ELECTRIC VEHICLE UPTAKE IN THE KINGDOM OF THAILAND: ANALYSIS USING ANALYTIC HIERARCHY PROCESS

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A THEMATIC SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

SCHOOL OF INFORMATION TECHNOLOGY

SRIPATUM UNIVERSITY

2018

THEMATIC TITLE	ELECTRIC VEHICLE UPTAKE IN THE KINGDOM OF THAILAND: ANALYSIS USING ANALYTIC HIERARCHY PROCESS
KEYWORDS	AHP, ANALYTIC HIERARCHY PROCESS, MULTI-CRITERIA DECISION MAKING, ELECTRIC VEHICLE, THAILAND
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LEVEL OF STUDY	MASTER OF SCIENCE IN INFORMATION TECHNOLOGY
FACULTY	SCHOOL OF INFORMATION TECHNOLOGY, SRIPATUM UNIVERSITY
YEAR	2018

ABSTRACT

Pressures on climate change and dwindling oil reserves have forced nations to start the switch from conventional engine vehicles to electric-driven ones. Government and OEMs drive and encourage the market to make the switch. Some countries have successfully introduced the usage of electric vehicles by studying which factors and criteria are important. In doing so, they have introduced policies and initiatives making electric vehicles more desirable to own. Thailand is also determined to usher in the use of electric vehicles in the Kingdom. The government formed a new agency EVAT to oversee and make policies to implement this in the country. Whether Thai consumers buy and accept EV cars is a big question mark and remains a complex decision-making choice. By using Analytic Hierarchy Process, this paper gives a systematic analysis for defining the main factors involved in the uptake of electric vehicles in the Kingdom of Thailand.

ACKNOWLEDGEMENTS

I would first like to thank my thesis advisor Asst Prof Dr Paralee Maneerat of the School of Information Technology at Sripatum University. The door to Prof. Maneerat's office was always open whenever I ran into a trouble spot or had a question about my research. She consistently allowed this paper to be my own work, but steered me always in the right the direction.

I would also like to thank the experts, my friends in the automotive industry, who were involved in the validation survey for this research project. Without their passionate participation and input, the validation survey could not have been successfully conducted.

Finally, I must express my very profound gratitude to my wife Kittiyakorn and my family and two sons, for providing me with unfailing support and continuous encouragement through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Paulino Mendoza, Jr.

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CHAPTER 1

1.1 Background and Nature of the Problem

There are growing pressures to increase the uptake of electric vehicles due to environmental changes and high prices of exhaustible fossil fuels. This has led many countries to advocate and to encourage the production and usage of electric vehicles. Thailand is one of many countries to join in this initiative.

Thailand is the 15th largest automotive manufacturing nation in the world. This transition to electrified vehicles has both negative and positive implication to the country. As this technology is disruptive and has major impacts to the parts manufacturing and complete vehicle assembly, the Thai government has not remained complacent and has drafted their own policy to keep abreast of world development in this area.

This policy has come in the form of a National EV policy which was initiated in March 2016 by the incumbent government. Based on this initiative, Thailand aims to have reached a milestone of 1.2Mio EV on the road, and 700-800 charging stations all over the country (Changsorn, 2016). While this domestic automobile usage may seem modest in comparison to amount of vehicles that Thailand annually manufactures, Thailand being a significant vehicle and auto parts exporter aim to capitalize on the manufacture of EV parts and EV vehicles for export. Still, with the relatively small number of EV vehicles that the government is targeting to be in the streets for the next 20 years, it is any wonder if the public can be coerced and convinced to make the transition to purchase and use EV in the coming years.

Situation in the countries with considerable usage of EV has shown that it is government incentive schemes that has encouraged and pushed the switch from ICE to EV usage. (Mersky et al, 2016) Still, what is interesting to understand is whether a country with a high awareness of the virtues of Electric Vehicles, being a prominent auto parts manufacturer, can transition easily and switch to EV, even if there are not so much pushing from the government.

This study will develop a model for structured techniques to organize and analyse this complex situation. Analytic hierarchy process is a technique, which is an effective tool for dealing with complex decision making, and may aid in setting priorities and defining the best decision. (Saaty, 2008) This tool will be investigated and explored to derive probable outcomes to this electric vehicle initiative in Thailand.

Therefore, this study aims to make a detailed picture on the technology commercialization of Electric Vehicles in Thailand, and whether predictive algorithms can make a substantial analysis of how the development will be.

1.2 Objectives of the study

This study will strive to do the following objectives:

1. Study the environment, opportunities and measures taken to introduce and propagate the commercialization of electric vehicles in a number of countries leading in the usage of such technology
2. Study the environment and conditions involved in the technology commercialization of electric vehicles in Thailand.
3. Define and structure the decision making model and conduct the analysis using Analytic Hierarchy Process.
4. Verify the results.

1.3 Study Questions

This study aims to make a detailed investigation on the feasibility of technology commercialization of electric vehicles in the kingdom of Thailand. This study will lay out all the different options and provide rankings.

There are now numerous studies done regarding electric vehicle technology and its applications and impact to transportation and modern lifestyle. Looking at the history of papers and projects that are found in this domain, most do not report on the impact towards the Thailand situation.

During the course of the study, electric vehicle implementation in various countries will be studied to give an indication of the environment and the underlying factors influencing the proliferation and acceptance of the technology. This will then be related to the Thai situation.

The main questions to be asked and hoped to be answered with this study are which are the main factors to consider to propagate the proliferation and adoption for use of electric vehicles in the Kingdom of Thailand.

Using a structured decision making model to this situation, we should be able to provide a ranking of the different alternative and find the “best” course of action to take.

1.4 Scope of the study

This study will focus on the topic of technology commercialization of electric vehicle on the Kingdom of Thailand. Parallel situation will be studied in countries where EV technology is starting to be commercialized.

A decision-making model will be used to layout the different alternatives and provide a ranking. The actual implementation is outside the scope and will not be covered by this study.

1.5 Benefits of the study

The study expect to provide the following benefits:

1. Academic benefits
    - 1.1 The study will provide an overview of the technological and social environments in selected countries which lead the way in using electric vehicles.
    - 1.2 The study will revolve around the various implementation and commercialization of electric vehicles in different countries.
    - 1.3 Another benefit to be derived from this study would be to witness the application of a decision-making model will be used in this study, particularly AHP Analytic Hierarchy Process. The academic community will benefit with a case study applied to a real-life situation in Thailand.

2. Economic benefits
    - 2.1 Government policymakers may benefit by being given new insights on the implementation of technology commercialization in other leading countries like China, USA and Norway.
    - 2.2 Vehicle companies will benefit from the model as they get an overview of the various dynamics and interactions among the stakeholders. Strategies can be defined in order to maximize the potential market penetration of EV technology in the Thai market.

1.6 Word dictionary

AHP	Analytic Hierarchy Process is a structured process developed by Thomas Saaty, which is a tool for dealing with complex decisionmaking, and is used to aid the decision maker to set priorities and make the best decision.
BEV	Battery Electric Vehicle is a type of electric vehicle, which uses chemical energy in rechargeable high voltage battery packs for propulsion. All power is derived from the battery system and there is no conventional combustion engine.
EV	Electric Vehicle is a vehicle which uses one or more electric motors for propulsion. These vehicles are normally powered by a self-contained battery which may be used solely, or in conjunction with a conventional combustion engine to drive the wheels. There are various types of EV vehicles based on the propulsion types.
LIB	Lithium-ion Battery
PHEV	Plug-in Hybrid Electric Vehicle has both a conventional combustion engine as well as a rechargeable battery pack. Propulsion is derived from the engines alternating to drive the wheels with the battery pack powering the vehicle during low speeds, while the combustion engine switching to drive the vehicle at medium to higher speeds.

Chapter 2

2.1 History of Electric Vehicles

Electric vehicles may appear to be an new innovative solution to the growing road congestion and worsening air quality in many parts of the world. It is surprising to know that this technology is not a new one, with the first electric vehicle being built sometime in 1834. A British inventor, Robert Anderson, developed the first crude electric car during this time, although it could be more accurately be termed as an electric carriage. Practical electric cars started to be build during the latter half of the 19th century by French and English inventors. By 1900, a third of all vehicles in US roads were electric. The rest of automobiles at that time were either gasoline or steam engine driven.

At that time, electric cars were popular, as it did not have any of the issues associated with the steam or gasoline cars. They were quiet, easy to drive and did not emit a smelly pollutant like the other cars of the time. Gasoline engine required a hand crank to start making them difficult to operate. Urban residents, especially women, accepted the use of electric vehicles. And as road conditions were generally poor outside cities anyway, people generally drove around the city in short trips.

The success of the gasoline powered cars brought about the decline and downfall of electric vehicles. Henry Ford's mass-produced Model T, introduced in 1908, costed $650, while an electric car sold for $1,750. The introduction of the electric starter eliminated the need to crank start the engine, resulting in the popularity and affordability of gasoline powered vehicles.

Other developments speeded the decline in the popularity of electrical vehicles – better improved roads meaning car users get to travel in longer distances, prices of gasoline became lower as more sources are discovered and consumers buying more. By 1935, electric vehicles have disappeared from the market. (US Department of Energy, 2014)

In late 1960s and early 1970s, soaring oil prices and gas shortages created a growing interest in lowering dependence on oil and brought about renewed interest to develop alternative fuel vehicles. OEMs developed prototypes for urban electric vehicles. However, compared to the gasoline engine vehicles, electric vehicles had limited performance with top speed of only 55 kilometers per hour and a range of about 50 kilometers before needing to be recharged.

Once more, in 1990s, The California Air Resources Board passed a new transportation emissions regulations – the 1990 Clean Air Act Amendment – created a renewed interest of electric vehicles in the US. (ARB, 2016) General Motors designed and developed a totally new design – the EV1. It had a range of about 100 kilometers and better acceleration and top speed performance. It gained popularity with a few sectors but was not commercially viable and production was discontinued in 2001.

