECTIVE

To investigate the key factors influencing purchase intention towards EVs in Bangkok Metropolis.

Analyze the correlations between the demographic variables and purchase intention towards EVs in the future.

IV. SCOPE OF RESEARCH

To determine the scope of this study, the researcher focused on studying the key factors to obtain the main influencing factors in the research process of this study. Subsequently, all sub-factors influencing purchase intention towards EVs will be studied in the next scope.

A. Variable of research

Each factor was presented the description of the factor categories, as obtained from the focus group, is given as shown in Table I.

Table I. Factors' Dimension Definition

Factor	Definition
Financial	These factors are related to the car price, fuel cost, maintenance cost, etc.
Performance	These factors are related to speed, acceleration, safety, range, battery, etc.
Infrastructure	These factors are related to charging stations, battery changing stations, etc.
Market efficiency awareness	These factors are related to design, technology, promotion, model variety, etc.
Information awareness	These factors are related to the attitude, advertisement, brand royalty, etc.
Environmental impact	These factors are related to the environmental friendliness, air pollution, etc.
Government support	These factors are related to the tax exemption, support policy, law, etc.

V.METHODOLOGY

This research is designed as a survey research which asked the respondents questions and recorded their responses. The results of the research will correspond with the objectives of the study.

A. Population and Sample

The population of this study is in Bangkok Metropolis. Samples are selected from Bangkok Metropolitan region which consists of 4 provinces namely Bangkok, Nonthaburi, Samutprakarn, and Pathumthani. This research was initially conducted on the sampling of 50 respondents by Stratified Random Sampling with a focus on the research objective.

B. Research Instrument

According to the previous researches which collected data from the literature review, the search in the website, the in-depth interviews of 6 stockholder groups in Fig.1. Hence, those discussions were interesting in terms of the dimensions that affect the EVs in Thailand. Finally, the questionnaire survey was validated by 5 experts who examined, evaluated, improved and used it with the sampling group.

Fig.1 The EV's Stockholders

The primary data was obtained from an online questionnaire. A total of 50 respondents answered the try-out questionnaire to prove the reliability.

1) The first part was designed by using the close-ended portion of questionnaire which adopted items from relevant literature. All items were the individual's demographic characteristics.7 items were measured by using a 5-point Linkert's scale of importance for rating: 5 points, 4 points, 3 points, 2 points and 1 point.

2) The third part of the questionnaire contains an open-ended portion of questionnaire "More suggestions on factors that will influence the future demand for EVs in Bangkok Metropolis".

C. Data analysis and statistics

The descriptive statistics of this study uses percentage and means. The average score is an assessment of the results based on the analysis of five levels; the result of each factor is the analytical interpretation of Means Scores evaluation.

The cross-table analysis was applied to get the two-dimensional whether there are relationships between demographics variables and the purchase intention EVs using the Chi-square test.

VI. RESULTS

A. Demographics of the Respondents

The demographic characteristics of respondents were shown in Table II.

Table II Background Characteristics of the Respondents

(N=50)	Item	Percentage	Cumulative
Gender	Female	46.0%	46.0%
	Male	54.0%	100.0%
Age	Less than 20	0.0%	0.0%
	20-30	18.0%	18.0%
	31-40	38.0%	56.0%
	41-50	42.0%	98.0%
	51-60	2.0%	100.0%
	More than 60	0.0%	100.0%
Highest Education	Primary	0.0%	0.0%
	Secondary	4.0%	4.0%
	Diploma degree	2.0%	6.0%
	Bachelor's degree	44.0%	50.0%
	Master's degree	44.0%	94.0%
	Doctoral degree	6.0%	100.0%
Occupation	Student	6.0%	6.0%
	Civil servant/State Enterprise employee	16.0%	22.0%
	Company employee	54.0%	76.0%
	Own business	16.0%	92.0%
	Self-employed	4.0%	96.0%
	Farmer	0.0%	96.0%
	Employee	2.0%	98.0%
	No occupation	0.0%	98.0%
	Other	2.0%	100.0%
Monthly Income	Less than 10,000 Baht	4.0%	4.0%
	10,000- 30,000 Baht	28.0%	32.0%
	30,001-50,000 Baht	28.0%	60.0%
	50,001-70,000 Baht	14.0%	74.0%
	70,001- 100,000 Baht	12.0%	86.0%
	100,001-150,000 Baht	6.0%	92.0%
	Over 150,000 Baht	8.0%	100.0%
Vehicle for Traveling	Private car	64.0%	64.0%
	Public transport	10.0%	74.0%
	Sky train	16.0%	90.0%
	Taxi	2.0%	92.0%
	Other	8.0%	100.0%
Daily Travel distance	Less than 10 km.	24.0%	24.0%
	10 – 50 km.	60.0%	84.0%
	51 – 100 km.	14.0%	98.0%
	More than 100 km.	2.0%	100.0%
Number of car owned	None	10.0%	10.0%
	1 car	34.0%	44.0%
	2 cars	24.0%	68.0%
	3 or more	32.0%	100.0%
Knowledge about EV	Very little	22.0%	22.0%
	Little	44.0%	66.0%
	Moderate	28.0%	94.0%
	Good	4.0%	98.0%
	Highest	2.0%	100.0%

B. Factors Influencing Purchase Intention Towards EVs

According to the respondents, the financial factor and the infrastructure are very important with an average of 4.56, 4.60 respectively. The factors that are fairly important are performance, market efficiency awareness, information awareness, environmental impact, and government support with an average 4.32, 4.02, 3.68, 4.00 and 4.06 respectively as shown in Table III.

