Consumer Preferences and Policy Assessment on Electric Vehicle Adoption in Thailand

Miss Phasiri Manutworakit

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การศึกษาความคิดเห็นผู้บริโภคและการประเมินนโยบายต่อการส่งเสริมการใช้รถยนต์ไฟฟ้าในประเทศไทย

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Dean of the GRADUATE SCHOOL
(Associate Professor YOOTTHANA CHUPPUNNARAT, Ph.D.)

DISSERTATION COMMITTEE

Chairman
(Professor Chongrak Polprasert, Ph.D.)

Thesis Advisor
(Professor Kasem Choocharukul, Ph.D.)

Examiner
(Associate Professor DAWAN WIWATTANADATE, Ph.D.)

Examiner
(Assistant Professor Suthirat Kittipongvises, Ph.D.)

Examiner
(Pongsun Bunditsakulchai, Ph.D.)

Examiner
(SUJITRA VASSANADUMRONGDEE, Ph.D.)

ภาศิริ มนัสวรกิจ : การศึกษาความคิดเห็นผู้บริโภคและการประเมินนโยบายต่อการส่งเสริมการใช้รถยนต์ไฟฟ้าในประเทศไทย. (Consumer Preferences and Policy Assessment on Electric Vehicle Adoption in Thailand) อ.ที่ปรึกษาหลัก : ศ. ดร.เกษม ชูจารุกุล

ประเทศไทยเผชิญกับปัญหาการใช้พลังงานและมลพิษทางอากาศเพราะการเพิ่มขึ้นของรถยนต์เผาไหม้ ซึ่งการแทนที่รถยนต์เผาไหม้เป็นรถยนต์ไฟฟ้าแบบแบตเตอรี่ช่วยสนับสนุนการขนส่งยั่งยืนและการใช้พลังงานทางเลือกโดยเป็นส่วนหนึ่งของระบบการขนส่งสีเขียวของประเทศไทย แต่อัตราการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ยังค่อนข้างต่ำ ประเทศไทยจึงต้องการนโยบายที่มีประสิทธิภาพเพื่อเพิ่มการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ในประเทศ วัตถุประสงค์ในการวิจัยนี้คือ ศึกษาสถานการณ์ปัจจุบันของรถยนต์ไฟฟ้าในประเทศไทย บ่งชี้ปัจจัยที่ส่งผลกระทบต่อความตั้งใจซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่ของประเทศไทย รวมทั้งเสนอแนะนโยบายเพื่อกระตุ้นการใช้รถยนต์ไฟฟ้า วิธีดำเนินงานวิจัยนี้เป็นการวิจัยเชิงปริมาณและเชิงคุณภาพ โดยวิธีวิจัยเชิงปริมาณใช้กับกลุ่มด้านอุปสงค์ ได้แก่ กลุ่มที่เป็นเจ้าของรถยนต์ที่มีความสนใจที่จะใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ในประเทศไทย แบบจำลองที่เสนอจะประยุกต์มาจากกรอบแนวคิดทฤษฎีรวมการยอมรับและการใช้เทคโนโลยีเป็นหลัก (Unified Theory of Acceptance and Use of Technology: UTAUT) ข้อมูลถูกเก็บผ่านแบบสำรวจทางออนไลน์จากกลุ่มตัวอย่าง 403 ตัวอย่าง แบ่งเป็นกลุ่มผู้ใช้รถยนต์ที่ขับเคลื่อนด้วยเครื่องยนต์สันดาปภายใน 395 ตัวอย่าง และกลุ่มผู้ใช้รถยนต์ไฟฟ้า 8 ตัวอย่าง ที่อาศัยอยู่ในจังหวัดกรุงเทพมหานครและปริมณฑล ซึ่งประมวลผลข้อมูลใช้การวิเคราะห์ทางสถิติด้วยวิธีแบบ PLS-SEM โดยกลุ่มผู้ใช้รถยนต์ไฟฟ้ามีปริมาณค่อนข้างน้อย ทำให้การวิเคราะห์ทางสถิติไม่ผ่านเกณฑ์ จึงเหลือเพียงกลุ่มผู้ใช้รถยนต์ขับเคลื่อนด้วยเครื่องยนต์สันดาปภายใน ผลการวิจัยพบว่า ปัจจัยด้านความคาดหวังในประสิทธิภาพ ความคาดหวังในความพยายาม อิทธิพลทางสังคม แรงจูงใจทางอารมณ์ และความวิตกกังวลด้านสิ่งแวดล้อม เป็นปัจจัยที่มีอิทธิพลเชิงบวกต่อความตั้งใจที่จะใช้งานรถยนต์ไฟฟ้าแบบแบตเตอรี่ ในทางตรงกันข้าม ปัจจัยด้านราคา เป็นปัจจัยที่ไม่มีอิทธิพลเชิงบวกต่อความตั้งใจที่จะใช้งานรถยนต์ไฟฟ้าแบบแบตเตอรี่ ความตั้งใจที่จะใช้ยังมีอิทธิพลเชิงบวกต่อพฤติกรรมการใช้งานจริง ขณะที่ปัจจัยสภาพการอำนวยความสะดวก และปัจจัยด้านมาตรการนโยบายไม่มีอิทธิพลเชิงบวกต่อความตั้งใจที่จะใช้งานและพฤติกรรมการใช้งานจริง รวมถึงปัจจัยความวิตกกังวลด้านสิ่งแวดล้อมไม่มีอิทธิพลเชิงบวกต่อพฤติกรรมการใช้งานจริง นอกจากนี้ ตัวแปรข้อมูลประชากร ได้แก่ อายุ การศึกษา อาชีพ รายได้ และจังหวัดที่อยู่อาศัย เป็นปัจจัยที่มีอิทธิพลต่อพฤติกรรมที่จะใช้งานรถยนต์ไฟฟ้าแบบแบตเตอรี่ สำหรับวิธีวิจัยเชิงคุณภาพใช้วิธีการเก็บข้อมูลด้วยการสัมภาษณ์เชิงลึกกับกลุ่มอุปทาน แบ่งเป็นสามกลุ่มได้แก่ ภาครัฐบาล ภาคเอกชน และองค์กรอิสระ โดยกลุ่มตัวอย่างต้องมีส่วนความรับผิดชอบหรือเกี่ยวข้องกับมาตรการนโยบายรถยนต์ไฟฟ้าในประเทศไทย ผลวิจัยชี้ให้เห็นว่ารัฐบาลต้องให้ความสำคัญอันดับแรกกับมาตรการนโยบายด้านการเงิน โดยเฉพาะอย่างยิ่งการยกเว้นภาษีรถยนต์ไฟฟ้าแบบแบตเตอรี่ ส่วนผู้ผลิตรถยนต์ไฟฟ้าต้องให้ความสำคัญในการพัฒนาประสิทธิภาพของรถยนต์ไฟฟ้าแบบแบตเตอรี่และสิ่งอำนวยความสะดวกให้สอดรับกับการใช้ของผู้บริโภค เพื่อเพิ่มการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่มากขึ้น นอกจากนี้ ภาครัฐต้องพิจารณามาตรการการเพิ่มภาษีกับรถยนต์ที่ปล่อยมลพิษและการให้สิทธิพิเศษกับรถยนต์ไฟฟ้าแบบแบตเตอรี่ ยกตัวอย่างเช่น ฟรีค่าธรรมเนียมการชาร์จไฟ ลดหรือฟรีค่าทางด่วน ลดหรือฟรีค่าจอดรถ สามารถวิ่งในช่องทางเร่งด่วน เป็นต้น อย่างไรก็ตาม ภาครัฐต้องมีมาตรการนโยบายที่ไม่ใช่ทางการเงินควบคู่ไปด้วย เช่น การเพิ่มสถานีชาร์จไฟ และการสร้างการตระหนักรู้และความเข้าใจเกี่ยวกับรถยนต์ไฟฟ้าแบบแบตเตอรี่ จากผลการวิจัยนี้จะสามารถช่วยให้การวางแผนและพัฒนามาตรการนโยบายเพื่อกระตุ้นการใช้รถยนต์ไฟฟ้าในประเทศไทยมีประสิทธิภาพมากขึ้น และตอบสนองโดยตรงทั้งด้านอุปสงค์และอุปทาน

สาขาวิชา	สิ่งแวดล้อม การพัฒนา และความยั่งยืน	ลายมือชื่อนิสิต .....
ปีการศึกษา	2564	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

6288314820 : MAJOR ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY
KEYWORD: Battery Electric Vehicles (BEVs), the Unified Theory of Acceptance and Use of Technology (UTAUT), partial least squares structural equation modeling (PLS-SEM)
Phasiri Manutworakit : Consumer Preferences and Policy Assessment on Electric Vehicle Adoption in Thailand. Advisor: Prof. Kasem Choocharukul, Ph.D.

Thailand faces a problem about energy consumption and air pollution because of increasing the number of consumption cars. The replacement of combustion cars with battery electric cars can help support sustainable transport and renewable energy on the green transportation in Thailand, but diffusion rates of battery electric cars are still low. Thailand requires efficient policies to increasing electric vehicles adoption. The objectives of the study are to study the current situation of EVs in Thailand, to identify factors affecting purchasing intention of BEVs in Thailand and to propose policy recommendations to stimulate BEV adoption in Thailand. This research was designed to use quantitative and qualitative approaches. The quantitative research deals with data from the demand side: car owner who are interested in adopting BEVs in Thailand. The proposed model expands the Unified Theory of Acceptance and Use of Technology (UTAUT) as the theoretical framework. Data were collected through an online questionnaire survey completed by 403 participants: 395 internal combustion cars group and 8 electric cars group in Bangkok and the vicinity and analyzed using partial least squares structural equation modeling (PLS-SEM). The sample size of electric cars group was too small, so the value of measurement model evaluation did not meet the criteria. The research was analyzed only combustion cars group. The result showed that purchase intention is significantly and positively influenced by performance expectancy, effort expectancy, social influence, hedonic motivation, and environmental concern. In contrast, purchase intention is not significantly influenced by price value. Use behavior is positively influenced by purchase intention. Facilitating conditions and policy measures do not significantly influence purchase intention and use behavior. Environmental concern does not significantly influence use behavior. Moreover, the socio-demographic variables as age, occupation, education, income, and accommodation province were found to have significant effects on purchase behavior. The qualitative research allowed a detailed exploration of the topic of interest in which information was collected through in-depth interviews from the supply side: governments, company, and independent organizations. The respondents have responsibility and role dealing EV policy measure in Thailand. This study suggests that the government choose the first priority in monetary policy measures especially exemption of car tax and electric car manufacturers should focus on improving cars and infrastructure to increase battery electric car adoption. Moreover, increase the tax on car emissions and electric car privileges should be considered as policy measures to support BEV adoption in Thailand. Example of electric car privileges are zero charging fees, reduced or zero toll fees, reduced or zero parking fees and fast lanes. However, non-monetary policy measures such as increasing the number of charging stations and raising awareness and understanding about BEVs, should complement monetary policy measures. The results of this research could be helpful in implementing a plan and improving policy to motivate the public to use BEVs in Thailand, leading to more efficient policy. Policymakers could also use the results to directly response to the needs of demand and supply.

Field of Study:	Environment, Development and Sustainability	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

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AC	Normal chargers
BEVs	Battery Electric Vehicles
BOI	Thailand Board of Investment
CBU	Completely Built Units
CFCs	Chlorofluorocarbon
CH_4	Methane
CKD	Completely Knocked Down Units
CO	Carbon monoxide
CO_2	Carbon dioxide
COP21	the Paris Agreement at the 21st session of the Conference of the Parties
DC	Fast chargers
DEDE	Department of Alternative Energy Development and Efficiency, Thailand
DK	Denmark
DLT	Department of Land Transport, Thailand
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office, Thailand
EVs	Electric vehicles
EVAT	Electric Vehicle Association of Thailand
FCEVs	Fuel Cell Electric Vehicles
FR	France
GER	Germany
HEVs	Hybrid Electric Vehicles
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IT	Italy
$MtCO_2e$	Metric tons of carbon dioxide equivalent

NESDC	Office of the National Economic and Social Development Council
NL	Netherlands
NO	Norway
NO_x	Nitrogen oxides
OECD	Organization for economic Co-operation and Development
OICA	Organisation Internationale des Constructeurs d'Automobiles
OTP	Office of Transport and Traffic Policy and Planning
PCD	Pollution control Department
PHEVs	Plug-in Hybrid Electric Vehicles
PM	Particulate Matters
PSUTA	Partnership for Sustainable Urban Transport in Asia
TGO	Thailand Greenhouse Gas Management Organization
TWh	Terawatt-hours
UK	The United Kingdom
UTAUT	the Unified Theory of Acceptance and Use of Technology
UNFCCC	the 1992 United Nations Framework Convention on Climate Change
VOCs	Volatile organic compounds

Chapter 1
INTRODUCTION

1.1 Background

Growing urbanization gives both challenges and opportunities for transportation. Every country must plan transportation infrastructure systematically and connect to the others so that people can reduce cost and time to travel. Moreover, they create more sustainable and develop in their ways. Sustainable Transport is an important network to link the natural and human together. The concept is to combine sustainable development to achieve three pillars: economic, environment and social. It reflects that the present need of this generation must be balanced with the future generation. Sustainable practices are also increasingly engaged in the construction and operation of transportation infrastructure. Government has been invested heavily in infrastructure because this is one of the major factors to promote economic growth including stimulate employment and labor mobility. Efficient transportation infrastructure provides economic and social benefit for communities (OECD, 2019). In addition, some research confirmed the positive impact of transportation investment to help total productivity growth and labor productivity growth (Farhadi, 2015).