Fast forward to present, and two main events are considered to be turning points in the revival of electric vehicles. The first one is Toyota's first mass produced hybrid electric vehicle Prius, which can be propelled by gasoline or electric power or both. It has gained worldwide popularity and acceptance, having been sold to about 90 countries and regions. It is claimed that since its inception in 1997, the Prius has surpassed the 4 million units sold by January 2017.

Another major event is the emergence in 2006 of Tesla Motors, which is a small Silicon Valley startup, which produces luxury electric sports car that could go more than 320 kilometers on a single charge. Since their establishment, Tesla has won wide acclaim for its cars.

Tesla' s announcement and subsequent success has motivated many big automakers to accelerate development on their own electric vehicles.

There are now much more choices than ever when it comes to buying an electric vehicle, and it really does have the potential to be a viable alternative to gasoline engines. Though there is so much more factors involved in the acceptance of electric vehicle than having varied products.

2.2 Electric Vehicles Basics

An electric vehicle is a vehicle that is driven by an electric motor, which draws its current either from storage batteries or from overhead cables. A fuel-cell car is an electric vehicle that makes its own electricity. The restricted range of the electric vehicle can be a disadvantage in the countryside. (Collins Dictionary)

In its basic concept, an electric vehicle consists of a battery that provides energy, an electric motor that drives the wheels, and a controller that regulates the energy flow to the motor.

Spurred on with the focus on renewable energy, new technological developments have seen the proliferation and applications to general consumer use. EV passenger vehicles are powered by a rechargeable high voltage battery, with very low carbon emissions. Electric vehicles are now starting to garner attention as a viable alternative to internal combustion engine vehicles as the models and technology are starting to be acceptable for general consumption.

There are three main types of electric vehicles, classed by the degree that electricity is used as their main energy source. Hybrid Electric Vehicles (HEVs) are powered by both petrol and electricity. The electric energy is generated by the car's own braking system to recharge the battery. Plug-in Hybrid Electric Vehicles (PHEVs), similar to the HEVs, which is powered by both petrol and electricity, can be charged by plugging into an external electrical charging unit. Battery Electric Vehicles (BEVs) are fully electric vehicles with no petrol engine. (Valentine-Urbschat & Bernhart, 2010)

Still, there are barriers to all-out acceptance to this technology. Due to urban congestion especially in the city downtown centers, more and more city residents are moving to the suburbs and outskirts of mega-cities. This means that travel distance of motorists are ever increasing, and due to the fact that people are very interested in the comfort standards of their personal vehicles, a number of motorist prefer to drive their own vehicles and not take public transportation. Longer travel distance, the ability to take spurious decisions to travel and get away, are some factors which makes it difficult to wean motorists away from conventional internal combustion driven vehicles.

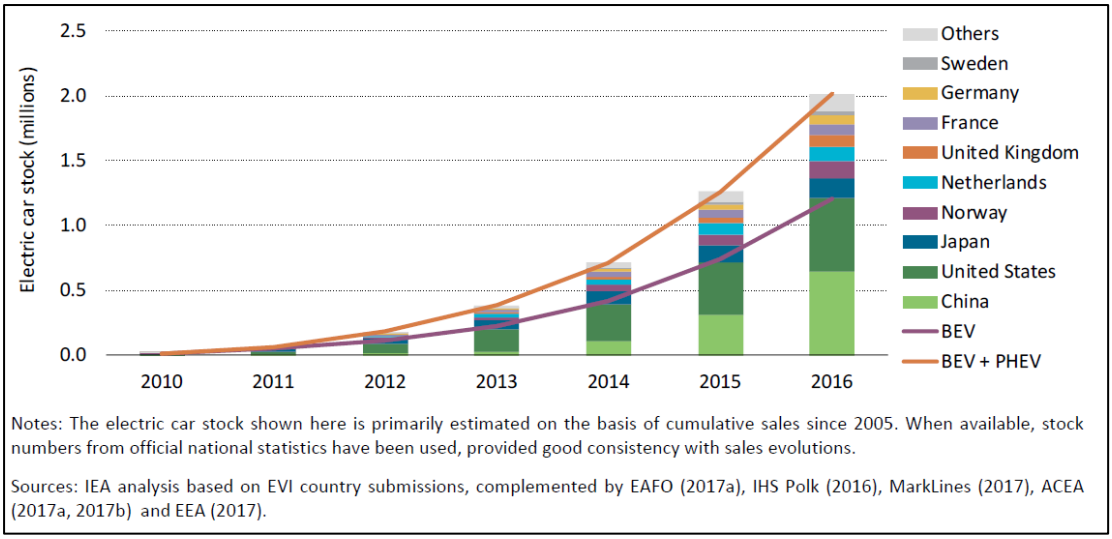
Charging infrastructure and customer negative perception about the driving range see the production and purchase of these vehicles to be in the very low <1 percent of all vehicles sold. Barriers to high market penetration of electric vehicles will be further discussed and detailed in the later parts of this study.

2.3 Trends in Electric Vehicle uptake

In 2016, global registration of electric cars hit 770,000 cars. In the same year, a new milestone of 2 million cars of electric vehicles are plying the global roads. Norway exhibits the most successful market penetration of electric cars with EVs being 29% of the market share. (IEA International Energy Agency, 2016)

China is the largest electric car market. 40% of all electric vehicles sold are registered in this country.

Figure 2.1 shows the progression from 2010-2016 showing significant year-on-year increase in the various countries highlighted.

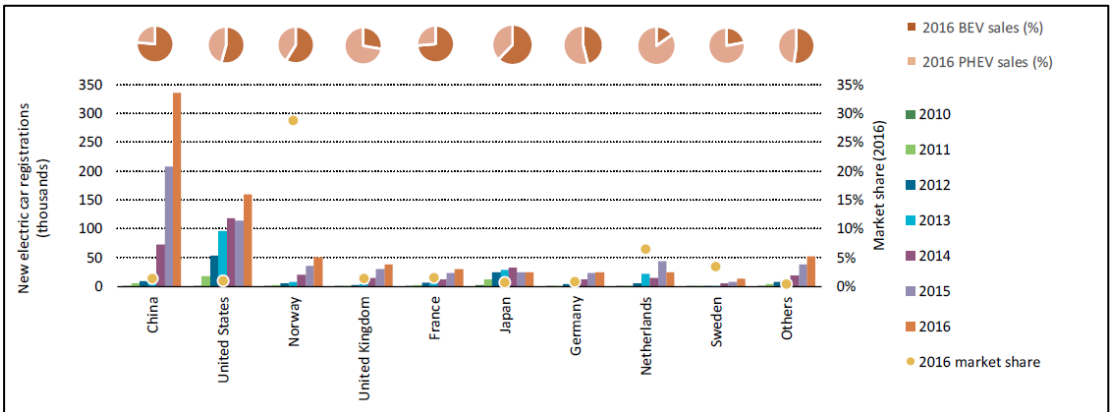


Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.

Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a), IHS Polk (2016), MarkLines (2017), ACEA (2017a, 2017b) and EEA (2017).

Figure 2.1 Global trends of electric vehicle 2010-2016

Figure 2.2 shows the electric vehicle purchases in the leading countries. Note the considerable increase of electric vehicles in China compared to USA and some European countries.



Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a), IHS Polk (2016), MarkLines (2017), ACEA (2017a, 2017b) and EEA (2017).

Figure 2.2 Electric vehicles sales per country 2010-2016

2.4 Thailand Trends towards Electrification

The Thailand government launched the move towards vehicle electrification by establishing the Electric Vehicle Association of Thailand (EVAT) in September 2015. Tasked with promoting the use of EV in Thailand, which will lead to a reduction of road pollution in major cities. EVAT also is charged to support industrial manufacturing, and research and development on EV technologies in Thailand. Membership to this committee comprise leaders and OEMs in the Thai automotive industry. (Praiwan, 2018)

Thailand market for electric vehicles is still restrictive with high prices preventing the high uptake with the general populace. Hybrid car sales in Thailand in 2015 accounted by mere 1% of total cars sold. Thai people perceive that EVs are too high priced compared to the performance of the same or similar conventional models. Even OEMs, Nissan and Toyota stated that the Thai automobile market will only be ready for EVs if there are supportive government measures promoting more competitive prices for EVs. (Pantaweesak, 2016)

PTT, leading petrochemical company in Thailand, signed a memorandum of understanding with six automakers to show commitment to proving electric charging stations for electric cars. The energy minister Gen Anantaporn Kanjannarat presided over the signing ceremony. A targeted of 20 standard EV stations will be opened for to service the public by 2017.

Figure 2.3 PTT signing ceremony (Pracharat, 2016)

Domestic demand has, so far, been limited. The lack of a solid charging infrastructure and high vehicle prices are preventing a high acceptance from the Thai market.

2.5 Consumer behavior towards Electric Vehicles

The focus of this study is to develop a model to assess the value of people place on the different aspects of buying and driving a car.

Barriers to uptake element energy

- EVs have a high premium price over ICEs
- Supply of EVs is limited, in terms of vehicle segments and brands.
- Consumers are concerned by EV's short range and long charging times.
- The majority of private vehicle buyers are not currently receptive to EVs.

2.5.1 Attitudinal segmentation

According to recent study of 3000 UK car buyers (which study???), attitudinal segmentation is a better predictor of EV acceptance.

- Enthusiasts – who are driven by innovativeness and prepared to pay a premium for EVs
- Aspirers – who are interested in EVs but concerned by their technical limitations
- Mass market – followers of social norms and are likely to become more receptive to EVs as their number increases.
- Resistors – who are unlikely to buy EVs as they strongly reject their symbolism (the perceived status and social acceptability of owning an EV). This group's receptiveness to EVs will change only once EVs have lost their current connotations, i.e., only once already widely accepted.