Table III. Factors Influencing Purchase Intention towards EVs according to Respondents' Opinion.

Factors influence	Average	S.D.	Result interpretation
1. Financial	4.56	0.52	Very important
2. Performance	4.32	0.47	Fairly Important
3. Infrastructure	4.60	0.53	Very important
4. Market efficiency awareness	4.02	0.42	Fairly Important
5. Information awareness	3.68	0.37	Fairly Important
6. Environmental Impact	4.00	0.42	Fairly Important
7.Government support	4.06	0.43	Fairly Important

The results of the analysis in Table IV show that approximately 56.0% of respondents to purchase intention the EVs in the future. The proportion 38.0% of respondents was not sure to purchase intention EVs. Whereas the respondents 6.0% no need to purchase intention EVs in the future.

Table IV. The Purchase Intention Towards EVs in the Future.

(N=50)	Answer	Percentage	Cumulative
Purchase intention the EV in the future	Yes	56.0%	56.0%
	No	6.0%	62.0%
	Not sure	38.0%	100.0%

C. Correlations between the Demographic Variables and purchase intention EVs

The cross-contingency tables and chi-square test are used to analyze the correlations between the demographic variables and purchase intention EVs.

The proportion of men and women will purchase intention EVs is the same (56.0%). The gender variable is no significantly different with purchase intention by a Chi-squared test ($\chi2$=5.051, df=2; p=0.080>0.05).

In terms of the age, the respondents of age group between 31-40 will not purchase intention EVs, whereas the proportion of respondents 41-50 years old will purchase intention EVs is higher. The age variable is not significantly different in purchase intention by a Chi-squared-test ($\chi2$=2.715, df=6; p=0.844>0.05).

With the proportion of the highest education, level of master's degree will purchase intention EVs. The education highest is also no significantly different in purchase intention by a Chi-squared-test ($\chi2$=6.533, df=8; p=0.588>0.05).

In terms of the occupation, the proportion of the company employee will purchase intention EVs is relatively high. Overall it can be stated that the occupation is not significantly different in purchase intention by a Chi-squared-test ($\chi2$=6.469, df=12; p=0.891>0.01).

In term of monthly income, the respondents with annual income 10,000-30,000 baht will purchase intention EVs.

The monthly income is no significantly different in purchase intention by a Chi-squared-test ($\chi2$=8.057, df=12; p=0.0781>0.05).

To summarize, we found the correlations between the demographic variables and purchase intention EVs that the gender variable, the variables of age, occupation, education highest and monthly income are all no significantly different in purchase intention the Electric vehicle.

D. Suggestions

The final part is the suggestions concerning the factors that influence the purchase intention towards EVs in Bangkok Metropolis. Many questions were shared, and the suggestions are as follows:

- **1.Financial factor**
- EV should have lower prices than the current prices.
- If prices are appropriate and there are enough charging stations, EV is a very interesting alternative for the respondents.
- **2.Performance**
- Expectation of the battery performance e.g. long life, safety, capacity, efficiency
- **3.Infrastructure**
- Charging station is very important.
- **4.Market efficiency awareness**
- Fuel consumption is higher, so it may be necessary to turn to electric cars in the future. EV have lower prices. The people can own them.
- EV is the new technology. The respondents' comment is that solar energy is better than EV.
- **5.Information awareness**
- The government and the related sectors should encourage the public to have a better understanding.
- The respondents want the government to use serious measures.
- **6.Environmental impact**
- Vehicles tend to be more environmentally friendly.
- The government should be sufficiently courageous to support the policy for EV, not the oil business.
- Encouragement to reduce pollutions
- **7.Government support**
- The government should support all positive factors influencing towards EVs in near future.

VII. CONCLUSION

This paper takes Bangkok Metropolis as a case study to examine the factors influencing purchase intention towards EVs. Fifty questionnaires of the respondents were analyzed for the descriptive information by using the means and percentages. The data shows that 54% of the respondents are males, 42% are below 41-50 years old, 44% have a bachelor's degrees and a master's degree, 55% are company employees, 28% have the monthly income of 10,000-30,000 baht and 30,000-50,000 baht, 64% of them have a private car, 60% travel distances every day, 34% own and use 1 car, 44% have little knowledge about EVs and the respondents had purchase intention EVs in the future 56%. With the proportion of factors influencing purchase intention EVs, th infrastructure factor and financial factor are very important with an average of 4.60, 4.56 respectively and the factors that were fairly important were performance, government support, market efficiency awareness, environmental impact and information awareness with the averages of 4.32, 4.06, 4.02, 4.00 and 3.68 respectively from most to least. In term of the correlations between the demographic variables and purchase intention towards EVs shown that the variables of gender, age, occupation, education highest and monthly income are all no significantly different for purchase intention towards EVs.

For the next scope, the researcher will continue the study of these factors to identify each factor influencing purchase intention towards EVs by using the research methodology that focuses on the research objective in order to create a new model forecast of the EV's demand in the future.

DISCUSSION

In Thailand, EVs still have a limitation in the complete adoption [19], it just promotes strongly the development of infrastructure such as charging stations; EV try-out driving is on the road, but consumers or the public do not really drive them. Hence, EV real driving has not happened. Major factors are import car duties, infrastructure, charging stations, and consumers do not have confidence and experience in using EV. Moreover, the government should support the research and development of EV technology, especially in terms of performance. The government should support the establishment and opening of charging stations. OEM car makers of EV may see restrictions in many aspects of importing EV into the market of Thailand. Therefore, the government should have the national policy on the management of major keys such as limited energy resources, environmental problem, global warming and climate change challenges because they strongly affect the people's quality of life and the country's competitiveness.

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