Nowadays, many cities face energy consumption problem and air pollution because of the increasing number of cars. The transport sector causes energy usage and air pollution. This is a common challenge for cities over the world, particularly in developing countries such as Thailand. People should consider the electric vehicle because it releases less greenhouse gas emissions than the combustion engine vehicle. Furthermore, the use of automotive technology, powered by electric vehicle, is a useful sustainable transport option for energy saving and reducing pollution ((Hawkins et al., 2013; Muneer et al., 2015; Richardson, 2013). There are government policies to continuously support this issue including the responsibility of all of us in the international community cooperate reduce energy usage and carbon emissions for better environment (Arent et al., 2011; Mowery et al., 2010; Rosen & Guenther, 2015).

In Thailand, transportation is the largest sector (37%) of increasing energy consumption compare with other sectors: industry (38%), residential (18%), commercial (8%) and agriculture (3%) in 2020 are shown in Figure 1 (DEDE, 2020). In addition, the most of greenhouse gas emissions problem come from transport sector. Transportation divides into 4 modes – road water air and rail. The highest greenhouse gas emissions is road transport, followed by air transport, water transport and rail transport 62.68 0.80 0.48 and 0.27 $MtCO_2e$ respectively, accounting for 97.59, 1.24, 0.75 and 0.42 percent of the total greenhouse gas emissions in the transport sector are illustrated in figure 1.2 (TGO, 2015). In present, Thailand has serious problem about air pollution such as CO, NOx and PM 2.5 that affected to human health. These gases and particles come from car that combusts fossil fuel. Thailand has to import this fuel but the crude oil price from foreign countries fluctuate according to the world situation. EVs will offer better environmental benefit in the future because they can reduce emissions and save oil (Huo et al., 2015).

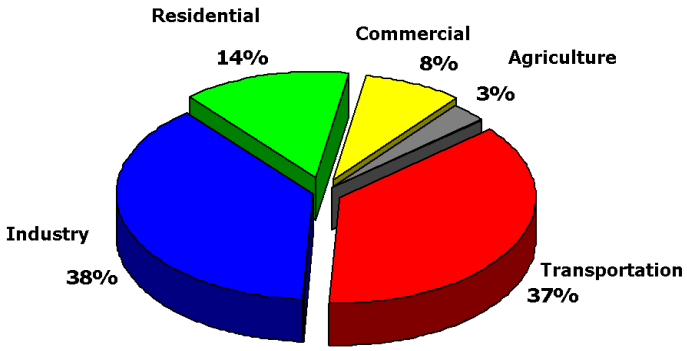

Figure 1.1 *Share of final energy by Sector (January – July 2020) (DEDE,2020)*

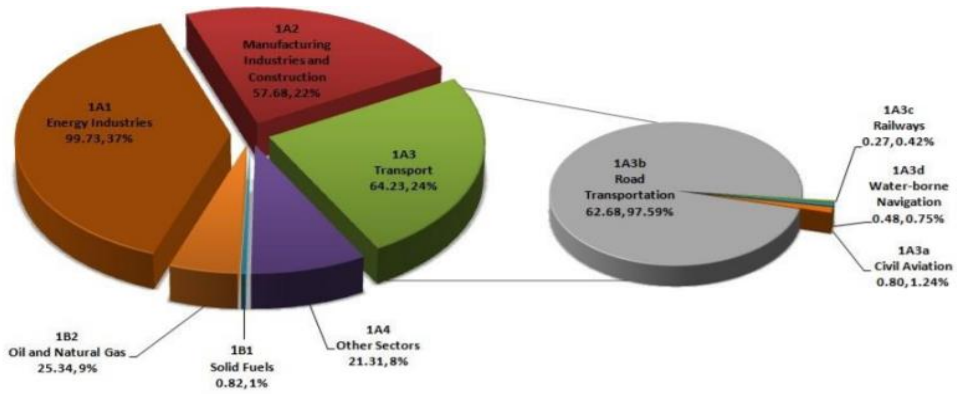

Figure 1.2 *CO_2 Emission from transport sector (TGO,2015)*

The electric vehicles in the current automotive market are divided into 4 main types which are 1) Hybrid Electric Vehicle – (HEV) 2) Plug-in Hybrid Electric Vehicle (PHEV) 3) Battery Electric Vehicle - BEV) and 4) Fuel Cell Electric Vehicle (FCEV). In comparison, HEV still relies on fossil fuels but is more efficient than normal engines. The PHEV can be charged from the vehicle itself running over a distance but within a limited weight. It has both a combination of the engine and electrical system. While the BEV uses only electrical energy, meaning it emits zero emission, the energy efficiency of the BEV is higher. More carbon monoxide, nitrogen oxides, hydrocarbons, and particulate matter are released when fuel is burnt in the FCEV than in other vehicles. The FCEV takes a long time to refuel and is a new technology with a high cost. By studying the overall energy consumption, the BEV is the most efficient energy usage, and it is probably the best choice for sustainable transport (Helmers & Marx, 2012).

The electric vehicles are a trend around the world at present. Car markets such as China, the USA, the United Kingdom, Norway, Germany, the Netherlands, Sweden and France are rapidly growing (Macioszek, 2020). China is the largest market of electric cars in the world, with electric cars constituting nearly half of all existing electric cars. On the other hand, the market of electric vehicles in Thailand was initially introduced to consumers in the personal car market. An increasing number of electric vehicles in many countries can reduce environmental problems and energy consumption because the pollutants of electric vehicles are lower than those of

combustion vehicles (Helmers and Marx, 2012). Hence, the research papers in this area are essential to explore the factors and issues that stimulate electric vehicle adoption (Ling et al., 2021), (Yang et al., 2020), (Macioszek, 2019).

Hence, many counties have to plan and create policies to support electric vehicle adoption in order to achieve the Sustainable Development Goals: ensure health and well-being for all (Goal3), improving energy efficiency (Goal7), the need to make cities inclusive, safe, resilient and sustainable (Goal 11) and Climate action (Goal 13). In the case of Thailand, the promotion of electric vehicles actively begun in early 2015 by the Reform National Council and government at the times of General Prayuth Chan-o-cha, which has been a major administration in driving electric vehicles in Thailand, among others, including the Ministry of Energy, the Ministry of Industry, the Ministry of Higher Education, Science, Research and Innovation and Ministry of Transport. From the COP21, there is a target to reduce the greenhouse gas emissions in the road sector by 25% in all regions by 2030 (approximately 111 million tons equivalent to carbon dioxide). Electric vehicles appear in many levels of development plans, including the 12th National Economic and Social Development Plan (2017-2021), the Energy Efficiency Plan (2015) and 20 years strategic plan for sustainable transport development (OTP,2018; EPPO,2019).

Based on the Department of Land Transport (DLT) database in 2019, Number of registered electric cars are 1,572 of BEV divided into 691 cars, 791 motorcycles, 57 three-wheeler and 33 public transport and 30,676 of HEV/PHEV divided into 26,447 cars and 4,229 motorcycles in Thailand (DLT, 2019). As figure 1.3, Electric cars in Thailand are steadily increasing since 2015. However, Electric car adoption rates are still low compared to combustion engine cars (IEA, 2019) in global including Thailand shown as Figure 1.4. Accumulative target 2035 for using electric cars and pickup trucks is 5.3 million units. Electric car usage and emission targets are currently far out of reach. Thailand requires efficient policies to increasing electric vehicles adoption especially focus on BEVs.

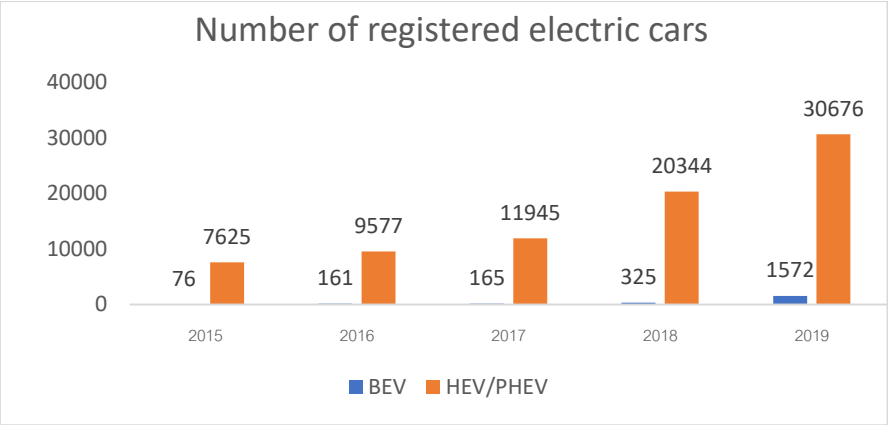

Figure 1.3 *Number of registered electric cars in Thailand (DLT,2019)*

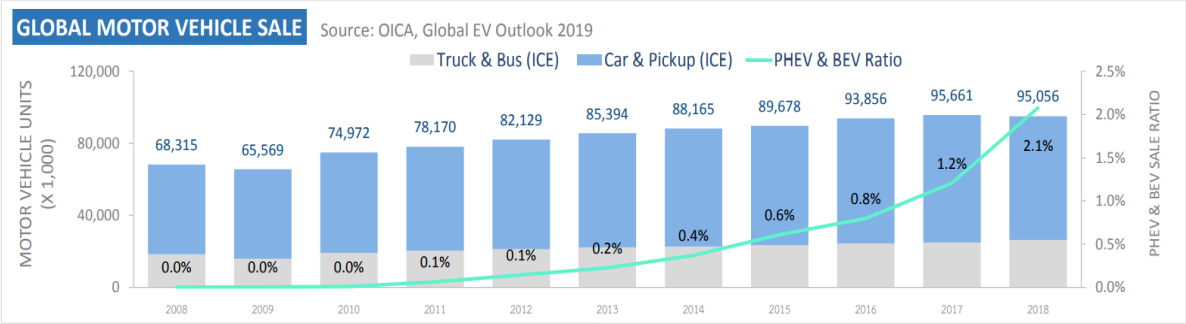

Figure 1.4 *Global motor vehicle sale (OICA,2019)*

1.2 Research Questions

The main research question is "What is the effective policy to stimulate EV adoption in Thailand?"

Sub-question 1: What is the current situation of EVs in Thailand?

Sub-question 2: What are the key factors that influence consumer purchasing behavior of BEVs in Thailand?

1.3 Research Objectives

The aims of this research are:

1. To study the current situation of EVs in Thailand
2. To identify factors affecting purchasing intention of BEVs in Thailand
3. To propose policy recommendations to stimulate BEVs adoption in Thailand

1.4 Scope of Study

This study collected data from questionnaire survey and interview. It investigated supply and demand sides of battery electric vehicles (BEVs) in Thailand separately. Questionnaire survey collect data from demand side who are making decisions about buying BEV car in Thailand. Demand side can represent public's attitudes and their strength from psychological perspectives. Interviews are conducted by collecting data from supply side, including Department of Land Transport as regulators (DLT) under Ministry of Transport, Ministry of energy, Ministry of Industry, Ministry of Finance, Pollution Control Department under Ministry of Natural Resources and Environment, Ministry of Commerce, Thailand Board of Investment (BOI), Electricity Generating Authority of Thailand (EGAT), Thailand Automotive Institute, Electric Vehicle Association of Thailand (EVAT) and manufacturing company. The respondents were selected by the specific sampling method to whom have responsibility and role dealing EV policy measure in Thailand. Data from questionnaire survey were analyzed using partial least squares structural equation modeling (PLS-SEM) and applied the unified theory of acceptance and use of technology (UTAUT).

1.5 Expected outcomes

The results of this research illustrated the behavior of car owner in Thailand, understand the current situation of EVs in Thailand, identify factors that lead to the purchase of BEVs, and provide policy recommendations of BEVs adoption. It was very helpful for implementing a plan and improving policy to motivate public use. The development and improvement of the policy will be more efficient. Policymakers can use the results to responds to the needs of demand and supply directly.

1.6 Organization of Dissertation

Following this, Chapter 2 presented literatures on Thailand's national policy, transport policy in Thailand, summary of Electric vehicle in the world, ASEAN region and Thailand include example of policy measure and policy assessment are summarized. Then, overview of the theoretical background adapted from the previous literature. Chapter 3 explained the research methodology with research design including data collection and data analysis. Chapter 4 described the results analysis and discussion from questionnaire, in-depth interview, and documents. Finally, Chapter 5 concluded the research by considering the findings of demand and supply side and suggesting policy measures and provides imitations and future research directions.

Chapter 2
LITERATURE REVIEW

This chapter first reviews Thailand's national policy, transport policy framework and regulations are discussed. Secondly, electric vehicle in the world, ASEAN region, Thailand including example of policy measure and policy assessment are summarized. Then, overview of the theoretical background adapted from the previous literature. Finally, the concept of sustainable transportation and indicators are presented.

2.1 Policies and Regulations in Thailand

2.1.1 National policy

The 20-year national strategic plan was endorsed by the office of the National Economic and Social Development Council (NESDC) which aims to ensure the country achieves vision: Thailand becomes a developed country with security, prosperity and sustainability in accordance with the Sufficiency Economy Philosophy with the ultimate goal being all Thai people's happiness and well-being. The national strategy is designed to uphold the country's capacity to effectively deal with changes generated by internal and external factors at all level; to upgrade Thailand's agricultural, industrial, and service sectors with technology and innovation for higher added values; to develop new economic drivers that will enhance the country's competitiveness, leading to higher income per capita and more adequate benefits distribution to all parts of the country; to develop people to be virtuous, skillful, disciplined, considerate, equipped with analytical skill and consistently able to know, obtain and adapt new technology; to have equal access to basic public service, welfare and justice system, with no one left behind (NESDC, 2018a). This plan is consisted of six primary strategies as follows (see as figure 2.1):

Strategy 1: Security aims to ensure national security and public contentment; to prepare and develop human capital; to employ integrated mechanisms designed to effectively deal with security problems in the public sector, private sector and civil sector based on good governance principle.

Strategy 2: Competitiveness Enhancement proposes to strengthen the economy and enhance competitiveness on a sustainable basis based on the three ideologies; Learning from the past for further development, Adjusting the present and Creating New future Values such as reduce inequality, and expand trading and investment opportunities in global market.