2.6 Market Studies in Various Countries

Top ten motivators influencing the purchase of a new/used car were fuel economy, reliability, brand good reputation, price/value for money performance/engine power, safety. Exterior appearance, riding and driving comfort, low cost maintenance and internal space (Lee, 2014)

The three most important attributes consumers take into account when evaluating car alternatives are the purchase price, the operating costs and the quality of the car. After information is obtained on these attributes, other factors are considered such as monetary attributes, non-monetary attributes , socio-economic attributes and the environmental attributes. Monetary attributes are – purchase price, operating costs which is maintenance costs and fuel consumption. Non-monetary attributes are – quality (reliability and safety), looks, acceleration and engine size, brand loyalty. Socio-economic attributes are important image-function and carrier of social status, to communicate lifestyle. (Lee & Govindan, 2014)

Thai consumers consider " suits with lifestyle and personal preference", better fuel consumption and superior performance and affordable price. Personal story and preferences have much influence on their purchasing decisions. (Ackaradejruangsri, 2015)

EVs present additional considerations compared to conventional cars and various prejudices exists. They may include but not limited to long charging duration and unsatisfying charging infrastructure. After a 6-month study were drivers were allowed to drive and charge EV to get firsthand experience, they found that the perceive (Saaty, 2008) problems were less of a barrier and viewed EV in a positive and likable experience. Those who experienced were not perturbed by the charging duration, although changes to lifestyle have to be made to accommodate for the charging time. (Buhler, 2014)

2.7 PEST Analysis

A study from Copenhagen business School (Mushtaq & Sarwar, 2011), identified key uncertainties

Key Trends

- Increasing focus on electric vehicles
- Rapid growth and rising incomes in Emerging markets
- Increasing urbanization
- The population in emerging nations are growing while the population in mature economies are aging
- Technological shift is heating up competition in the automobile industry
- Rising CO2 emissions
- Increase focus on global warming

- Increasing number of strategic alliances and untraditional technology sharing collaboration within the automobile sector, suppliers and third parties
- Cost pressure / capital pressure
- Lack of qualified engineers and researchers in the mature economies

Key uncertainties

- To what extent will consumer accept the emerging alternative vehicles?
- To what extent are manufacturers able to produce quality technology? Technological success or failure?
- To what extent will fuel prices remain low and stable or will they be high and volatile? Oil to peak soon or later?
- To what extent will governments across the world support with subsidies and promotions
- To what extent will external sources raise capital?
- To what extent will environmental awareness increase?
- How will the role of complementary industries evolve?
- Whether there will be major improvements in technologies
- What extent will new entrants or players emerge?
- To what extent will key suppliers experience profound changes in their industries and markets because of emerging technologies
- Who are the buyers and where are the markets
- How will the emerging fuel technologies impact the rivalry
- What will happen to the industry value chain?

2.8 Literature Review

This study has referenced quite extensively previous studies, which will be outlined in the following paragraphs. In general, researches on the three main topic areas analytic hierarchy process, electric vehicle adoption in a few select countries, and decision mechanisms for the purchase of electric vehicles.

2.8.1 Analytic Hierarchy Process

The development of decision models have referenced the works of Dr. Thomas Saaty on Analytic Hierarchy Process. The AHP concepts he has built detailing the decision-making algorithms to help with complex decision-making. The process also helps the decision-maker to set priorities and make the best decision under the defined set of circumstances. (Saaty, 1990)

Generally, AHP works by evaluating a set of criteria and a set of alternatives. Weights are generated for each evaluation criterion, with the most weight awarded the most important attribute. AHP then assign a score to each option according to the decision maker's pairwise comparison of the options. This AHP assigned score means that the higher score is a better performance of the option. With all the options assigned an AHP score, all the scores are aggregated and a global score and ranking assigned to each option.

It works on the principle that the best option may be the most suitable trade-off between the different criteria. This techniques has myriad of applications where the implementation of AHP as a multiple criteria decision-making toll that has been used in almost topics and subjects related to decision-making. A few cases were chosen to demonstrate the capabilities of AHP. (Vaidya & Kumar, 2004)

One interesting study was to apply Analytic Hierarchy Process principles in the selection of luxury vehicles. The research made a comparative analysis of affective factors in the domestic purchase of premium luxury vehicles in which the most important criteria compared were flexibility in customer customization, brand image and after sales service quality. The study provided a deeper understanding of the problem and the systematic approach towards the decision-making methodology. (Apak, Gogus, & Karakadilar, 2012)

Another study referenced in this research is the use of Analytic Hierarchy process to find prioritization of functional strategies (manufacturing, marketing, human resource, and financial management) by small and medium enterprises operating the auto parts manufacturing sector in Pakistan. The study presented a clear and concise easy to understand application of the AHP technique which lead the researcher to understand the methodology on how to make a successful study. (Ahmad & Pirzada, 2014)

With respect to this study, it is hoped that the proper application of AHP regarding the technology commercialization of electric vehicle in Thailand may help to detail out the options and provide a ranking of alternatives in order to flesh out and make more transparent the alternatives and options involved in this topic.

2.8.2 On electric vehicles in various countries

A number of countries have already successfully initiated the technological commercialization of electric vehicle as a viable choice for consumers. A variety of models has been setup to analyze factors that influence market uptake and the different ways to accelerate diffusion of the technology.

Countries like Norway, China and USA have made numerous studies and have compiled huge experiences in their jurisdiction. Studies made in these countries are referenced extensively in this paper.

Mersky, et al., 2016 made a study on the implementation of EVs in Norway. They analyzed the sales of electric vehicles on a regional and municipal basis and cross analyzed with demographic data to ascertain which factors lead to a higher BEV adoption. Government incentives to alleviate the EV higher prices, exemption from road access tolls, access to charging stations, and use of public bus lanes were also investigated. It was concluded that access to BEV charging infrastructures and regional incomes had the greatest predictive power for the growth of BEV sales. (Mersky, Sprei, Samaras, & Qian, 2016)

2.8.2.1 Electric Vehicles in Norway

Some interesting facts, as of September 2014, Norway is considered to be the undisputed world leader in terms of the BEV market share of new vehicles sold. As of January 2018, registration statistics show that sales of electric and hybrid cars rose above 50% of new registrations in 2017. Norway exempts new electric cars from almost all taxes and grants perks in terms of free or subsidized parking, re-charging and easy access to toll roads, ferries and tunnels. In this regard, Norway is far ahead of any nations regarding electric vehicle sales and usage. (Knudsen & Doyle, 2018)

2.8.2.2 Electric Vehicles in China

China is another country where there is considerable uptake of electric vehicle. Technological progress and development prospects were highlighted in a study by Du (2013).

Government activities and policies on supporting electric vehicle development such as subsidies, tax reduction and exemptions. Private buyers in Beijing, Shanghai, Changchun and other city states are given subsidies of RMB50,000 for PHEVs and max subsidies of RMB60,000 for BEVs. Other inventive policies are travel tax relief and free issuance of license plates.

Technological advances on high voltage batteries, traction motors, fuel cell technologies and overall electric vehicle were also highlighted in the Du study.

Electric vehicles appear to be well-fitted to Chinese commuter needs. A large percentage of the car market is made up of fist-time car buyers. Being first time car users, they are not so accustomed to the greater power and longer range of conventional gasoline engine cars. Commutes in Chinese cities are typically short distances at low speeds at congested traffics. These are driving conditions which are suitable for electric vehicles.

Obstacles that may hinder the growth include the prohibitive prices of electric vehicles compared to its gasoline counterparts, and the availability of charging stations for the vehicles.

The majority of urban Chinese live in apartments, thereby making it difficult to install personal charging systems. Ultimately, the cost of electric vehicles will be the main factor influencing the widespread uptake in China. As the projected pricing of electric vehicles are higher than the fossil-fueled counterparts, this price gap may eventually force a majority of consumers to purchase conventional engine cars. (Hoversten, 2010)

2.8.2.3 Electric Vehicles in the United Kingdom

The United Kingdom is another country worth noting in terms of electric vehicle proliferating its roads. In a study commissioned by The Committee in Climate Change, the UK market is assessed in terms of outlook on supply and the main factors influencing vehicle purchase. A model of consumer demand was plotted and developed to assess the value people place on different aspects of purchasing and owning a car in Great Britain. These aspects consists of up-front costs, running costs, driving range, servicing, infrastructure, and charging times. As well, the study analysed and matched consumer preferences with the current and projected supply of EVs and their characteristics. Barriers to market uptake were identified and some recommendations to overcome these barriers were defined. (The Committee on Climate Change, 2013)

2.8.3 Decision Mechanisms on Electric Vehicle Purchases

This study has investigated a number of literature which studies the intent of consumers to purchase electric vehicles and on a larger scope, vehicles in general. Obviously, knowledge on user acceptance for electric vehicles have a high relevancy towards major stakeholders in this new vehicle market.

The studies had a common insight to understand the decision mechanisms involved in car purchase decisions. Of an even more interesting note is to understand the needs and behavior to purchase a hybrid or a fully electric vehicle.

In a survey done with French-German EV users, several advantages were stated such as advantageous driving characteristics, reduced CO2 emissions, and enhanced prestige. However, two main barriers were identified, which is, limited range and high purchase prices. (Ensslen, Kuehl, Stryja, & Jochem, 2016)

A study by Egbue indicated that consumer acceptance of HEVs is influenced by perceived risks with the new product as opposed to benefits derived due to better fuel efficiency, size and price. The study concluded that cost and performance are the main factors which sustainability and environmental benefits are the perceived factors favoring the adoption of EV vehicles. (Egbue, 2012)

Priessner's research categorized the characteristics to have an influence on willingness to purchase electric vehicles for consumers in Austria. Four main grouping were established and subgroups defined within these four main groups. (Priessner, Sposato, & Hampl, 2017) Shown in Table 3-1 are the categories developed in the study.

Table 3.1 Purchase and non-purchase motives (Priessner, Sposato, & Hampl, 2017)

Factor 1	General EV motives	Emission-free protection of the environment and climate high efficiency of electric motor ideal for short distances low operating costs
Factor 2	Technological motives	Charm of modern technology Low noise EV battery as buffer storage
Factor 3	Structural barriers	Availability of e-charging stations Too expensive Range of the car Short-live batteries Low charging duration No charging station at apartment
Factor 4	Attitudinal barriers	Diesel car is clean enough High complexity The electric car is only a transition technology Electric cars are rather small Also pollutes the environment

A similar line of study was done in China by Wang, wherein online Chinese consumers were subjected to a survey and were asked questions on willingness to adopt electric vehicles. Factors affecting consumer' s willingness to purchase electric vehicles are summarized as follows: Demographics, Personality Characteristics of Consumers, Perceived Risks, Performance Attributes, Financial Benefits, Marketing Effectiveness, Charging Infrastructure, Government Policies and Social Influence. (Wang & Liu, 2015)

CHAPTER 3

3.1 Research Methodology

This research is a study to develop a predictive model on the popular use of electric vehicles in Thailand. Various related literature has been gathered and used as initial reference to generate baseline L1 information. A group of experts were consulted their personal opinions on the initial baseline reference. The experts' responses are converted into quantitative information and used in the model to obtain results. Weights are assigned to various criteria pairs and these pair-wise comparisons are analyzed using AHP. To be presented in details the overview of the various paired alternatives. Various criteria and steps are likewise to be shared later in the study.

3.2 Conceptual Framework of the Study

In order to develop research model and testing hypothesis, the research was conducted by two step methodology:

(i) Step 1 – review of existing relevant literature

(ii) Step 2 – implement AHP methodology

In Step 1, review of related literature will be made. Researches on similar studies will be done with the main focus to get understanding on the subject, and to build on previous researches.

In Step 2, the study utilizes the AHP methodology for the ranking of functional strategies. The hierarchy is composed of different levels in AHP with the objective of the study at Level 1. Based on the objective of the study, the first level of AHP hierarchal model is set to be the prioritization / ranking of the functional strategies of forecasting the market factors for the technology commercialization of EVs.

By following the AHP procedure described above, the hierarchy of the problem is shown in Figure 3.1

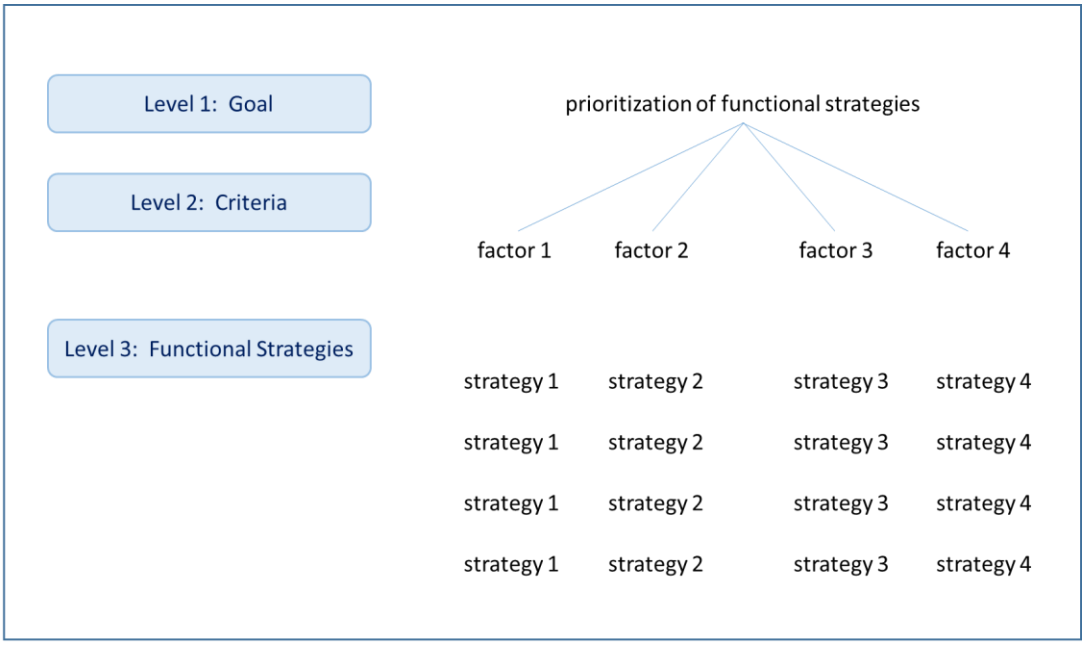


Figure 3-1 AHP Problem Hierarchy.

A panel of experts, constituting the focus group, was identified for participation in the study, and eventually interviewed. The panel was asked regarding the functional strategies considered to be important with some rationale. The data were compiled and shared with the panel regarding the top five functional strategies.

In the final step, the data regarding the ranked functional strategies were again shared with the panel to give their final viewpoint. The panel was asked to give their brief comments if someone differs from the categorization of functional strategies. Thus, the consensus on important functional strategies was achieved by a group of experts.

These panel of experts must have the following characteristics and experiences:

- have extensive experience working in the Thailand automotive industry, at least 10 years working experience
- have a leading managerial position in a company, or a governmental agency
- be knowledgeable about the automotive industry and be familiar with the concepts of vehicle electrification

3.2.1 Review of Literature

Theories and literatures relevant to the study were researched and synthesized. Studies relevant to technology commercialization of EV were identified and analyzed. Technology commercialization in leader countries such as in Norway, Netherlands, China, USA, and others, were studied. Desk research help the author have a better understanding about the forces that promote and constrain the electric vehicle market in Thailand.

3.2.2 Analytic Hierarchy Process Methodology

This paper will make use of the Analytic Hierarchy Process tool to analyze the data from the stated preference survey to obtain the most suitable choice among the various criteria. It is hoped that using AHP, which is an algorithm to paint a picture of the various criteria combination pairs and which alternatives are conducive, or not, towards the eventual commercialization of electric vehicles in Thailand.

Table 3.2 Conceptual Framework

Study Steps	Process Steps	Output
Analyse and synthesize conceptual framework in the study implementation	Study concepts, theories and basic foundations related to vehicle technology Study concepts, theories and basic foundations related to technology commercialization Study concepts, theories and basic foundations related to complex decision making, especially AHP	Define a conceptual framework for the analysis and implementation of electric vehicle implementation in the Kingdom of Thailand

Table 3.2 Conceptual Framework

Study Steps	Process Steps	Output
Design, develop the conceptual framework for the technology commercialization of Electric Vehicles in the Kingdom of Thailand	Design the working model by identifying the Level 1 topics relevant to the study Identify the Level 2 Criteria / Level 3 Functional Strategies relevant to the proper implementation of AHP Define the major steps and processes involved in the proper implementation of the AHP model	Level 1, Level 2, Level 3 criteria defined and AHP model computed
	A panel of experts to be surveyed and consulted on their opinions	
Analyse and synthesize current status in the technology commercialization of Electric Vehicles in the Kingdom of Thailand	Design and define an AHP implementation model involved in the technology commercialization in the Kingdom of Thailand	Generate potential outcomes and criteria in order to provide a guide for policy makers and stakeholders

AHP is a decision making process which provides comprehensive structure to combine the intuitive rational and irrational values with a pairwise comparison approach. Since its creation in 1980s, the applications of AHP has been used globally in wide variety of complex decision situations. Fields such as government, business, industry, healthcare, education and many others, has applied this technique.

In a nutshell, the technique would help decision-makers find one that best suit their goal and understanding of the problem, rather than providing the "correct" decision. It provides a rational approach to structure a decision problem, identify and quantify the key criteria, relate these criteria to the stated overall goals, evaluate quantitatively these elements, and make an assessment of the alternative solutions.

CHAPTER 4

4.1 Implementation and Analysis

During the course of the implementation of AHP, functional criteria was needed to be defined. As per desktop study on decision mechanisms on the adoption of electrical vehicles, we may have observed that from the various references we have obtained, all these studies bear notable similarities from each other despite being done in different continents and countries.

We have chosen the study done by Wang in China, based on the reasoning that the study is quite recent and also reflects somehow Asian culture and norms. In this context, 'recent' mean that the technological performance of the vehicles are based on the latest technology available. The study being done in an Asian context means that the priorities and societal norms may be closer to the Thai consciousness rather than a study done in other continents. We have reduced the number of factors down to five to make the model more suitable to implement using the AHP technique. This reduced list of factors make it easier to use during the survey phase of this study.

Therefore, the Level 2 Criteria to be used are:

1.1 Demographics

1.2 Personality Characteristics of Consumers

1.3 Performance Attributes

1.4 Financial Benefits

1.5 Government Policies

The Level 3 Functional Strategies are defined and shown in Table 4-1, referencing Wang's study. (Wang & Liu, 2015)

Table 4.1 Level 2 Criteria and Level 3 Functional Strategies

Level 2 Criteria	Level 3 Functional Strategies
Demographics	Gender Education Income
Vehicle performance	Reliability Safety issues Drive performance Battery life Driving range
Driver personality	Environmental awareness Innovativeness Social conformist Exudes maturity High regard from peers
Financial aspects	Lower fuel costs Lower maintenance costs Higher vehicle costs
Government policies	Purchase tax incentives Free use of toll Electricity cost subsidies Charging infrastructure Free parking

A questionnaire consisting of all strategic factors, criteria of the level of the AHP model is designed and is used to collect the pairwise comparison judgments from all evaluation members, which possessed expertise in the Thai automotive industry. A sample of the survey questionnaire can be found in the Appendix 1.

The survey was conducted to nine qualified industry experts with at least 10 years experience and involvement in the Thailand automotive industry. Respondents were asked to fill-up the AHP-based questionnaire, and they returned the filled-up forms with valid responses.
Respondents were asked the question "Of the paired criteria, which one would you consider important in the uptake of electric vehicle in the Kingdom of Thailand?".