Strategy 3: Developing and Empowerment Human Capital aims to develop Thai people of all ages in a multidimensional manner to become good, skillful and quality citizens.

Strategy 4: Broadening Opportunity and Equality in Society aims to develop cooperation between private sector, general public and local communities for strategy implementation. Thai people access to quality public services and welfare practices.

Strategy 5: Environmentally-friendly growth aims to achieve all development aspects of the Sustainable Development Goals (SDGs), including society, economy, environment, good governance and cooperation partnerships at both national and international levels.

Strategy 6: Reforming Government Administration aims to enhance the efficiency of public sector management based on the concept of "a public sector of the people, for the people and the public interest".

Figure 2.1 *The 20-year National Strategy Plan (2017-2036) Framework (NESDC,2018a)*

2.1.2 Transport policy

According to the 20-year national strategic plan, the 12th National Economic and Social Development Plan (2017-2021) relate to transport in Strategy 7: Improvement of Infrastructure and logistic system. All this strategy relay though transport policy which implement in the present.

Thailand's transport system development in the future focus on accommodating the changes in lifestyle, travel behavior and modes of doing business as well as rising travel demand, which are the consequences of globalization and decentralization. As a result, transport systems of the future must be innovative systems that are able to meet the needs of the public, accommodate growth and improve the quality of life (OTP,2016).

The concept of transport system development from 20 years plan (2017-2036) is set in the Thailand Strategic Transportation Framework, taking into account 4 areas of efficient transport. Green and Safe Transportation has been a priority to promote equitable use of electric vehicles (EV). And implementing effective innovation and management tools apply to use in the process of developing transportation systems. Figure 2.2 shows Strategic Transportation Framework in Thailand (OTP,2016).

- Green and Safe transport

Safe transportation should be supported for every mode of transport. In order to achieve that, infrastructure that is safe and in line with acceptable standard must be provided. Traffic and transportation laws must be enforced. For example, regulators must ensure that transport service providers of all kinds comply with the concerned rules and regulations. Motorists must be encouraged to adhere to traffic laws, especially those regarding road use, as road accident rates in Thailand are high. New technology should be used in infrastructure development as well as transport management to ensure efficiency. In addition, agencies providing transport services must ensure concerned personnel such as pilots, air traffic controllers and bus or boat drivers adhere to a suitable number of working hours per day/shift to avoid fatigue as their work has a direct impact on public safety. In term of green transport, People should be encouraged to use eco-friendly and non-motorized transportation such as

bicycling and walking. Public or mass transportation systems should be developed in major cities of the country's non-central regions to increase transportation options available to the public, focusing especially on water and rail transport as these 2 modes of transportation are eco-friendly. Road transport facilities such as bicycle parking spaces, park, and ride lots and convenient and safe pedestrian lanes should be provided to entice people to avoid using personal cars. In addition, companies are encouraged to switch to clean or alternative energy. Transport technology that is nature-friendly such as electric vehicles should be supported. Diligent car and motorcycle inspection as well as efficiency improvement for flight operations, airport use, and air traffic management is also needed.

- Transport Efficiency

The efficiency of transportation and logistics should be improved by developing transport infrastructure to ensure connectivity between agricultural and industrial areas, between trade gateways and major tourist destinations, between different modes of transport and between major cities in non-central regions. Transport services should be managed efficiently to reduce logistics costs and bottlenecking. Emphasis should be put on connected modes of transportation with focuses on rail and water transport and roads as feeder systems. The capacity and efficiency of infrastructure including railways, airports and seaports should be augmented to increase the country's competitiveness. Technology should be used to maximize the efficiency of transport service provision and management. They can be used in real-time traffic reporting, traffic light and speed controls, electronic fee calculation systems, smart highways, etc. With the use of smart technology, traffic information can be exchanged without traffic information centers. Another example of smart technology is the use of GPS for public transport and freight truck controls.

- Inclusive Transport

Transport services should be designed in line with the Universal Design/Transport for all concept with focuses on accessibility, affordability, and efficiency. This concept should be taken into account in all stages of designing and developing infrastructure and transport services. For Thai society to grow, all groups of people should be able to participate in economic and social activities, which can be

achieved by allowing people to have equal access to public and mass transport services. The use of subsidies for groups with special needs should be considered.

In order to realize these three concepts, Thailand must focus on developing personnel as well as technology. Research and development, innovation and management efficiency should be used as essential tools for developing transport systems and infrastructure when analyzing, designing, constructing, monitoring, and evaluating any transport/infrastructure project.

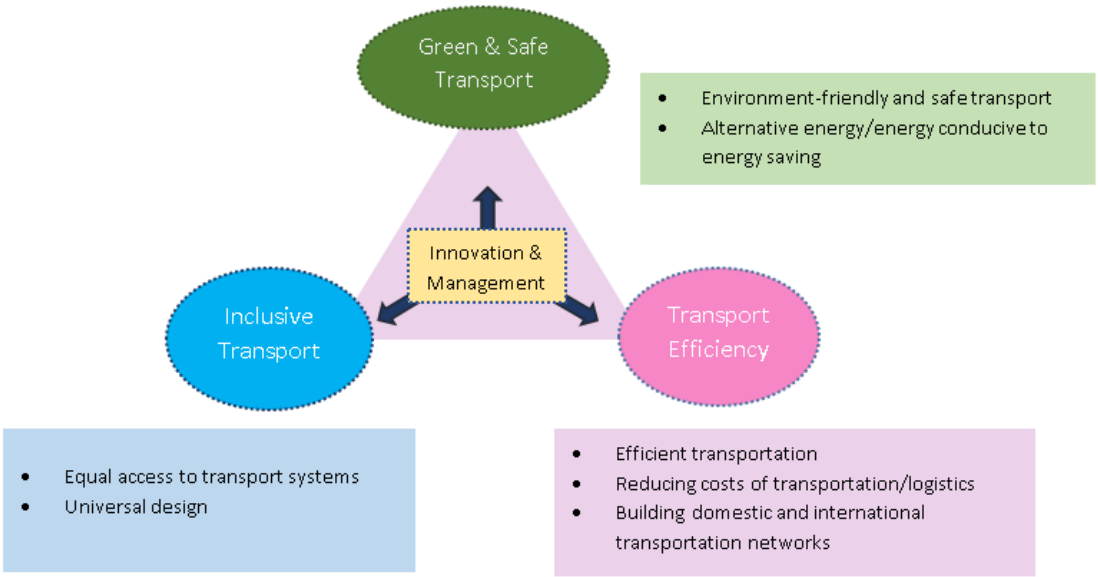

Figure 2.2 *Thailand Strategic Transportation Framework (OTP,2016)*

2.1.3 Regulation and Law

In Thailand, Private cars (not more than 7 passenger seats) are regulated by Motor Vehicle Act (1979) as followed:

1. Category 2: Annual Tax in section 29 private cars are used more than 5 years. There are tax break rate after each year – year 6 get 10 %, year 7 get 20 %, year 8 get 30 %, year 9 get 40 %, year 10 and beyond get 40 %. In present, annual tax rate of combustion vehicle cars (not more than 7 passenger seats) is calculated from maximum engine capacity (cc) of each car. Annual tax rate for electric cars is calculated in the same way as combustion cars (more than 7 passenger seats) by calculating from vehicle weight so tax rate of electric car is lower than combustion

cars (not more than 7 passenger seats). Annual tax for electric cars in the future has to be reconsiderated in order to stimulate to change from combustion cars.

2. Category 3: Driving License in section 43 Temporary license for private vehicle, the validity period is two years while validity period of regular license is five years.

2.2 Electric vehicle situation

2.2.1 Overview electric vehicle in the world

In 2018, Electric cars have more than 5.1 million cars which increase around 2 million cars compare with 2017. As Figure 2.3, China is the largest market of electric cars in the world nearly half of existing electric cars. The first market share of electric cars in the world is Norway (IEA, 2019). Many Norwegians buy electric car instead of combustion car ((Hjorthol, 2013; Klöckner et al., 2013; Nayum et al., 2016). Adoption of electric cars in Denmark diffuse slowly (Thøgersen & Ebsen, 2019). The usage of energy from electric cars is 58 terawatt-hours (TWh) and greenhouse gas emission 41 million tons CO_2 equivalent in 2018. It can reduce greenhouse gas emission 36 million tons CO_2 equivalent compare with combustion cars. Electric vehicle technology is new development that must be supported by the government and the early adopters who have specific motivation: less fuel cost, higher philosophy for the global environment, getting on the trend, free use of express lanes and policies, etc. (Figenbaum et al., 2014; Helveston et al., 2015; Krupa et al., 2014; Lieven, 2015; Nandanpawar, 2017). For example, China and Japan have production support for the industrial and infrastructure, Europe and South Korea have supporting measures to give privileges for electric car such as permission to reduce toll and parking fees. All of these, electric vehicle become more popular in present. The most important factor for prospective electric vehicle drivers is the concern with environment benefit (Figenbaum et al., 2014). Moreover, the number of car charging station increased to 5.2 million stations. Most stations are slow charging (normal charging) installed at home and work. Public charging station approximately 540,000 stations which are 150,000 quick charging stations.

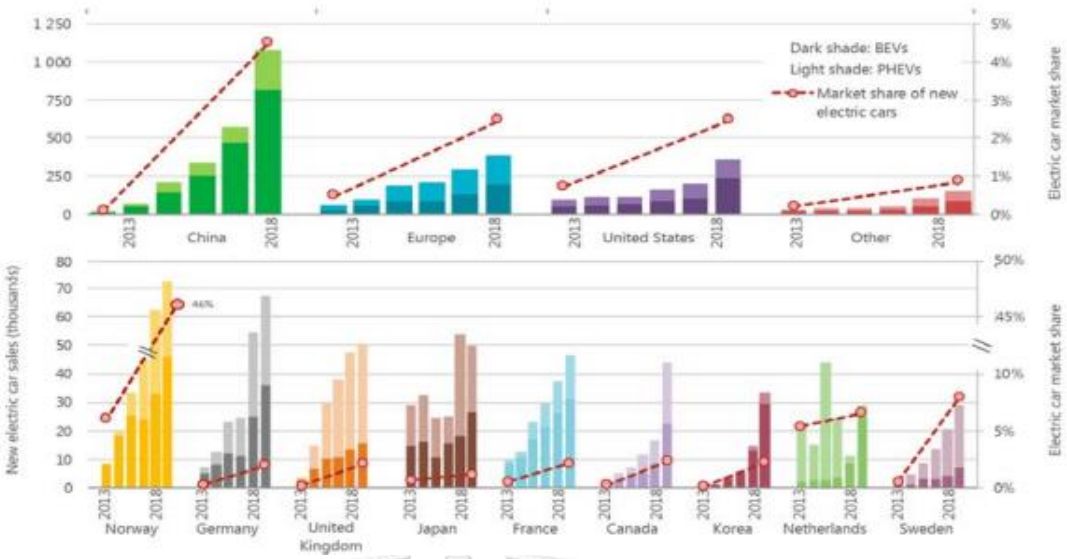

Figure 2.3 *Sales and market share of electric cars in the world (IEA,2019)*

2.2.2 Electric vehicle in ASEAN region

Electric Vehicle Association of Thailand (EVAT) organized the ASEAN EV Summit 2019 on June 5, 2019, at the Bangkok International Exhibition and Convention Center (BITEC) to present the promotion of electric vehicles in ASEAN region. By inviting representatives from Malaysia, Myanmar, Philippines, and Singapore can be summarized as follows:

Malaysia: The government has set goals for the year 2020: 100,000 electric cars, 100,000 electric motorcycles, 2,000 electric buses and has 125,000 charging stations. The development of electric vehicles in Malaysia consists of three strategies which are (1) supporting the use of electric buses and promoting personal electric vehicles (2) enhancing electric vehicle ecosystems and electric power and charging infrastructure; and (3) accelerating technology that has develop opportunities in the country.

Myanmar: Currently, Myanmar has a total of 1.3 million cars, not more than 500 electric vehicles. Nissan Leaf is the most popular electric car. There is assembly electric car factory from China investor. For electric buses, there is a joint investment between Myanmar and the European Union countries to set up assembly factories for

domestic use and export to foreign countries. But in Myanmar, there is an electric power problem. The Myanmar government has to develop an electric power infrastructure to cover the entire country and plan of charging station development to support the increasing quantity of electric vehicles in the future.

Philippines: There are three objectives in promoting the use of electric vehicles: (1) reducing fuel consumption (2) creating opportunities and development of the automotive industry and (3) increases the quality of life and livelihood of the people. Together with four policies to promote electric cars 1. Increasing demand of electric car use 2. Reduce cost of electric car 3. Charging Infrastructure development 4. Development of electric car industry.

Singapore: Year 2015 - 2017, the Government has a policy to promote the use of electric vehicles from configuration plan of Carbon Emission-Based Vehicle Scheme (CEVS) by electric vehicles. Hybrid Electric Vehicle: HEV receives a tax rate discount equal to plug-in Hybrid Electric Vehicle: PHEV and electric vehicles. As a result, cars use electric power become more popular. Year 2018 – 2019, plan has been modified to the Vehicle Emission Scheme: VES) by canceling the hybrid electric vehicle tariff discount. But still discounts the Plug-in hybrid electric vehicle tax rate in order to make people more popular to use this type of car and increase the tax rate for diesel cars.