The level of importance were represented by values from 1-9 based on Saaty's scale of importance which is shown in Table 4.2

Table 4.2 Saaty's Scale of Importance

Value	Level of Importance
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance

The survey being conducted and the values received from the respondents, the matrix for Level 2 Criteria is calculated based on the pair-wise comparison of the 5 criteria. The calculation as summarized by Saaty, consisted of the following steps:

(a) State the problem;

(b) Broaden the objectives of the problem by considering all actors, objectives and outcomes;

(c) Identify the criteria and/or sub-criteria;

(d) Structure the problem hierarchically by considering the goal, criteria, sub-criteria, and a set of alternatives;

(e) Construct a set of pairwise comparison matrix,

The matrix can be defined by

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

where n is the order of matrix

Then the consistency property in the pairwise comparison is examined by the procedure as following: i. Build the normalized pairwise comparison matrix A1

$$A_1 = \begin{bmatrix} a_{11}' & a_{12}' & \dots & a_{1n}' \\ a_{21}' & a_{22}' & \dots & a_{2n}' \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1}' & a_{n2}' & \cdots & a_{nn}' \end{bmatrix}$$

and $a_{y'} = \frac{a_y}{\sum_{i=1}^{n} a_y}$ for i,j = 1, 2, …, n.

ii. Calculate the eigenvalue and the eigenvector.

$$w = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}, \quad \text{and} \quad w_i = \frac{\sum_{i=1}^{n} a_{y'}}{n} \text{ for i = 1, 2, …, n.}$$

$$w' = Aw = \begin{bmatrix} w_{1'} \\ w_{2'} \\ \vdots \\ w_{n'} \end{bmatrix},$$

and $\lambda_{max} = \frac{1}{n}\left(\frac{w_{1'}}{w_1} + \frac{w_{2'}}{w_2} + \cdots + \frac{w_{n'}}{w_n}\right)$,

where w is the eigenvector, w' is the eigen value of criterion i, and λ_{max} is the largest eigen value of the pairwise comparison matrix.

(f) Compute to find CI which is the consistency index, CR is the consistency ratio, and RI is the random index, where $CI = (\lambda_{max} - n)/(n-1)$ and $CR = CI/RI$. Table 4-3 shows a set of recommended RI values as presented by Saaty.

Table 4.3 Random Index

N	2	3	4	5	6	7	8	9	10
RI	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Figure 4.1 shows the result of the calculation. The normalized weights of User Demographics, Vehicle Performance, Driver Personality, Financial Aspects, and Government Policies are calculated as follows: 0.058, 0.316, 0.106, 0.268, and 0.252, respectively with CR = 0.02 which is less than 0.10.

Consolidated Decision Matrix

Aggregation of judgments

	1	2	3	4	5
1	1	0.15	0.57	0.30	0.21
2	6.88	1	2.50	1.33	1.07
3	1.75	0.40	1	0.42	0.37
4	3.37	0.75	2.37	1	1.63
5	4.83	0.93	2.71	0.61	1

Figure 4.1 Comparison matrix for Level 2 Criteria

Based on the priority of these five criteria, arranged from highest priority decreasing to lowest priority:Vehicle Performance, Financial Aspects, Government Incentives, Buyer Personality and User Demographics, where Vehicle Performance is considered to be the most important factor among the Level 2 Criteria, with Financial Aspects and Government Incentives rated second and third, close to each other.

Figure 4- 2 shows a graphical representation of the normalized weights. It is immediately apparent that Vehicle Performance play a prominent role in the adoption and acceptance of electric vehicle.

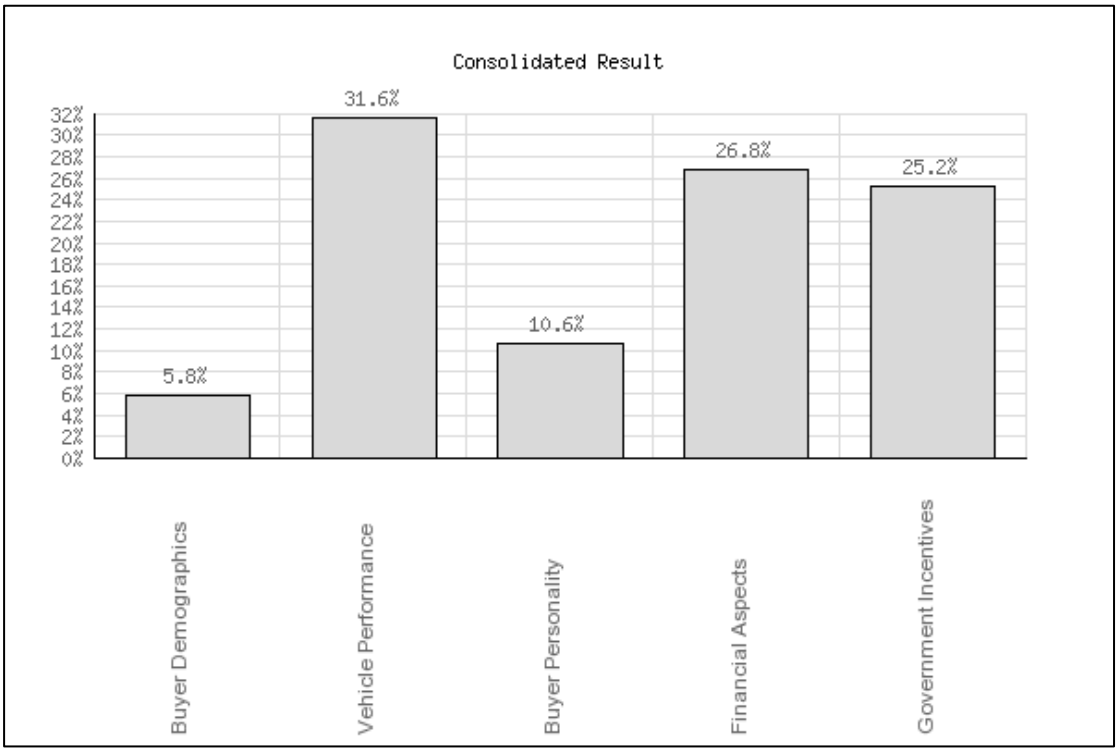


Figure 4.2 Normalized weights of Level 2 Criteria

Based on the analysis above, we can now understand clearly the preferences and factors deemed to be important, as per the surveyed focus group.

In the next pages, we will proceed to make a deeper analysis of the different Level 3 Functional Criteria in order to understand in more detail, which factors within the subgroup play a major influence on each Level 2 Criteria.

Regarding Buyer Demographics, the normalized weights for Gender, Education and Income are 0.101, 0.194, and 0.705, respectively with a CR = 0.2% which is less than 0.1. Largest factor with a group consensus is Income, which is 0.712. Figure 4.4 depicts a column graph showing that in the Buyer Demographics Criteria, Income is a prominent factor.

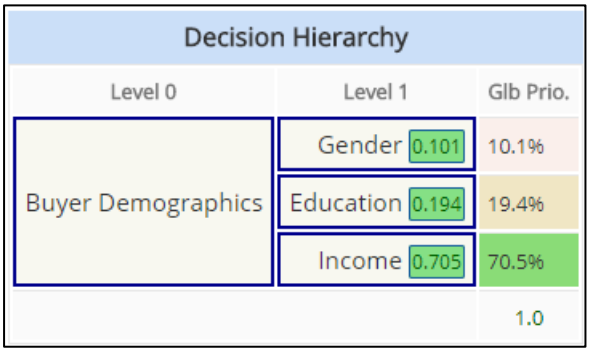


Figure 4.3 Normalized weights for Level 3 Buyer Demographics

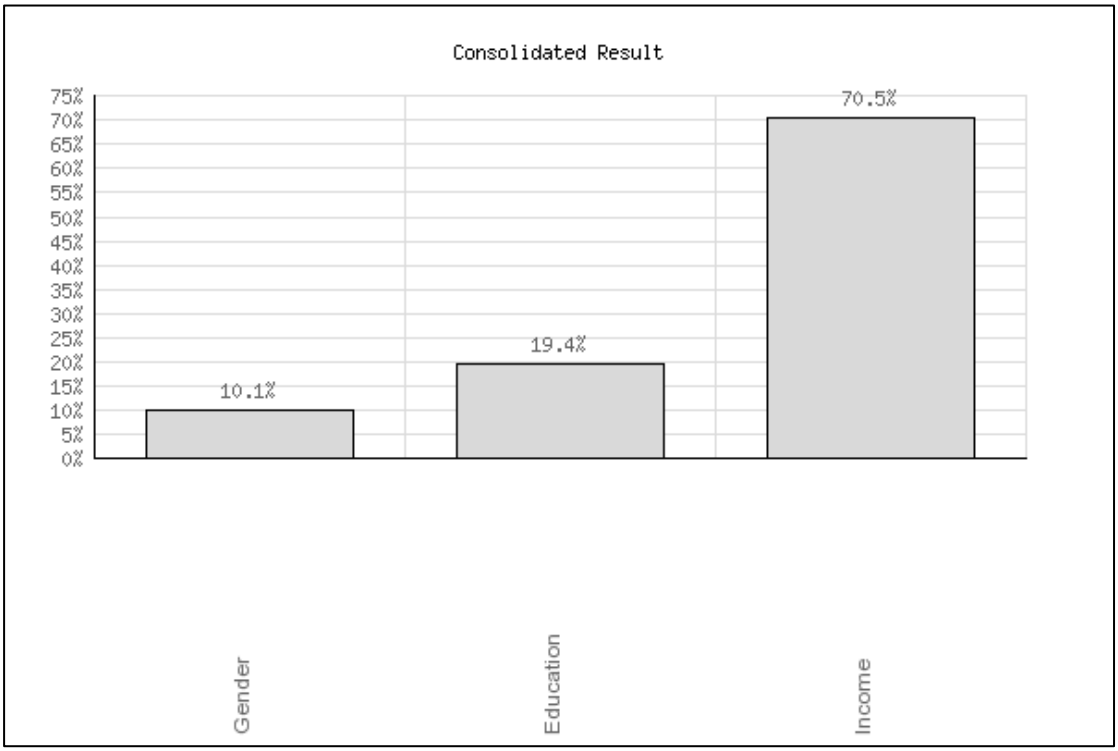


Figure 4.4 Column Graph for Level 3 Buyer Demographics Normalized Weights

Regarding Vehicle Performance, the normalized weights for Drive Performance, Reliability, Charging Time, Driving Range and Safety Issues are 0.108, 0.240, 0.169, 0.115, and 0.369, respectively with a CR = 0.058 which is less than 0.1. Largest factor with a group consensus is Safety Issues, which is 0.369. Figure 4.4 depicts a column graph showing that in the Vehicle Performance Criteria, Safety Issues is a prominent factor.

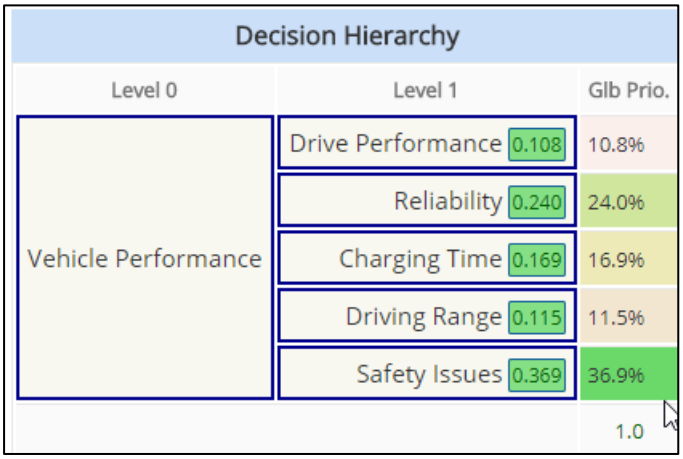


Figure 4.5 Normalized weights for Level 3 Vehicle Performance

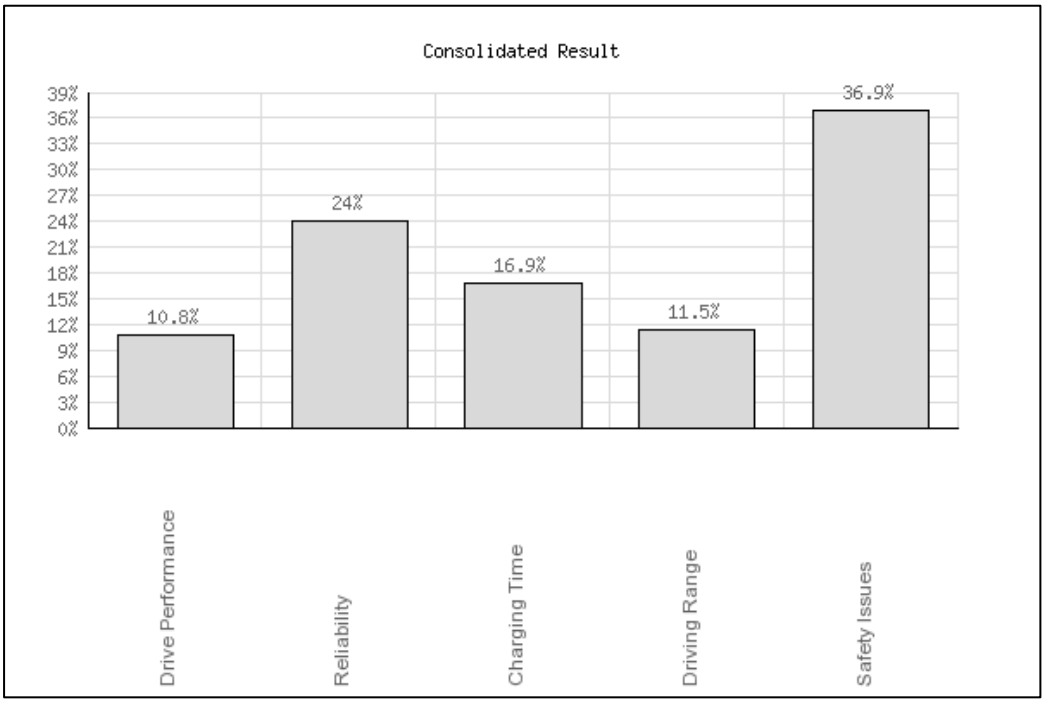


Figure 4-6 Column Graph for Level 3 Vehicle Performance Normalized Weights

Regarding Financial Benefits, the normalized weights for Lower Fuel Cost and Lower Maintenance Cost are 0.368 and 0.632, respectively with a CR = 0.0 which is less than 0.1. Largest factor with a group consensus is Lower Maintenance Cost, which is 0.632. Figure 4-8 depicts a column graph showing that in the Financial Benefits, Lower Maintenance Cost is a prominent factor.

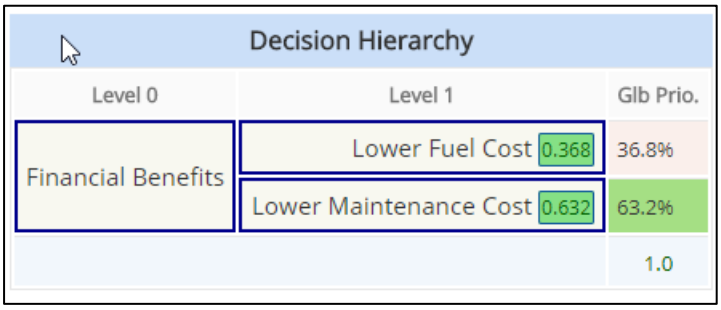


Figure 4.7 Normalized weights for Level 3 Financial Benefits

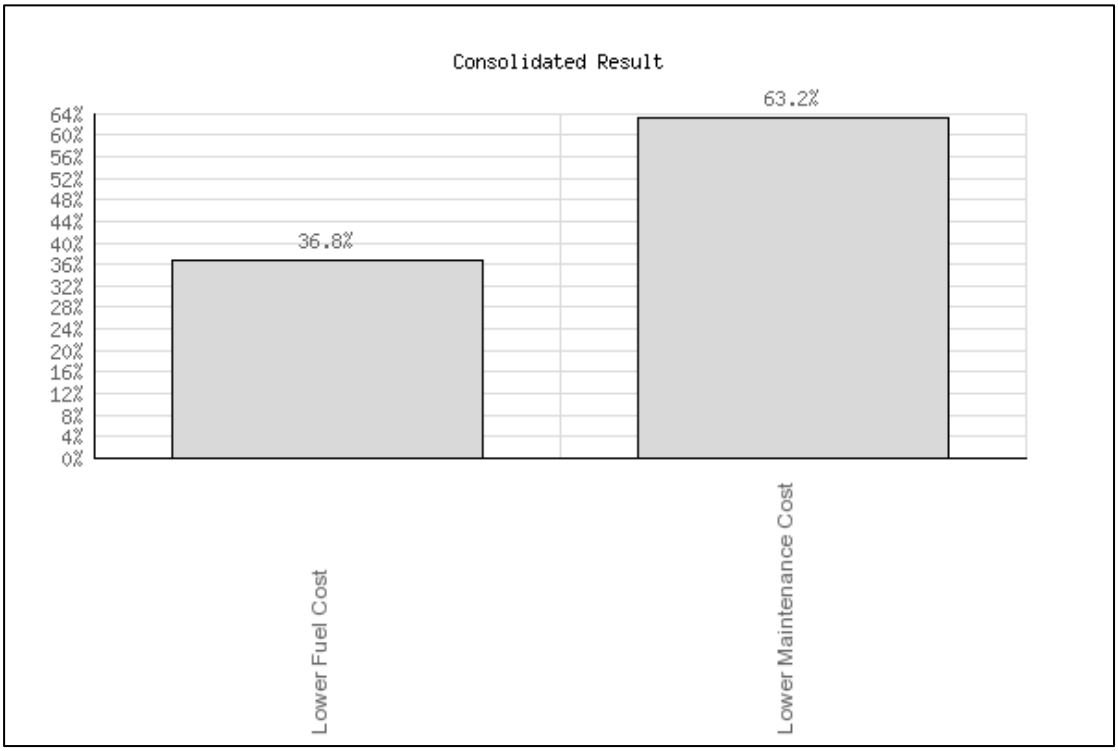


Figure 4.8 Column Graph for Level 3 Financial Benefits Normalized Weights

Regarding Government Policies, the normalized weights for Tax Incentives, Free Toll, Free Parking, Electricity Cost Subsidy, and Charging Station Incentives are 0.367, 0.100,0.096, 0.188 and 0.250, respectively with a CR = 0.032 which is less than 0.1. Largest factor with a group consensus is Tax Incentives, which is 0.367. Figure 4-10 depicts a column graph showing that in the Government Policies, Tax Incentives is a prominent factor.