2.2.3 Electric vehicle in Thailand

The promotion of electric vehicles in Thailand has begun to be actively promoted since the beginning of 2015 by the Reform National Council and government by the times (General Prayuth Chan-ocha), which has a major administration in driving electric vehicles in Thailand including the Ministry of Energy, the Ministry of Industry, the Ministry of Higher Education, Science, Research and Innovation and Ministry of Transport. Each country government recognizes the importance and ensures that electric vehicle technology will replace internal combustion vehicles. It has invented and established measures to promote both the production and initiate its use. The success of expansion usage depends on the level of support and the suitability of the local context. Thai government has promoted the production of electric vehicles in the country. To setting goals for the year 2036, total

of 1.2 million electric cars are used through the Investment Promotion Benefit policy of the electric vehicle industry by The Board of Investment of Thailand (BOI), especially manufacturers such as corporate income tax exemptions, import duty exemptions, parts and equipment, and measures to reduce excise tax (OTP, 2018). From collecting the trends of the expansion of electric vehicles in the world and Thailand analyze with various effects SWOT assessment and the status of the domestic industrial production sector including challenging issues, supporting factor and consumer concerns. The results were summarized on three supporting issues except supporting the manufacturing sector as table 2.1 illustrate.

Table 2.1 *Supporting issues of electric cars use (OTP,2018)*

Demand side support	Infrastructure and transport system support	Power generation and distribution system support
1. Reduce cost: tax measures, subsidies, and low-interest loans	1. Studying the usage behavior and charging of electric vehicles	1. Improvement the forecast of electricity demand
2. Encourage private and public to own electric vehicles for use	2. Set an area that limits traffic and give privileges for electric cars	2. Promote investment for improve the power delivery system to support smart charge
3. Promote electric vehicles in public transport and categorize electric vehicles	3. Improve the connection of public transport system and preparation of charging stations	3. Issue regulations and laws for setting the tariff and distributing electricity from car to vehicle to grid
4. give the privilege of travelling with electric cars	4. Develop charging technology under the traffic surface	

The awareness of the market and the increase in the number of registered electric vehicles is a result of the government's policy to promote and support electric vehicle. Government around the world have introduced different policies to promote and support electric vehicle in two categories: financial and non-financial policy (Li et al., 2020). Thai government establishes guidelines for promoting integration in every side by dividing the promotion measures into 6 measures as follows (OTP, 2018):

1. **Investment promotion measures to create supply**

The Board of Investment of Thailand (BOI) considered investing promotion manufacture of electric cars and parts covering the electric vehicle manufacturing business HEV, PHEV and BEV, important parts of electric vehicles including the electric charge station business under the conditions, the project must be submitted as a combined plan consisting of automobile assembly manufacture of parts or the use of important parts such as batteries, motors, Battery Management System (BMS) and Driving Control System (DCU), used battery management plan and development plans for manufacturers of raw materials or parts in the country in the condition that the participating car in the support project must pass the type approval standard of the UN Regulation. Benefits for the project will have exemption of import duty on machinery, reduction of import duties on raw and essential materials, corporate income tax exemption, exemption of import duty on electric cars with finished batteries in pilot test. By those who can accept the procurement of the production project, eco cars can count cars manufactured under this project as actual production volumes but eco cars have to qualify of energy saving, environmental friendliness and safety. Thailand have pushed investment in manufacture of electric cars, important parts of electric car and continuous industrial under Eastern Economics Corridor Development Project (EEC).

Excise Department and Customs Department under Ministry of Finance has proposed the rate criteria collect excise tax at a special rate. HEV and PHEV cars will be entitled for the reduction of the excise tax rate from the normal rate to half and BEV cars will be entitled for the reduction of the excise tax rate to 2 percent. The project must be approved the project from BOI and the battery is manufactured and used in the country from the fifth year onwards. Moreover, Import BEV electric vehicles for market trials in quantities exempt duty when approved by the Board of Investment in duration not more than two years.

Ministry of Commerce, Ministry of Foreign Affairs, Ministry of Finance and Ministry of Industry measures to push for negotiate with China. In order to determine the appropriate import duty rate for BEV cars under the ASEAN-China Free Trade Agreement.

2. **Measures to stimulate the domestic market**

Three ministries, namely, the Ministry of Industry, the Ministry of energy and the Ministry of transport, have been tasked with stimulating the domestic EV market by replacing some of their internal combustion cars with electric vehicles, thus enlarging the proportion of PHEVs and BEVs in their fleets and setting examples for other government agencies as well as the private sector.

3. **Infrastructure preparation**

Energy Policy and Planning Office (EPPO) under Ministry of energy, Office of Transport and Traffic Policy and Planning under Ministry of Transport, Electricity Generating Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) have joint approach to study plans for installing charging stations in the target areas and the main road that connects the target area. Moreover, Government offers incentives for the installation of EV charging equipment such as rebate, tax credits, grants and loans. The key players in the investment of charging stations, state enterprises, international oil and gas companies, automotive companies, large firms, and start-ups in the green energy sector have entered the EV charging business so the private sectors have been a major driving force in the expansion of the charging infrastructure such as PTT, Bangchak, MG, Nissan, EA Anywhere and Evolt. In 2020, Number of public EV charging stations of Thailand have approximately 647 stations: 1,220 normal chargers and 706 fast chargers (EVAT, 2020). EA Anywhere has been the most active company that can expand the charging network to 405 locations by partnering with shopping centers, leading restaurants, and property developers. EV charging stations tend to be in Bangkok, key provinces (Chiang Mai, Nakhon Ratchasima, Phuket) and tourist destinations such as Pattaya and Huahin.

4. **Preparation of electric vehicle standards**

Thai Industrial Standards Institute (TISI) under Ministry of Industry issued a standard declaration for sockets of electric vehicles and preparing other necessary standards such as electric vehicle charging system standard, electromagnetic

compatibility standards and battery standard and direct current meter standards for use in electricity distribution.

Department of Land Transport (DLT) under Ministry of transport has revised the original announcement regarding electricity motor power requirements used to drive in accordance with the law on cars and guidelines for the use of small electric cars for appropriate situation and can accommodate more comprehensive small and medium electric vehicles. Moreover, DLT has studied guidelines for establishing safety requirements for electric vehicles and accessories according to international standards that suit for Thailand as well as how to check the condition of electric vehicles.

5. **Management of car wrecks and used batteries**

Ministry of Industry had set up a working group to study automobile wreck management to study, give opinions and propose concrete measures for car wreck management in Thailand including studying the development of continuous industries or related industries. In order to, that can be recycled as new raw materials according to the concept of circular economy to achieve a systematic car wreck management mechanism. Moreover, Ministry of Industry establishes criteria for setting up a vehicle recycle factory and promote investment in recycle factories, car wrecks and batteries.

Pollution Control Department under Ministry of Natural Resources and Environment had guidelines for defining electric vehicle battery products in the Waste Electrical Appliances and Equipment Management Act.

6. **Other measures**

Thailand Automotive Institute and Ministry of Industry have undertaken a project to increase productivity focus on the development of the personnel certification system for 5 years to continuously support the automotive industry in the future. There is platform to meeting between university, research unit and private sector relate to electric vehicle operated by the Electric Vehicle Association (EVAT).

From the above, it can be seen that the widespread promotion of electric vehicles requires commitment and government policy as a starting point. Globally, there are strong policies include tax reduction, financial purchase subsidies and exemptions, preferential parking and charging option, free use of ferries for BEV drivers, road space privileges (bus lanes) and information campaigns (Sierzchula et al., 2014), (Bjerkan et al., 2016), (Kester et al., 2018), (Zhuge & Shao, 2019), (Hardman, 2019) and (Brückmann & Bernauer, 2020). Policy to promote the use and production of electric vehicles must be integrated between government agencies, private enterprises, independent agencies.

2.2.4 Policy measures

Each government recognizes the importance of using electric vehicles to replace combustion vehicles, so policies have to support development, production and adoption EVs. Electric vehicles can reduce greenhouse gas emission, energy saving and environmental protection (Hofmann et al., 2016; Ma et al., 2017; Shi et al., 2016). There exist several kinds of policy measures at present. All exist policy measures could be organized into 3 categories: monetary issues, traffic regulations, and charging infrastructure or divided into 2 categories: monetary issues and non-monetary policy measures. (Lieven, 2015; Zhu et al., 2016). The consumers chose EVs mainly because economic incentives which can support people to save money (Bjerkan et al., 2016; Liao et al., 2017). Table 2.2 shows example of policy measures if people buy EV cars in many countries.

Table 2.2 *Example of policy measures in the world*

Issues	**Policy measures (if people buy EV cars)**	**Canada USA (States)**	**Europe**	**Asia**	**Other**
Monetary issues	1. Tax credit or Tax deduction	Colorado Georgia	Austria Belgium	-	Israel

Issues	Policy measures (if people buy EV cars)	Canada USA (States)	Europe	Asia	Other
		Oklahoma Utah	Netherlands		
	2. Subsidies or Discount car price	Canada California Hawaii Illinois Louisiana Maryland Tennessee Texas	Spain Sweden UK	China (pay for Manufacturer)	-
	3. Feebate	-	Austria Estonia France Ireland Luxemburg Spain Sweden	China Japan Singapore	-
	4. Exemption or Reduction of new registered car tax	New Jersey Washington Maryland	Denmark Finland Ireland Netherlands Norway Portugal Romanian Sweden UK	India Malaysia Singapore	Costa Rica Israel
	5. Exemption or Reduction of road use tax or annual	-	Austria Denmark	India Japan	Australia New

Issues	Policy measures (if people buy EV cars)	Canada USA (States)	Europe	Asia	Other
	vehicle tax		Finland Germany Italy Ireland Netherlands Norway Portugal Romanian Sweden Switzerland Greece UK Czech Republic		Zealand
	6. Reduce or Free parking fee	-	Denmark France Netherlands Norway Portugal UK	-	-
	7. Reduce or Free charging fee at public parking	California	Netherlands Norway	-	-
Non-monetary issue (Traffic regulations/	8. Right to use of bus/fast lanes	Canada Arizona California Florida New Jersey	Netherlands Norway Portugal	Korea	-

Issues	Policy measures (if people buy EV cars)	Canada USA (States)	Europe	Asia	Other
Charging infrastructure)	9. Separate allocations of EV license plates	Canada Illinois Massachusetts	UK	China	-
	10. Charging Network on Freeways	Canada USA	Norway Netherlands UK Switzerland Germany Belgium France Italy Spain Austria Portugal Finland Ireland	Japan China	-

2.2.5 Policy Assessment

From the above, policy incentives divided into 2 types: monetary issues and non-monetary issues. Previous researches found monetary issues especially purchase cost reduction to be the strongest incentive in promoting BEV adoption such as Norway and Denmark (Bakker & Jacob Trip, 2013; Bjerkan et al., 2016). The BEV market share of Norway is far higher than other country. Norway announced the ban of combustion vehicles by 2025 while other European countries aim for a ban in 2030 (Haustein et al., 2021). Purchase cost reduction relate to public and private sector. Government can provide direct subsidies for people when they purchase an electric vehicle. However, such subsidies can be costly and may be ineffective if the price of electric vehicle remain too expensive. In order to, car manufacturers still do not

reduce the cost of electric vehicle when they may not get the benefit of the policy. Moreover, less prominent incentives such as road tolling exemption and bus lane access have affected some BEV users in Norway (Haustein et al., 2021). Road tolling exemption can reduce expense for BEV users. Bus lane access provide significant time saving for travel but the presence of BEVs in bus lane has caused public transport delay. Any government aware of the importance of electric vehicle technology and confident that electric vehicles will replace internal combustion vehicles, has come up with measures to support the manufacturing and usage of electric vehicles. Their success in expanding the electric vehicle market depends on the level of support and the country's context. In Thailand, the support for electric vehicles began in 2015 in every facet of the industry. However, this support has not been enough and has not produced tangible successes. On the supply side, supportive measures have been implemented in a manner that has not impacted eco carmakers whose government support began earlier than the support for electric vehicles. Energy infrastructure preparations have also been made. On the demand side or the side of consumers, before taking any actions like designating target cities or areas or offering privileges, the government has had to consider a possible wider impact on society including factors such as traffic congestion and encourage to use public transport.

2.3 Theoretical Background

Human behavior has explicated several theoretical methods to explore individual adoption of technology and determine factors. The unified theory of acceptance and use of technology (UTAUT) is the one of the model which developed from eight existing theories of behavior including Theory of Reasoned Action (TRA) posits the influence of beliefs and perceived subjective norms on behavior, Technology Acceptance Model (TAM) represents the relationships between perceived usefulness, perceived ease of use and intention to use new technology, Theory of Planned behavior (TPB) explains how the attitude toward the behavior, subjective norm, perceived behavior control and behavioral intention, Motivational Model (MM) used in psychology for explain behavioral motivation, Combined TAM and TPB , Model of personal computer Utilization (MPCU) which predict individual acceptance and

use of technology, Diffusion of Innovations (DOI) and Social Cognitive Theory (SCT) (Ajzen, 1991; Davis, 1985; Fishbein & Ajzen, 1975; Venkatesh et al., 2003). The UTAUT model has explained user intention to use an information system and actual behavior which amplify from TAM model (Venkatesh et al., 2003). This model has four main factors of behavioral intention (BI) including performance expectancy (PE), effort expectancy (EE) and social influence (SI). Facilitating Conditions (FC) became the factor that related to usage behavior. Moreover, Gender, Age, Experience and Voluntariness of Use constituted optional variable (see Figure 2.4).

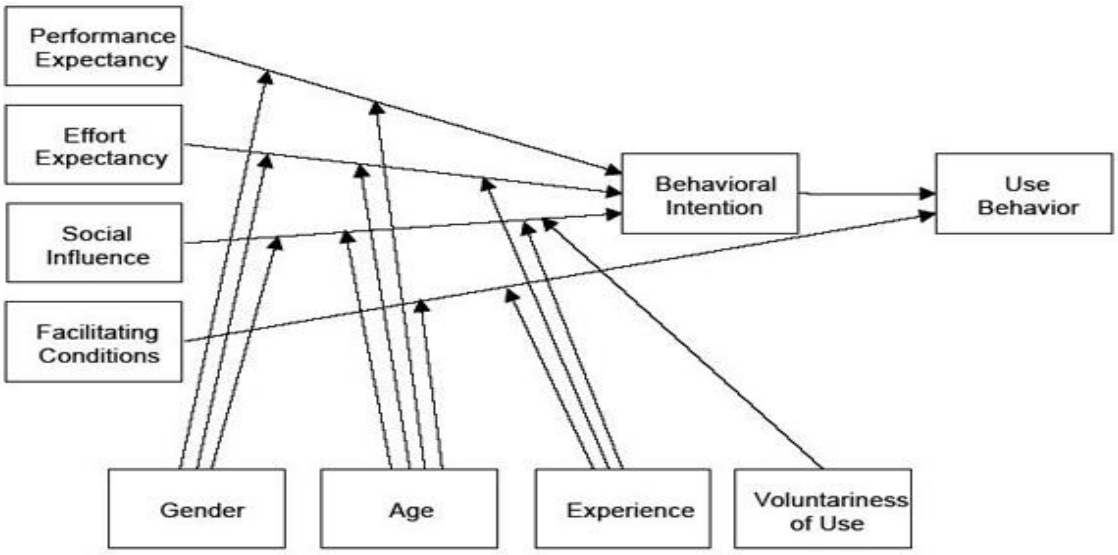

Figure 2.4 *The original UTAUT model (Venkatesh et.al.,2003)*

The UTAUT model was widely applied to many fields of research such as the medical field, e-commerce and transportation (Kijsanayotin et al., 2009; Madigan et al., 2017; Oliveira et al., 2014). For previous research, the UTAUT model can be applied to public acceptance of new technology transport modes like Wolf and Seebauer (Wolf & Seebauer, 2014). They surveyed Austrian adopters and find the reasons for using electric bicycles, Madigan, et al.,2017 adapted UTAUT to investigate factors that impact acceptance user of automated road transport systems. Tran, et al., 2019 adapted UTAUT to investigate determinants of Electric carsharing acceptance. They found that more factors have extended the UTAUT in a consumer context into UTAUT2 model. The study examined the impact of hedonic motivation

which have positive impact on behavioral intention. Price value incorporated one of other variables that was developed for individual acceptance and use setting (Venkatesh et al., 2012). Declaration of eco-friendly for EVs and environmental action proposals can reinforce each other to help increase intention to purchase EVs (Turner, 2007), (Adnan et al., 2018). Moreover, Electric vehicle adoption in the world is highly dependent on strong electric vehicle policies such as California, China, Germany, and Norway (Lévay et al., 2017; Münzel et al., 2019). For policies, prior research tends to examine incomprehensive policy instruments in promoting EV adoption, but policies are integration both of financial and non-financial instruments (Li et al., 2020; Wang et al., 2017; Wang et al., 2018). In Korea, researchers find environmental concern and financial incentives impact on adoption electric vehicle intention (Kim et al., 2018). Germany survey find external policies: infrastructure, incentives and communication relate to adoption electric vehicle intention (Heidenreich et al., 2017). Their results showed that the main policies have a positive impact on consumer purchase intention include purchase subsidies, parking fee reductions and driving privileges (Hackbarth & Madlener, 2013; Helveston et al., 2015; Sang & Bekhet, 2015; Zhang et al., 2011). Accordingly, Hedonic motivation, Price value, Environmental Concern and Policy Measures are factors that consider more than factor from the original UTAUT.

2.3.1 Research model and Hypothesis

The current study attempted to predict purchase intention on BEV cars. We combined the original UTAUT model with the previous research results to add more factors include Hedonic motivation (HM), Price value (PV), Environmental Concerns (EC) and Policy Measures (PM) on purchase intention (Huang & Ge, 2019; Venkatesh et al., 2012). Each variable expected to make a unique contribution to the overall predictive capability of the model. Previous research has shown purchase intention of EV car and used Technology Acceptance Model (TAM) and Theory of planned behavior (TPB) in different countries such as China, Canada, and Norway have all confirmed the positive roles of attitude, subjective norm, perceived behavioral control and personal norm in promoting electric vehicle purchase intention

(Huang & Ge, 2019; Klöckner et al., 2013; Mohamed et al., 2018; Panson, 2018). Thus, this study applied UTAUT model to investigate purchase intention of EV car which be specific and hardly show in previous study.

The proposed UTAUT research model is given each factor details as follows:

2.3.1.1 Performance Expectancy (PE)

Venkatesh et.al. defined performance expectancy as the level of personal belief that using collaboration technology will improve work efficiency and lead to operational success. Electric cars are associated with many benefits such as reduced energy use and air pollution. Therefore, **Hypothesis 1 (H1)** is that performance expectancy has a significant positive effect on BEV purchase intention.

2.3.1.2 Effort Expectancy (EE)

Effort Expectancy refers to the level of awareness of the ease of using technology, or that it can be easily learned and used, is convenient, and is not complicated. The perception of simplicity allows users to anticipate technology performance and ultimately intend to demonstrate technology behavior. EE is applied to perceived ease of use in TAM. Thus, **Hypothesis 2 (H2)** is that effort expectancy has a significant positive effect on BEV purchase intention.

2.3.1.3 Social Influence (SI)

The role of social influence arises from the individuals who influence the decision of users such as family and friends. Social influence is also defined as the power of a co-worker or supervisor to influence how technology users express themselves. Therefore, **Hypothesis 3 (H3)** is that social influence has significant positive effects on BEV purchase intention.

2.3.1.4 Facilitating Conditions (FC)

Facilitating Conditions are defined as the availability of technology, organizational systems, and resources in terms of infrastructure, software system, and experts that the organization has prepared to support the use of technology. Moreover, facilitating conditions became the factor

that related to usage behavior. Thus, **Hypothesis 4a (H4a)** is that facilitating conditions significantly positively effect BEV purchase intention. **Hypothesis 4b (H4b)** is that facilitating conditions have a significant positive effect on use behavior.

2.3.1.5 Hedonic Motivation (HM)

Hedonic motivation is the fun or enjoyment derived from using technology. Perceived enjoyment impacts consumer acceptance and use of a new technology. From this relationship, **Hypothesis 5 (H5)** is that hedonic motivation has a significant positive effect on BEV purchase intention.

2.3.1.6 Price Value (PV)

Many research and social roles mentioned that price influences purchase intention (Venkatesh et al., 2012). Similarly, business owners operate at a lower cost and generate more profits or customers decide to buy cheap and good-quality products. Therefore, **Hypothesis 6 (H6)** is that price value has a significant positive effect on BEV purchase intention.

2.3.1.7 Environmental Concerns (EC)

With increasing global issues, environmental concerns have become more significant in purchasing decisions. Global warming from CO_2 emissions produced by cars is impacting the purchasing decisions of car consumers (Razak et al., 2014). The relationship between environmental concerns and actual behavior is complex. According to earlier research findings, the impact of environmental concerns is an important factor that leads to increased behavioral intention and sustainable consumption behavior (Saari et al., 2021). Thus, **Hypothesis 7a (H7a)** is that environmental concerns have a significant positive effect on BEV purchase intention. **Hypothesis 7b (H7b)** is that environmental concerns have a significant positive effect on use behavior.

2.3.1.8 Policy Measures (PM)

Incentive policy measures are essential factors that influence purchase intention. If governments do not support EVs, consumers may have low intentions to purchasing EVs (CATARC, 2018; Liao et al., 2017). Incentive

policy measures are divided into two categories: monetary and non-monetary incentive policy measures. Tax credit, subsidies, discount car price, exemption of new registered car tax, reduced parking fee, and free charging fees are examples of monetary incentive policy measures in developed countries. Non-monetary incentive policy measures aim to provide convenience to consumers when they buy and use BEV such as fast Lane for EVs. Adoption of EVs is especially low where policy measures are lacking. Subsidy policies is implemented to induce high level of the adoption of green products and is connected to consumers' behavior (Hong et al., 2021). Thus, **Hypothesis 8a (H8a)** is that policy measures have a significant positive effect on BEV purchase intention. **Hypothesis 8b (H8b)** is that policy measures have a significant positive effect on use behavior.

2.3.1.9 Purchase Intention (PI) and Use Behavior (UB)

Perceived attitudes and use behavior determine actual actions (Taylor & Todd, 1995). Purchase intention is a major determinant of use behavior. The following hypothesis was proposed: **Hypothesis 9 (H9).** BEV purchase intention has a significant positive effect on use behavior.

The conceptual model consists of 9 hypotheses and is shown in Figure 2.5.

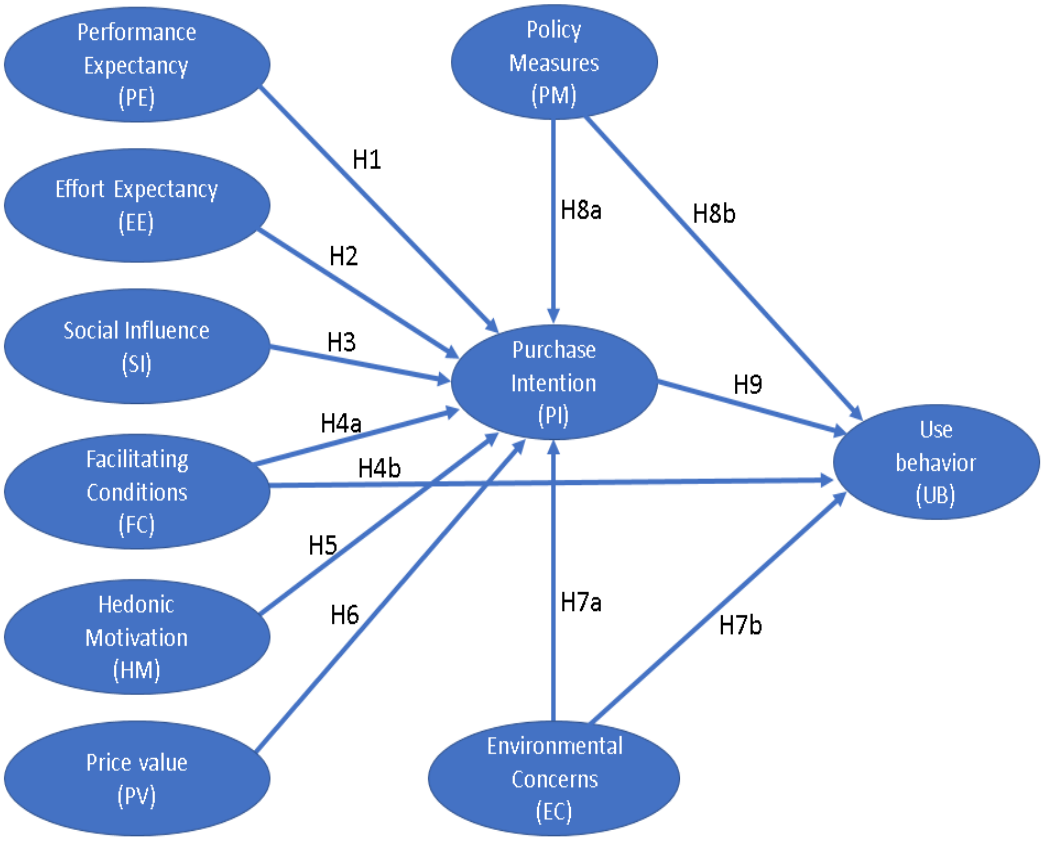

Figure 2.5 *the hypothesized conceptual model of this study*

2.4 Sustainable Transportation

The measures of sustainable transport perform in three dimensions are 1.social – accessibility, health and safety 2.economic – cost effectiveness, impacts on competitiveness and generation of wealth 3.environment – natural resource consumption and pollutions (Kennedy et al., 2005; Litman, 2016). Three dimensions must be balance for sustainable transport in the country (see Figure 2.6). Moreover, Partnership for Sustainable Urban Transport in Asia (PSUTA) has studied in sustainable transport in Asia that summarized into main four aspects; Government and sustainable transport, Environment Health and safety, Economic and Social including twenty subtopics as shown in figure 2.7.

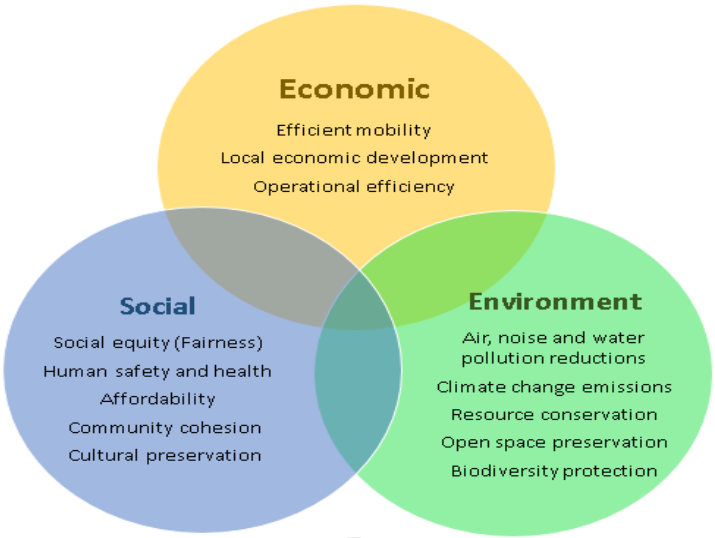

Figure 2.6 *Sustainable Transport Goals (Litman,2016)*

Government and sustainable transport	Environment, health and safety	Economic	Social
• Sustainable transport policy • Bus rapid transit • Rail and metros • Taxi cars and vans • Non-motorized transport • Two and three whellers • Pedestraian Planning • Ferries • Road infrastructure	• Vehicle emissions and improvements • Air quality management • GHG emissions	• Urban transport financing • Regulation, costs and subsidies • Urban transport institutions	• Public participation • Urban road safety • Poverty alleviation and gender • Transport demand management • Sourcebook

Figure 2.7 *Elements of sustainable transport (PSUTA,2007)*

In addition, Transportation had studied impact on sustainability in facilities and activities as indicated in Table 2.3 (Litman & Burwell, 2006). Indicators for sustainable transports that reflect sustainability goals are indicated in Table 2.4.