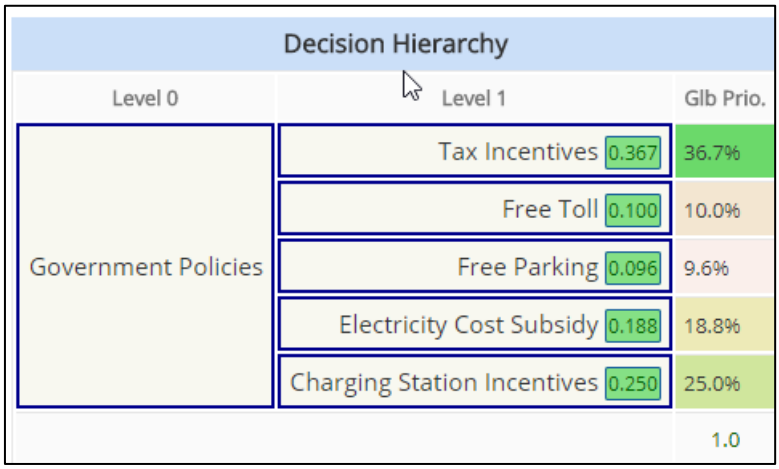


Figure 4.9 Normalized weights for Level 3 Government Policies

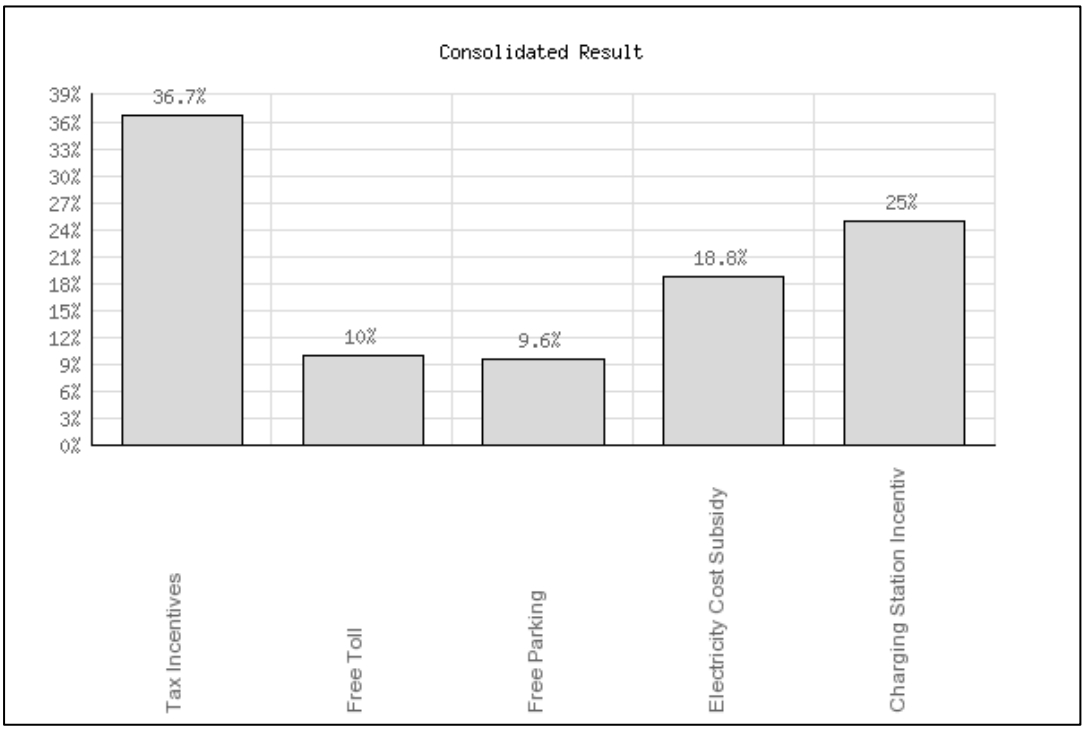


Figure 4-10 Column Graph for Level 3 Government Policies Normalized Weights

Regarding Owner Personality, the normalized weights for Environmental Awareness, Innovativeness, Social Conformist, Exudes Maturity Style and High Regards from Peers, the normalized weights are 0.417, 0.209, 0.083, 0.118, and 0.173, respectively with a CR = 0.058 which is less than 0.1. Largest factor with a group consensus is Environmental Awareness, which is 0.417. Figure 4-12 depicts a column graph showing that in the Owner Personality, Environmental Awareness is a prominent factor for considering electric vehicle uptake.

Decision Hierarchy		
Level 0	Level 1	Glb Prio.
Owner Personality	Environmental Awareness 0.417	41.7%
	Innovativeness 0.209	20.9%
	Social Conformist 0.083	8.3%
	Exudes Maturity Style 0.118	11.8%
	High Regard from Peers 0.173	17.3%
		1.0

Figure 4.11 Normalized weights for Level 3 Owner Personality

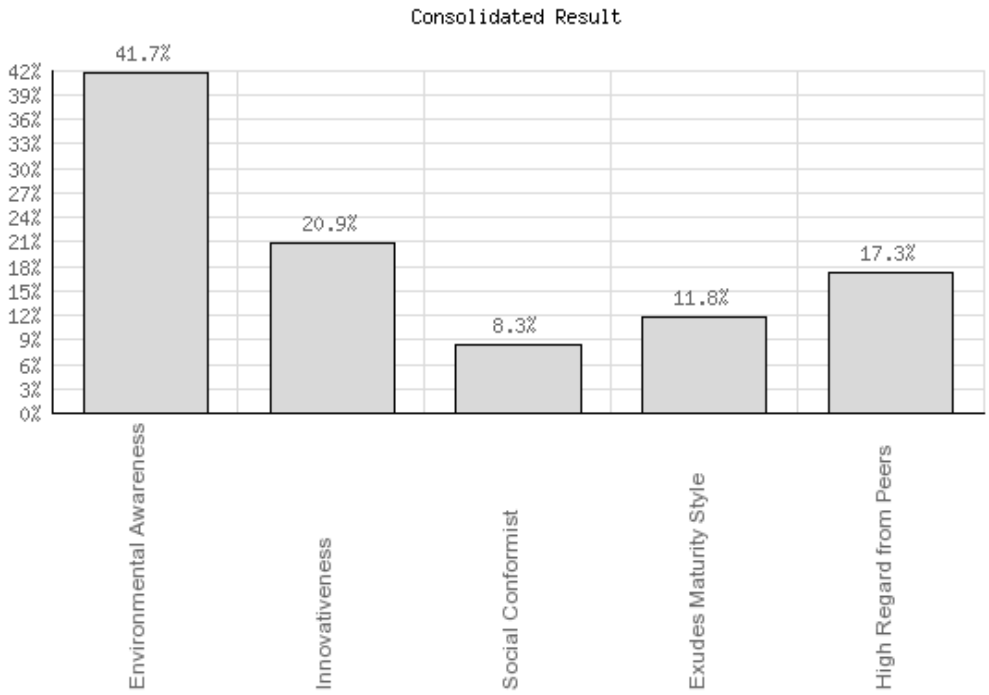


Figure 4.12 Column Graph for Level 3 Owner Personality Normalized Weights

As such, based on the implementation of the Analysis Hierarchy Process, Table 4-3 provides a highlighted view of the criteria and functional strategies which are considered to be the main factors to have an impact on the electric vehicle uptake in the Kingdom of Thailand.

Table 4.3 Level 2 Criteria and Level 3 Functional Strategies with Normalized Weights

Level 2 Criteria	Level 3 Functional Strategies
Demographics	Gender Education **> Income**
> Vehicle performance **31.6%**	Reliability **> Safety issues** Drive performance Battery life Driving range
Driver personality	**> Environmental awareness** Innovativeness Social conformist Exudes maturity High regard from peers
> Financial aspects **26.8%**	Lower fuel costs **> Lower maintenance costs**
> Government policies **25.2%**	**> Purchase tax incentives** Free use of toll Electricity cost subsidies Charging infrastructure Free parking

CHAPTER 5

5.1 Conclusion and Findings

Commercialization in a number of countries studied. This study centered on the issue to commercialize electric vehicle in the Kingdom of Thailand. This topic is a broad and complex one due to the long entwined history between us and the automobile. The issue cannot boil down to replacing one technology for the other, that is, changing from fossil-fueled conventional automobiles to electrically driven ones. But rather encompasses entire city infrastructures, country economies, manufacturing industries, societal norms and even cultural preferences. The electrification of the automobile means that there are so many issues and concerns that have to be uprooted and adjusted to make the successful transition.

There is no denying that the change will come. There are too many pressures – climate change, high prices and volatile supply of oil, countries pushing their own agenda and raised societal environmental consciousness – for conventional petrol and diesel cars to remain as the mainstream choice. Change will come.

To usher in this change is not as simple. And to bring about this change in order to align with the timing agreed global climate accords add a sense of urgency to this complex situation. There are just so many factors that stakeholders must consider in order to make a successful change without resorting to random trial-and-error, which is wasteful and directionless.

This complex situation can be considered to be a ripe situation to apply multi-criteria decision analysis. This research made a desk study of various techniques and has focused on applying Analytic Hierarchy Process to the problem.

The geographical scope of the study has been confined to the Kingdom of Thailand. A number of countries have achieved success introducing and encouraging the commercialization of electric vehicles in their own domains. Norway, UK, USA and China are some of the notable ones. Each country had to find their own way to usher in the changes. Norway gave huge tax incentives and many intangibles such as free parking and waived toll fees. China is using government clout to make abrupt gradual changes to the transportation infrastructures, and so on.

Environment to commercialize electric vehicle in Thailand studied. Thailand is at the onset of implementing electrical vehicle technology, starting with the formation in 2016 of a government agency EVAT to spearhead activities. Two years hence, there are still no clear distinct policy changes nor actions to steer the country to a certain direction on this issue. There are just too many things to consider, and too many stakeholders have varying agenda to pursue.

The China experience is benchmarked, with the China market situation used as a guide in formulating the AHP criteria and functional strategies. As an Asian country, it is assumed that the situation would be a more appropriate model for Thailand, compared to Northern European examples.

Decision-making model defined and structured. Applying the AHP principles, a panel of industry experts were consulted and the findings were that Vehicle Performance, Financial Benefits and Government Policies were the main factors, which were deemed to have the most impact towards the commercialization and implementation of electric vehicles in Thailand. Figure 5-1 shows the main factors mostly impacting the uptake of electric vehicle in the Kingdom of Thailand.

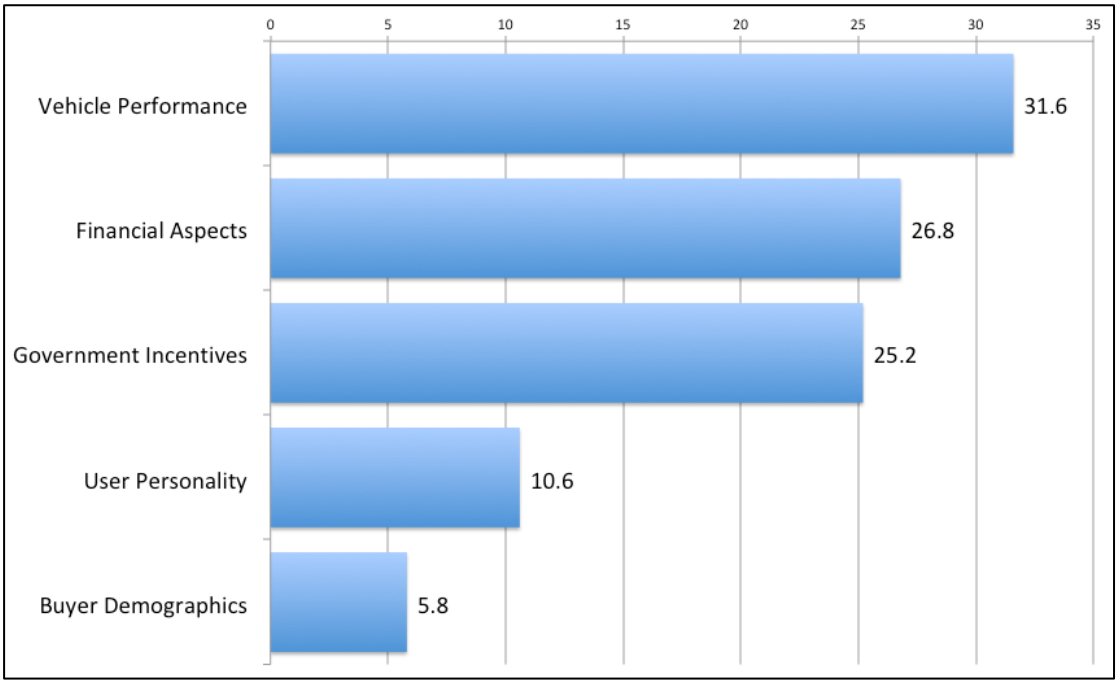


Figure 5.1 Main impacting factors as defined from AHP analysis

During the course of the AHP study, the problem became more defined and a deeper understanding of the situation happened. AHP pair-wise comparison methodology, simplified the prioritization process since it is easier to make comparisons between variable as opposed to making comparisons among many variables. It is also easier to consider the subjective assessment, due to inavailability of available quantitative measures for some criteria.