Table 2.3 *Transportation impacts on sustainability*

Economic	Social	Environmental
Traffic congestion	Inequity of impacts	Air and water pollution
Mobility barriers	Mobility disadvantaged	Habitat loss
Accident damages	Human health impacts	Hydrologic impact
Facility costs	Community interaction	Depletion of non-renewable resources
Consumer costs	Community livability	
Depletion of non-renewable resources	Aesthetics	

Table 2.4 *Summaries sustainability goals, objectives and indicators (Litman,2016)*

Sustainability Goals	Objectives	Indicators
I. Economic		
Economic productivity	Transport system efficiency Transport system integration Maximize accessibility Efficient pricing and incentives	Per capita GDP Portion of budgets devoted to transport Per capita congestion delay Efficient pricing (road,parking,fuel,etc) Efficient prioritization of facilities
Economic development	Economic and business development	Access to education and employment opportunities Support for local industries
Energy efficiency	Minimize energy costs, particularly petroleum imports	Per capita transport energy consumption Per capita use of imported fuels
Affordability	All residents can afford access to basic (essential) services and activities	Availability and quality of affordable modes (walking,cycling,ridesharing and public transport) Portion of low-income households that spend more than 20 % of budgets on transport
Efficient transport operations	Efficient operations and asset management maximizes cost efficiency	Performance audit results Service delivery unit costs compared with peers Service quality
II. Social		
Equity/fairness	Transport system accommodates all users, including those with disabilities, low incomes, and other constraints	Transport system diversity Portion of destinations accessible by people with disabilities and low incomes

Sustainability Goals	Objectives	Indicators
Safety, security and health	Minimize risk of crashes and assaults, and support physical fitness	Per capita traffic casualty (injury and death) rates Traveler assault(crime) rates Human exposure to harmful pollutants Portion of travel by walking and cycling
Community development	Helps create inclusive and attractive communities	Land use mix Walkability and bikability Quality of road and street environments
Cultural heritage preservation	Respect and protect cultural heritage Support cultural activities	Preservation of cultural resources and traditions Responsiveness to traditional communities
III. Environmental		
Climate stability	Reduce global warming emissions Mitigate climate change impacts	Per capita emissions of greenhouse gases (CO_2, CFCs, CH_4, etc.)
Prevent air pollution	Reduce air pollution emissions Reduce harmful pollutant exposure	Per capita emissions (PM, VOCs, NO_x, CO, etc.) Air quality standards and management plans
Minimize noise	Minimize traffic noise exposure	Traffic noise levels
Protect water quality & hydrologic functions	Minimize water pollution Minimize impervious surface area	Per capita fuel consumption Management of used oil, leaks and stormwater Per capita impervious surface area
Openspace and biodiversity protection	Minimize transport facility land use Encourage compact development Preserve high quality habitat	Per capita land devoted to transport facilities Support for smart growth development Policies to protect high value farmlands and habitat
IV. Good Governance and Planning		
Integrated, comprehensive and inclusive planning	Clearly defined planning process Integrated and comprehension analysis Strong citizen engagement Lease-cost planning	Clearly defined goals, objectives and indicators Availability of planning information and documents Portion of population engaged in planning decisions Range of objectives, impacts and options considered Efficient and equitable funding allocation

Transport serves economic and development through distributions of goods and services and personal mobility. At the same time, transport is a major user of energy. Energy use in transport therefore contributes to depletion of natural resources, to air pollution and to climate change. Reducing energy use intensity in transport can reduce environmental impacts of this sector while maintaining its economic and social benefits. Adoption of electric cars can support sustainable transport in three pillars - economic: reduce demand of fossil fuels, - environmental: reduce greenhouse gas emission and to climate change, - social: good for human health.

Chapter 3
RESEARCH METHODOLOGY

In this chapter, conceptual framework of the research is presented. Research design part illustrates the scope of study, sample design, data collection is described. Then questionnaire design and analytical techniques applied in this study are explained.

3.1 Conceptual Research framework

The relation between transport demand and transport supply evolve to transport system (Rodrigue et al., 2006). In this study, the demand side relates owner cars which expresses the transport needs, even if those needs are satisfied fully, partially or not at all (Rodrigue et al., 2006). The supply side relates to public and private sector including Department of Land Transport (DLT) as regulators under Ministry of Transport, Ministry of energy, Ministry of Industry, Ministry of Finance, Pollution Control Department under Ministry of Natural Resources and Environment, Ministry of Commerce, Thailand Automotive Institute, Electric Vehicle Association of Thailand (EVAT) and manufacturing company. Moreover, Transport demand and supply involve infrastructures facilitate support movement. Mobility must occur over three components of transport; demand, supply and infrastructure. Based on three components of transport system, Sustainable transport policy will formulate and respond the real demand and supply then government can improve enough infrastructure. Therefore, the conceptual framework of the study is illustrated in Figure 3.1.

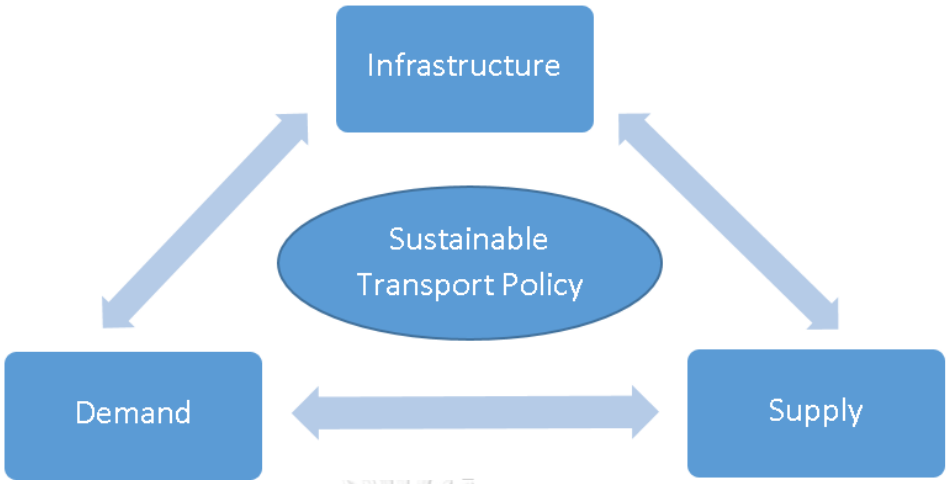

Figure 3.1 *Conceptual framework of the study*

According to the literature, 2.4 sustainable transport, four elements of sustainable transport concepts were included as follows;

1. Social – public participation
2. Environment – air quality and greenhouse gas emission
3. Economic – transport financing
4. Policy aspects – sustainable transport policy

These elements were studied using indicators and measures. The current transportation policy focusing on EV plan and measure was also studied and analyzed in order to understand situation and know the gap, barriers and factors in Thailand. This data interviewed the experts under each of four perspectives: social, environmental, economic and policy aspects, along with 2 policy measures that stemmed from literature review. Therefore, the research framework of policy assessment is illustrated in Figure 3.2.

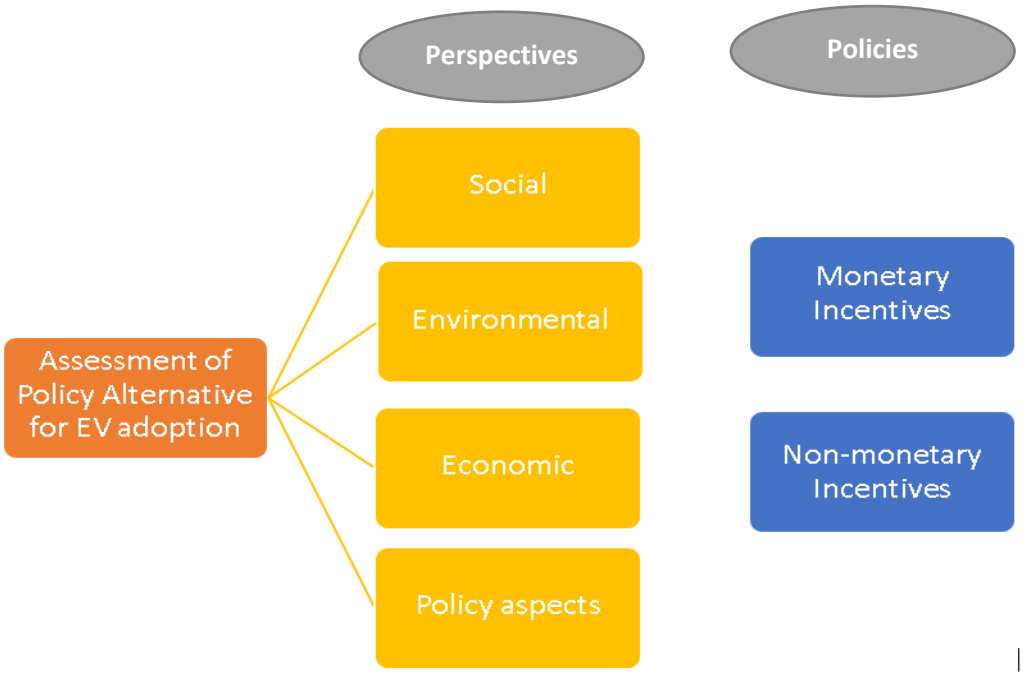

Figure 3.2 *The research framework of policy assessment*

3.2 Research design

3.2.1 Research Approach

This research used Mixed method. Mixed methods integrate quantitative and qualitative approaches to research for answer questions (Tashakkori, 2010). The main research question is "What is the effective policy to stimulate EV adoption in Thailand?" so the author need to understand the current situation of BEVs and its impacts and investigate owner car behavior in Thailand from different aspects then particularly factors either affecting or hindering them to use. Information can apply and practice policies which measure to encourage people use more BEV cars in Thailand. This study collects data from questionnaire survey and interview. There are separated in supply and demand sides of BEV cars usage in Thailand. The quantitative research deals with data of demand side: owner car who interest to adopt BEV in Thailand. The data collect from questionnaire survey analyzed using partial least squares structural equation modeling (PLS-SEM) and applied the unified theory of acceptance and use of technology (UTAUT). The qualitative research is normally explained as allowing a detailed exploration of a topic of interest in which information that is collected by a researcher through case studies, interviews and so on (Harwell, 2011). Its method also described as an inductive that researcher may

construct explanations and conceptualizations from details provided by respondents. Inductive analysis would be appropriate method for supply side. Data will collect by semi-structured interview of executive including public and private sector: Department of Land Transport as regulators (DLT) under Ministry of Transport, Ministry of energy, Ministry of Industry, Ministry of Finance, Pollution Control Department under Ministry of Natural Resources and Environment, Ministry of Commerce, Thailand Board of Investment (BOI), Electricity Generating Authority of Thailand (EGAT), Thailand Automotive Institute, Electric Vehicle Association of Thailand (EVAT) and manufacturing company such as Toyota, Great Wall Motor, MG and BMW. Then, process gather and analyze empirical data. The research approach of this study is presented in Figure 3.3.

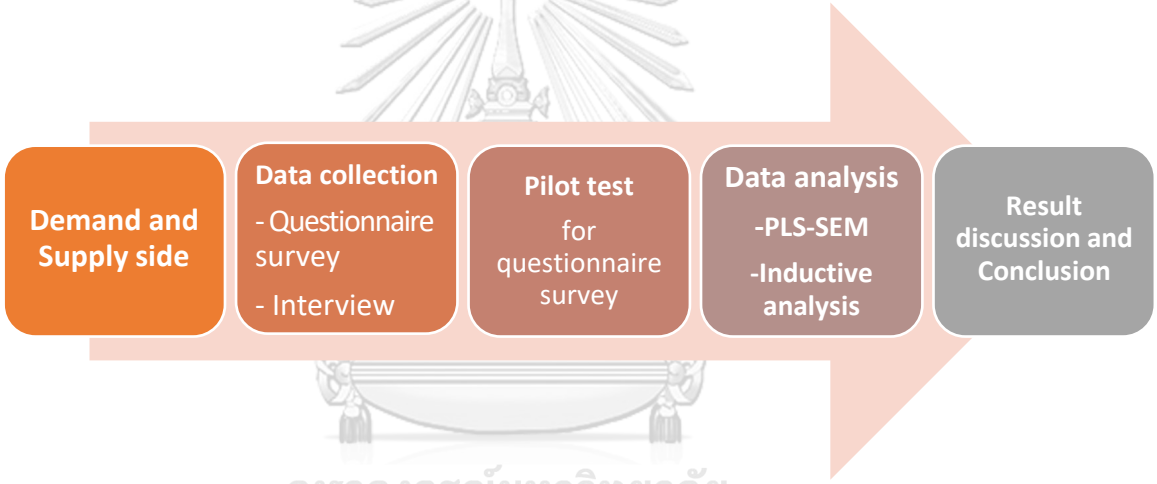

Figure 3.3 *Research Approach of the study*

3.2.2 Sample design

Designing a sample starts with defining population of study. The issue of generalizability which relates to the minimum requirement of participant samples is vital for data analysis.

For demand side, the samples were intending to buy a BEV who are living in bangkok and vicinity. They are over 18 years old with driving license of Thailand and live in bangkok and vicinity.

For supply side, purposive sampling method was applied in order to select the key respondents. This technique widely used in qualitative research for the

identification and selection of information-rich cases (Patton, 2002). The sampling of supply groups in this study includes private and public sector which involve stimulate more BEVs adoption. The data collect from executive of organization such as director general or deputy director general of DLT, Ministry of energy or executive of company. All respondents are from 3 different stakeholder categories including government agencies, manufacturing companies and independent organizations. Table 3.1 shows respondent categories.

Table 3.1 *Respondent categories of supply side*

Respondent categories	Agencies
Governmental agencies	- Department of Land Transport as regulators (DLT) under Ministry of Transport - Ministry of Energy - Ministry of Industry - Ministry of Finance - Pollution Control Department under Ministry of Natural Resources and Environment - Ministry of Commerce - Thailand Board of Investment (BOI) - Electricity Generating Authority of Thailand (EGAT)
Manufacturing companies	- Toyota - Great Wall Motor - MG - BMW
Independent organizations	- Automotive Institute - Electric Vehicle Association of Thailand (EVAT)

Table 3.2 shows the summary of sample design used in this research.

Table 3.2 *Summary of sample design*

Type of Respondent	Inclusion criteria	Exclusion criteria	Rights
1. Demand side - ask them before send questionnaire - more collect data instead of incomplete data	- over 18 years old - live in bangkok and vicinity	- don't own a car	Participants' rights to decline to participate and to withdraw from the research once it has started and don't have incentives for participants. The study covers up information of participants so there is confidentiality and no risk for them.
2. Supply side - Researcher send formal letter for allowing before interview	- executive of organization (government, manufacturing companies and independent organizations)	- no experience and knowledge in EV	

3.2.2.1 Study area for demand side

In present, there are BEV cars in bangkok and vicinity more than other provinces, so this study selects the area. Bangkok and vicinity occupy 7,761.7 square kilometers in the Central of Thailand and has an estimated population of 10.98 million as of 2020. It accounts 16.4 % of the country's population (BMA, 2019). Bangkok consists of 50 districts separate in 6 zones serve as administrative subdivisions under the authority of The Bangkok Metropolitan Administration (BMA). Six zones of Bangkok comprise North Bangkok zone, South Bangkok zone, East Bangkok zone, Middle Bangkok zone, North Thonburi zone and South Thonburi zone. It was located by official places and commercial business areas.

- North Bangkok zone: Latphrao, Bangkhen, Chatuchak, Bangsue, Laksi, Donmuang and Saimai
- South Bangkok zone: Pathumwan, Bangrak, Sathon, Bangkholaem, Yannawa, Watthana, Khlongtoei, Suanluang, Phrakhanong and Bangna
- East Bangkok zone: Bangkapi, Prawet, Saphansung, Bungkum, Khannayao, Minburi, Khlongsamwa, Latkrabang and Nongchok
- Middle Bangkok zone: Dusit, Phayathai, Dindaeng, Ratchathewi, Wangthonglang, HuayKhwang, Pomprapsattruphai, Samphanthawong and Phranakhon
- North Thonburi zone: Taweewhatana, Talingchan, Bangphlat, Bangkoknoi, bangkokyai, Khlongsan, Thonburi and Chomthong
- South Thonburi zone: Nongkhaem, Bangbon, Bangkhunthian, Thungkhru, Ratburana, Phasicharoen and Bangkhae

Vicinity is the five adjacent provinces of Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan, and Samut Sakorn. The study explores Bangkok and vicinity, as illustrated map in Figure 3.4.

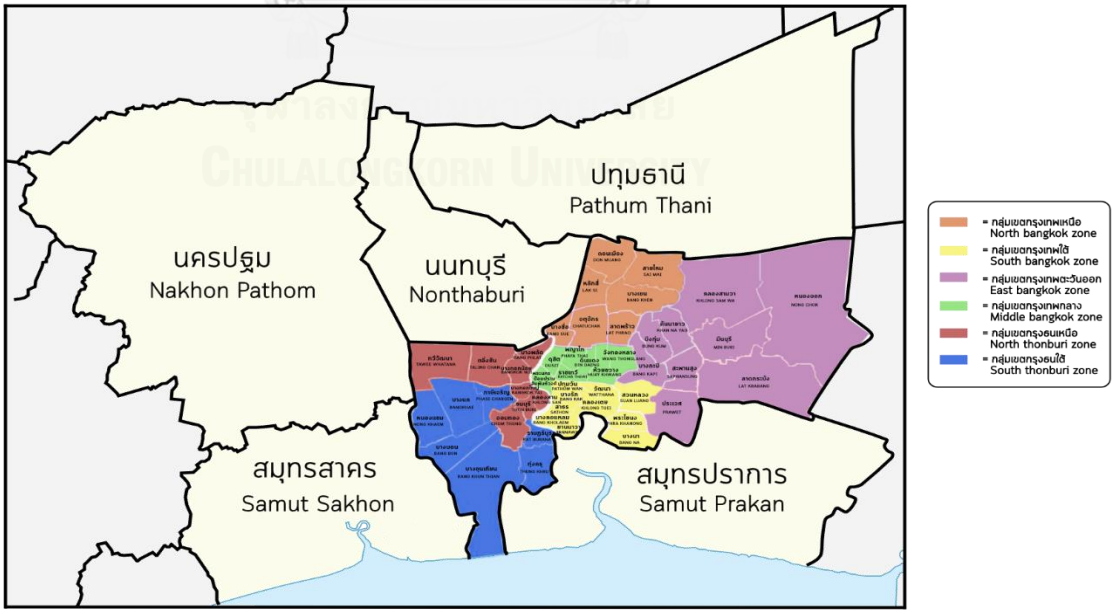

Figure 3.4 *Map of Bangkok and vicinity (BMA,2019)*

3.2.2.2 Sample size of demand side

The required sample size acceptable apply for partial least squares structural equation modeling (PLS-SEM) depends on model complexity (Kline, 2011). The sample size is larger that produces more reliable outcomes. The researcher has set sample size for demand size by using the formula of Yamane to find the sample size (Taro, 1973) for the study of the population mean with a confidence interval of 95% and an allowable error as ± 5%. The calculation formula of Yamane is presented as follows.

$$n = \frac{N}{1 + N(e)^2}$$

Where :

n = sample size required

N = number of people in the population

e = allowable error (%)

Based on the Department of Land Transport (DLT) database in 2020, number of private cars (not more than 7 passenger seats) in Thailand were 559,553 cars. After calculated the sample size by substituting the numbers into Yamane formula, the numbers of sample estimates 399.72. The researcher set the sample target in this study to 400 sample. A pilot study sample should be 10 – 20 % of the sample size anticipated for the parent study (Connelly, 2008). Moreover, the survey questionnaire is first trailed with 40 BEV car users for revise of the survey content based on the feedback.

3.2.3 Data collection method

Quantitative data and qualitative data have used in the varieties of social research (W Lawrence, 2014). Both approaches are involved in this study using multiple research technique, questionnaire survey and in-depth interview for demand and supply side.

Demand side

Most surveys ask many participants about their characteristics, opinions and behaviors. Regarding this, surveys are appropriate for gathering descriptive information and evaluate hypotheses due to learn about behaviors. Questionnaire survey was constructed various types of questions: closed-ended questions, open-ended questions, and Likert scale. In closed-ended question, participants can choose their answer from a fixed set of responses provided. This type of questions is usually applied in large scale survey as the reason that is faster and easier for both participants and researchers (W Lawrence, 2014). Open-ended question gets an unstructured and free answer from participants. This question is difficult to analyze and conclude (W Lawrence, 2014). Likert scale is used in this research to capture user behavior. Five- point Likert scale usually ask people to indicate whether they strongly agree or strongly disagree with the statement.

Supply side

In-depth interview is aimed to gather background information, facts, and expert knowledge (Harrell & Bradley, 2009). It is applied in the policy research. In this study, the questions are used in developing for the semi-structured interview. Semi-structured interview interacts between two strangers with the explicit purpose of one person receiving information from the other. Interview takes the form of questions to ask the respondents from various organizations. The respondents provide insight information and further suggestions. They are from multi-organizations as well as various fields of expertise, so these get multiple viewpoints of key stakeholders in this study. The respondents' expertise is classified in different fields including transportation, environment, economic, industry, marketing, and planning. In this study, open-ended and descriptive questions were used in developing for the semi-structured interview. Topics of interview relate on stimulate people to use more BEV car. Researcher will ask about perspective of BEV in Thailand, plan, measure, and policy in the present and the future including challenges and obstacle including measure or policy can support this issue. The interview has 2 sections including general information of respondents and in-depth questions composing of 5 sets of questions as follow:

Section 1 General information of respondent 2 questions

Section 2 In-depth questions consisting of 5 sets of questions

Set 1 Current situation of BEV car in Thailand	2 questions
Set 2 Social dimension	2 questions
Set 3 Economic dimension	1 question
Set 4 Environmental dimension	1 question
Set 5 Policy assessment of organization for BEV adoption	1 question

The data collect for demand and supply side then gather and analyze to answer research questions of this study. Moreover, the data apply to assess existing policies in Thailand and develop policies in the future. Tools of analysis use partial least squares structural equation modeling (PLS-SEM) and inductive analysis. The PLS-SEM is the most common analysis technique to test the hypotheses about casual relationships between latent variables which are measured by several consistent items. In addition, probing of different interviews was used to ensure information had consistency and clarification. Table 3.3 shows data collection method that researcher performs in Covid-19 situation.

Table 3.3 *summary of data collection method*

Research technique	**Sampling**
1. Questionnaire	- Online questionnaire because of Covid-19 situation - Simple random sampling of questionnaire in many careers such as government officer, doctors, employees, teachers, business owner etc.
2. In-depth Interview	- Call or email to organization after researcher send formal letter for allow and assign person to attend interview - Formal letters send to the head of organization that can decide to interview. - All of organization have information of address, phone number and email - Online interview because of Covid-19 situation

3.2.4 Questionnaire design

In this study, the survey questionnaire will design to capture information about the constructs in the proposed model. We divide the questionnaire into three parts. The first part requests participate demographics including gender, age, education level, occupation, income, accommodation province, number of owned cars and electric cars. The screening question about purchase intention of car is the second part. The hypothesized conceptual model of this research contains nine constructs: performance expectancy, effort expectancy, social influence, facilitating condition, hedonic motivation, price value, environmental concern, policy measure, purchase intention and use behavior (see figure 2.5). These items are used to measure the proposed UTAUT dimensions in the second part (Venkatesh, et al.,2012). All hypotheses have presented in 2.3.1 Research model and hypothesis in Chapter 2. The questions follow those items were measured by a five-point Likert scale ranging from "strong disagree = 1" to "strongly agree = 5". The third part requests participate give suggestion about policy measures that they think Thailand should have to support more people use BEV cars.

After completing the preliminary draft of the questionnaire for the study, the online questionnaire must do the pilot test with 40 BEV car users (Connelly, 2008). The results of pilot test ensure to revise the questionnaire. The analysis of questionnaire needs to have reliability and validity then start to collect data from questionnaire survey. The questionnaire modulated after pilot survey. Table 3.4 shows measurement items of variables for BEV car adoption.

Table 3.4 *Measurement items of variables for BEV car adoption*

Constructs	Items	Description	Source
UTAUT			
Performance Expectancy (PE)	PE1	I would find a BEV useful for my travel.	Applied from (Fleury et al., 2017; Venkatesh et al., 2003) and Pilot test
	PE2	I think using a BEV would help my travel more convenient.	
	PE3	I think using a BEV reduce energy cost	

Constructs	Items	Description	Source
		per month.	
	PE4	I think using a BEV will help me reach my destination more quickly.	
	PE5	I think using a BEV reduce cost of maintenance.	
	PE6	I think safety is important to use a BEV.	
	PE7	The limited distance is a major disadvantage of using a BEV.	
	PE8	The distance that a BEV can be run is enough to meet the needs of everyday use.	
	PE9	Battery life per charge is important to the discomfort of using a BEV.	
	PE10	Silence is a key advantage of electric vehicle technology.	
Effort Expectancy (EE)	EE1	I would find a BEV easy to use.	Applied from (Fleury et al., 2017; Venkatesh et al., 2003) and Pilot test
	EE2	I can learn to use it easily and quickly.	
	EE3	My interaction with a BEV would be clear and understandable.	
	EE4	It would be easy for me to become skillful at using the BEV system.	
Social Influence (SI)	SI1	Social trends influence the decision to buy a BEV.	Applied from (Alain, 2010; Fleury et al., 2017; Venkatesh et al., 2003) and Pilot test
	SI2	I often explore what products others buy or use.	
	SI3	I think I am more likely to use a BEV if my friends and my family use it.	
	SI4	Driving a BEV that attracts others' attention is important to me	
	SI5	Owing a BEV will make people see me as a technology leader.	
	SI6	People who influence my behavior think that I should use a BEV for my dairy	

Constructs	Items	Description	Source
		travel.	
Facilitating Conditions (FC)	FC1	The resources necessary to use a BEV are existed such as charging stations, service centers.	Applied from (Venkatesh et al., 2012) and Pilot test
	FC2	I have the knowledge necessary to use a BEV.	
	FC3	I can get help from others when I have difficulties using a BEV.	
	FC4	Having an electric vehicle charger at residence making it convenient to use a BEV.	
	FC5	The presence of electric vehicle service centers across the country that can make people don't have to worry about problem of using a BEV.	
	FC6	10-years battery warranty or warranty within 150,000 kilometers that can make people don't have to worry about problem of using a BEV.	
	FC7	I don't worry about longer charging times than refuel car.	
Hedonic Motivation (HM)	HM1	Driving a BEV is fun and enjoyable.	Applied from (Venkatesh et al., 2012) and Pilot test
	HM2	Due to its smoothness and high acceleration, driving a BEV is very entertaining.	
	HM3	I am satisfied with the distance traveled by a BEV.	
	HM4	I feel free to travel with a BEV even if it can run a limited distance.	
Price Value (PV)	PV1	The price of a BEV is an important factor for buying.	Applied from (Venkatesh et al., 2012) and Pilot
	PV2	BEVs are reasonably priced.	