Results verified. Interviews with industry experts and consulted about the results from the AHP method. The findings appeared to be consistent with the sentiments in the industry. Vehicle performance is seen to be the most prominent concern factor for motorists and consumers whether electric vehicles are a viable alternative in terms of driving range and safety risks. Obviously, Financial Benefits play a major factor as the change should have tangible benefits, which must be readily apparent to the users.

We can conclude that this study was able to fulfill the objectives defined from the onset, which is to study and obtain an overview of the electric vehicle adoption and commercialization in the Kingdom of Thailand. The AHP methodology was implemented, and proven applicable and effective in defining the set of factors impacting EV commercialization in Thailand.

5.2 Areas for further study

Further study can be done on an application of AHP towards a deeper, more focused investigation of the Thailand situation. A survey can be done to gather information and formulate criteria which are specific to the Thai settings. This will allow a more detailed look on the Thai situation regarding EV technology adoption.

The breadth of the study can be expanded looking at a wider scope of application. Research can be done to develop a full technology commercialization study on this subject, as this study focused mainly on the multi-criteria decision analysis aspect to define viable courses of action.

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APPENDIX 1

AHP Survey Questionnaire

Electric Vehicles in the Kingdom of Thailand

Survey using the AHP Approach
Level 1 Questionnaire

Which would you consider the most important factor to influence the uptake of Electric Vehicles in the Kingdom of Thailand?

User Demographics 1
- Gender
- Education
- Income

Vehicle Performance 2
- Reliability
- Safety Issues
- Drive performance
- Battery Life
- Driving Range

Driver Personality 3
- Environmental awareness
- Innovativeness
- Social conformist
- Exudes maturity
- High regard from peers

Financial Aspects 4
- Lower fuel costs
- Lower maintenance costs
- Higher vehicle cost

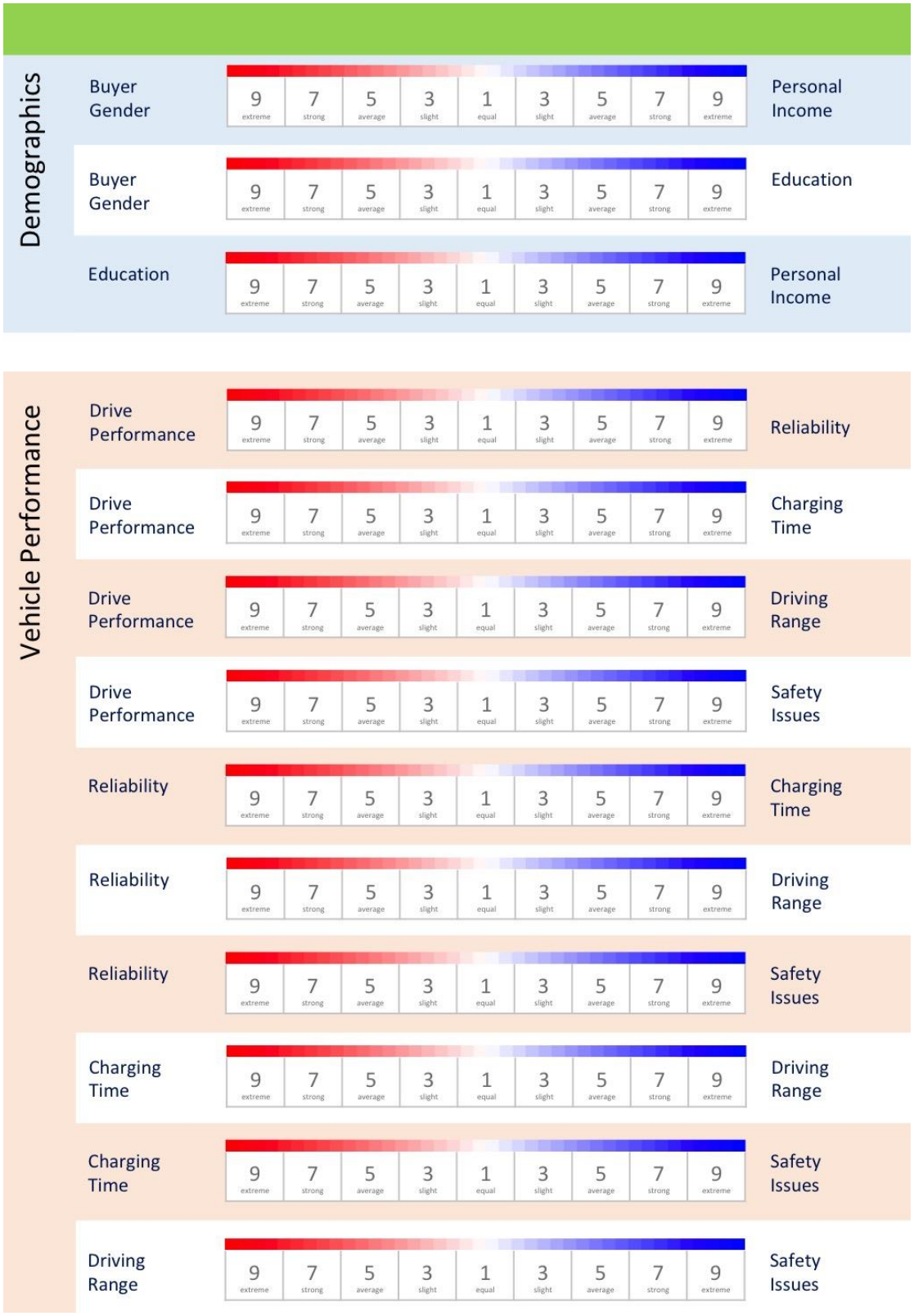
Government Policies 5
- Purchase tax incentives
- Free use of Toll
- Electricity cost subsidies
- Charging infrastructure
- Free Parking

Thank you for participating in this survey!

Using pair-wise comparison, this study intends to define the main factors deemed important to influence the uptake of electric vehicles in the Kingdom of Thailand.

Please indicate which of the two paired-factors you consider will have higher influence on the acceptance and usage of electric vehicles.

User Demographics	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Vehicle Performance
User Demographics	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	User Personality
User Demographics	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Financial Aspects
User Demographics	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Government Incentives
Vehicle Performance	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	User Personality
Vehicle Performance	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Financial Aspects
Vehicle Performance	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Government Incentives
User Personality	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Financial Aspects
User Personality	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Government Incentives
Financial Aspects	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Government Incentives


Demographics
Buyer Gender
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Personal Income
Buyer Gender
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Education
Education
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Personal Income
Vehicle Performance
Drive Performance
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Reliability
Drive Performance
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Charging Time
Drive Performance
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Driving Range
Drive Performance
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Safety Issues
Reliability
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Charging Time
Reliability
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Driving Range
Reliability
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Safety Issues
Charging Time
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Driving Range
Charging Time
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Safety Issues
Driving Range
9 extreme 7 strong 5 average 3 slight 1 equal 3 slight 5 average 7 strong 9 extreme
Safety Issues

Financial Benefits

Which of the below financial benefits would you consider to have more impact in purchasing and using Electric Vehicles. Please mark your feedback.

Lower Fuel Cost	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Lower Maintenance Cost

Government Policies

Which of the below government policies would you consider to have more impact in purchasing and using Electric Vehicles. Please mark your feedback.

Tax Incentives	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Free Toll
Tax Incentives	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Free Parking
Tax Incentives	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Electricity Cost Subsidy
Tax Incentives	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Charging station incentives
Free Toll	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Free Parking
Free Toll	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Electricity Cost Subsidy
Free Toll	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Charging station incentives
Free Parking	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Electricity Cost Subsidy
Free Parking	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Charging station incentives
Electricity Cost Subsidy	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Charging station incentives

Which of the owner personality characteristics would you consider to have more impact in purchasing and using Electric Vehicles. Please mark your feedback.

Owner Personality Characteritics

Environmental Awareness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Innovativeness
Environmental Awareness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Social Conformist
Environmental Awareness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Exudes Maturity, Style
Environmental Awareness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	High regard from Peers
Innovativeness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Social Conformist
Innovativeness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Exudes Maturity, Style
Innovativeness	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	High regard from Peers
Social Conformist	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	Exudes Maturity, Style
Social Conformist	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	High regard from Peers
Exudes Maturity, Style	9 extreme · 7 strong · 5 average · 3 slight · 1 equal · 3 slight · 5 average · 7 strong · 9 extreme	High regard from Peers

This marks the end of the survey.

Thank you very much for your feedback.
Kindly email the updated file to J.Mendoza@gmx.net

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	.....2000 BMW Manufacturing Thailand Co., Ltd. .....
	.....2008 RMA Automotive Co., Ltd. .....
	.....2011 Danieli Thailand Co., Ltd. .....
Current employment	.....2016 BMW Thailand Co., Ltd .....