Constructs	Items	Description	Source
	PV3	BEVs are good value compare with price.	test
	PV4	The price of BEVs is acceptable.	
Environmental Concerns (EC)	EC1	I want to buy a BEV due to the air pollution crisis.	Applied from (Razak et al., 2014) and Pilot test
	EC2	BEVs contribute to saving the environment for the next generation.	
	EC3	BEVs cause less pollution.	
	EC4	I want to preserve energy and environment.	
Policy measures (PM)	PM 1	Satisfaction with monetary incentive policy measures such as tax exemption, purchase subsidy, parking fee reduction and free charging fee.	Applied from (Huang & Ge, 2019) and Pilot test
	PM 2	Satisfaction with non-monetary incentive policy measures such as the right to use bus lanes and separate allocations of EV license plates.	
	PM3	The government should announce measures about subsidizing the purchase of electric car.	
	PM4	The government should have tax exemption measures.	
	PM5	The government should give special privileges to electric vehicle users such as parking or reduce toll fees.	
	PM6	The government should fund the construction of charging stations to cover the whole country.	
	PM7	The government should have measures to exempt charging fees for electric vehicle users.	
Purchase	PI1	If I had a BEV available, I would prefer	Applied from

Constructs	Items	Description	Source
Intention (PI)		to drive it rather than a traditional car.	(Alain, 2010; Han et al., 2017; Kim et al., 2018) and Pilot test
	PI2	If I have the chance, I will buy a BEV.	
	PI3	If I replace my car, I will consider a BEV first.	
	PI4	I would recommend others to purchase a BEV.	
	PI5	I have studied the information and planned to find a BEV for use in the future.	
	PI6	There is a high probability that my next car will be a BEV.	
Use Behavior (UB)	UB1	I will only use a BEV in the next 3 years.	Applied from (Venkatesh et al., 2012) and Pilot test
	UB2	I will only use a BEV in the next 5 years.	
	UB3	I will only use a BEV in the next 10 years.	

3.2.5 Analytical techniques

3.2.5.1 Quantitative Data Analysis

In this study, Partial Least Squares Structural Equation Modeling (PLS-SEM) and SPSS Statistics are the main data analysis tool, to test the causal relationships between hypothesized variables, path analysis and structural model. Statistics is used to analyze this research including

1. Descriptive Statistics

Descriptive Statistics are used to describe the characteristics of the questionnaire respondents with the results shown in the forms of valid percentage and frequency distribution.

2. Measurement Model Evaluation

The objective of the evaluation of the measurement model is to assess the consistency of questions. The question that created in the same purpose

or not which be tested with outer loadings and reliability. An assessment of the validity of the variables will be evaluated by convergent validity and discriminant validity (Memon & Rahman, 2014). The details can be described as follows

- Indicator Reliability

The reliability of the questionnaire is measured by Cronbach's alpha and Composite Reliability which should be in the range of 0 and 1. The value approaching zero means low reliability while the value approaching one means high reliability. An acceptable value for a study should be above 0.7 (Fornell & Larcker, 1981; Hair Jr et al., 2014; Nunnally, 1978). The cronbach's alpha can be calculated as follows:

$$\rho_T = \frac{k^2\,\overline{\sigma_{ij}}}{\sigma_x^2}$$

Where: ρ_T = tau-equivalent reliability or Cronbach's alpha

k = number of items

σ_{ij} = covariance between X_i and X_j

σ_x^2 = item variances and inter-item covariances

The composite reliability (CR) can be calculated as follows:

$$\text{CR} = \frac{\left(\sum_{i=1}^{p}\lambda_i\right)^2}{\left(\sum_{i=1}^{p}\lambda_i\right)^2+\sum_{i}^{p}V(\delta_i)}$$

Whereby, λ_i is the standardized factor loading for item i, V (δ_i) is the error variance for item i, and p is the number of items.

- Convergent validity

The statistic used to measure convergence validity is Average Variance Extract (AVE). The value of AVE should be $\geq$ 0.5 show latent variable can explain variance of variable more than 50 % (Hair Jr et al., 2014). The average variance extracted can be calculated as follows:

$$\text{AVE} = \frac{\sum_{i=1}^{k}\lambda_i^2}{\sum_{i=1}^{k}\lambda_i^2+\sum_{i=1}^{k}Var(e_i)}$$

Here, k is the number of items, λ_i is the factor loading of item i, and Var (e_i) is the variance of the error of item i (Fornell & Larcker, 1981).

- Discriminant validity

Discriminant validity is index indicating that the observed variable or measure of one construct must be separate from another construct measure. The classification of discriminant validity by using two types of criteria: Fornell-Larcker Criterion and Cross loadings.

- Fornell-Larcker Criterion: Tested by comparing the square root of AVE of each latent variable with that of the other latent variables in the model. If the square root of AVE of each latent variable greater than the correlation of the latent variable with other variables in the squared model. It shows that the measure of the variable is enough discriminant validity (Hair Jr et al., 2014)

- Cross loadings: To consider the relationship between component loading index of the latent variable and component loading index and other latent variables in the model. Each of latent variable should be component loading more than other latent variables; not less than 0.7 (Hair Jr et al., 2014). The value can less than 0.7 but not less than 0.5 and positive value (Lee et al., 2011).

Moreover, the questionnaire presented respondents with several questions that were dismantled from the structural model and unrelated to the research. The procedure involved a latent variable that was dependent on the other variables in the model. Common method bias approached the variables as potential antecedents and included the necessary indicators. In this regard, variance inflation factors (VIF) needed to be lower than 3.3 to ensure that the sample was not influenced by common method bias (Kock, 2015; Kock & Lynn, 2012)

3. Structural Model Assessment

- Coefficient of determinant (R^2): The result should be in the range of 0 and 1. If the result shows that the data do not conform to a normal distribution, responses that are outside the criteria (outliers) are discarded (Kline, 2011). If R^2 has value 0.75 0.50 and 0.25 are considered accurate to be high, medium, low, respectively (Hair et al., 2014).

- Path coefficients: The relationship between the latent variables according to the assumptions. The result should be in the range of -1 and 1. If approaching 1, the relationship is positively strong. If approaching -1, the relationship is negatively strong.

The hypothesis testing is to calculate the path coefficient of Inner Model and Outer Model. PLS-SEM is used to test the statistical significance of a parameter with bootstrapping process which is used to find the confidence interval of parameter estimation, find the mean and standard error of each parameter for statistical analysis (Hair Jr et al., 2014; Henseler et al., 2016). This research uses the assumption that based in one-tailed test with path coefficient of Inner Model has a significance level of 0.001($p<0.001$), 0.01 ($p<0.01$) and 0.05 ($p<0.05$) so that hypothesis support the research.

3.2.5.2 Qualitative Data Analysis

Inductive approaches are intended to aid an understanding of meaning in complex data through the development of summary themes or categories from the raw data. The data was refined into patterns and themes using the systematic coding (Corbin & Strauss, 1990). Categories and coding themes can be derived three sources: data, previous related studies, and theories (Zhang & Wildemuth, 2009). Inductive coding begins with consideration of the multiple meaning that are inherent in the text. Therefore, Coding themes in this study were come from semi-structured stakeholder interviews. The respondents come from multi-organizations and various fields of expertise.

Ethic Considerations

Ethical issues are crucial in this research: to ensure that participates are harmed or suffered from negative consequences from this research. In both quantitative survey and in-depth interview, there are pass the ethical review process. This research has certificate of research approval from Office of the Research Ethics Review Committee for Research Involving Human Subjects, the second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts at Chulalongkorn University.

Chapter 4
REAEARCH RESULTS AND DISCUSSION

The results analysis from questionnaire, in-depth interview, and documents. This chapter was separated into 3 parts: Firstly, finding from in-depth interview of supply side: current situation of EVs in Thailand, barriers for BEVs in Thailand, factors supporting BEVs use in Thailand, policy measures to support BEVs adoption in Thailand. Secondly, finding from questionnaire of demand side was divided into factors affecting purchasing intention of BEVs in Thailand, policy measures to support BEVs adoption in Thailand. Thirdly, the results were discussed.

4.1 Finding from in-depth interview of supply side

4.1.1 Current Situation of EVs in Thailand

Thailand is one of the parties that ratified the Paris Agreement at the COP21 to the UNFCCC with the shared goals of keeping the average global temperature increase below 2 degrees Celsius as well as using energy with net zero emissions in the long term. This prompted Thailand to set policy toward clean energy and CO_2 emission reduction during the period of 2065 – 2070. One measure to help the country achieve those goals is to switch the energy used in the transportation sector to green energy with help from EVs in line with the EV30@30 policy under which zero-emission vehicles account for at least 30% of the country's car production by 2030. Switching from fossil fuel to electricity is one measure that can help reduce greenhouse gas emissions, increase energy efficiency in the transportation sector and alleviate the PM 2.5 air pollution problem. It is predicted that by 2030 the use of personal electric vehicles will have reduced the demands for fossil fuels by 2.19 – 5.54 million tons of oil equivalent or 25.75 - 53.23 billion thousand gigawatt-hours, accounting for 5.45 – 11.26 percent of the demands of energy for road transport. Electric energy demands will rise by only 0.21 – 2.41 million tons of oil equivalent or 2.41 – 7.78 billion thousand gigawatt hours. GHG emissions will be reduced by 6.9 – 13.5 million tons of CO2 equivalent, accounting for 4.74 – 9.31 percent of GHG emissions from land transport, depending on the rise of the electric vehicle number (IPCC, 2006). A report published by the International Energy Agency (IEA) claimed

that electric vehicles would cause a paradigm shift and predicted that the global electric car stock would grow by 43% from 2019 to reach 10 million EVs in 2020. BEVs would account for two-thirds of newly registered electric vehicles as well as two-thirds of sold EVs. Global use of electric vehicles has several advantages. It would help reduce noise and air pollution as well as energy consumption, especially during traffic jams.

Thailand set up the National Electric Vehicle Policy Committee on 7 February 2020. The committee is chaired by the Prime Minister and has representatives of concerned agencies, namely the Ministry of Energy, the Ministry of Industry, the Ministry of Transport, the Ministry of Finance, the Board of Investment and the National Economic and Social Development Council as committee members. The committee's authority and duties are as follows:

1. Setting direction and goals for the country's EV development in line with the 20-year National Strategy and related cabinet resolutions.

2. Deliberating before approving plans, action plans and projects of government agencies that are related to EV development in line with the 20-year National Strategy and related cabinet resolutions.

3. Integrating and evaluating the results of EV development efforts in line with specific plans and frameworks as well as giving advice and suggestions about EV development work in order to realize the country's EV development policy's goals and reporting accomplishments to the Cabinet.

4. Appointing committees, sub-committees or working groups to support the work of the Committee as appropriate; and

5. Performing other duties as assigned by the Cabinet or the Prime Minister.

The National Electric Vehicle Policy Committee on 24 March 2021 set direction for EV promotion through reduced use of combustion engine cars for Thailand to become a low-carbon society and a global EV and EV parts manufacturing hub (creating an ecosystem). The goal is to have 1,127,000 EVs in use by 2030, comprising 444,000 cars/pickup trucks, 650,000 motorcycles and 33,000

buses/trucks. The number will be increased to 3,037,000 EVs by 2035, comprising 1,154,000 cars/pickup trucks, 1,800,000 motorcycles and 83,000 buses/trucks. Another goal is to produce 1,434,000 EVs by 2030, comprising 725,000 cars/pickup trucks, 675,000 motorcycles and 34,000 buses/trucks and increase the number of EV production to 3,284,000 EVs by 2035, comprising 1,350,000 cars/pickup trucks, 1,850,000 motorcycles and 84,000 buses/trucks. The committee also set policy for driving the EV industry, coming up with clear short-term, mid-term and long-term measures covering usage, infrastructure, and batteries. The measures are set to promote use of all types of EVs, plan charging station building, support the establishment of a battery testing center and environment-friendly management of old batteries from domestic use, encourage excise-tax structure revision, make preparations for management of old batteries from EVs in line with international standards that focus on safety and environment. The measures are also aimed to increase infrastructure preparedness to support the use of vehicles running on clean energy.

Based on the Department of Land Transport (DLT) database between 2017-2021, New number of registered electric cars are greatly increased especially BEV as shown in Figure 4.1. Thai people use EVs 45,990 unit and BEVs 7,325 unit by 2022 (June 2022), which seems a small amount. The growth rate has reached 100%. The goal is to have 1,127,000 EVs in use by 2030 and 3,037,000 EVs by 2035. Electric vehicle car usage is currently far of reach. Government needs to stimulate EVs 1,081,010 unit by 2030 and 2,991,010 unit by 2035. In present, there are accumulated BEV 18,644 unit which divide into 7,173 cars, 10,791 motorcycles, 378 Tuk Tuk (three-wheeler), 285 buses and 17 truck. Number of public charging stations in Thailand approximately 855 stations, 2,285 outlets: 1,343 AC (normal chargers), 1,116 DC (fast chargers) (EVAT, 2022). EA Anywhere has been the most active company that can expand the charging network to 417 stations.

Thus, in order to achieve tangible results from EV development efforts with efficiency and efficacy in every facet and in a manner that could keep up with the ever-changing technology, the National Electric Vehicle Policy Committee set up four sub-committees as follows:

1. The Sub-committee on EV and EV Parts Manufacturing Industry Promotion chaired by the Permanent Secretary of Industry.

2. The Sub-committee on Infrastructure and Battery Development for EVs chaired by the Permanent Secretary of Energy.

3. The Sub-committee on EV Promotion Effects on Fossil Fuel and Greenhouse Gases chaired by the Permanent Secretary of Energy; and

4. The Sub-committee on EV Use Promotion chaired by the Permanent Secretary of Finance or their representative.

Regarding charging stations, the Ministry of Energy is drafting an EV charging station map, hoping to drive the development of charging stations and ensure the installation of charging stations in a number that is adequate to support EV development, which will build confidence in the EV market. Guidelines and plans for EV charging stations that are in line with the targets set by the National Electric Vehicle Policy Committee are needed. In addition, the ministry is deliberating on data and suitability in terms of the number of charging stations and other related equipment as well as considering the potential effects of electric vehicle development on the country's electricity network investment. A target has been set to have fast charging stations for personal cars and pickup trucks nationwide by 2030 with 12,000 connectors in total.

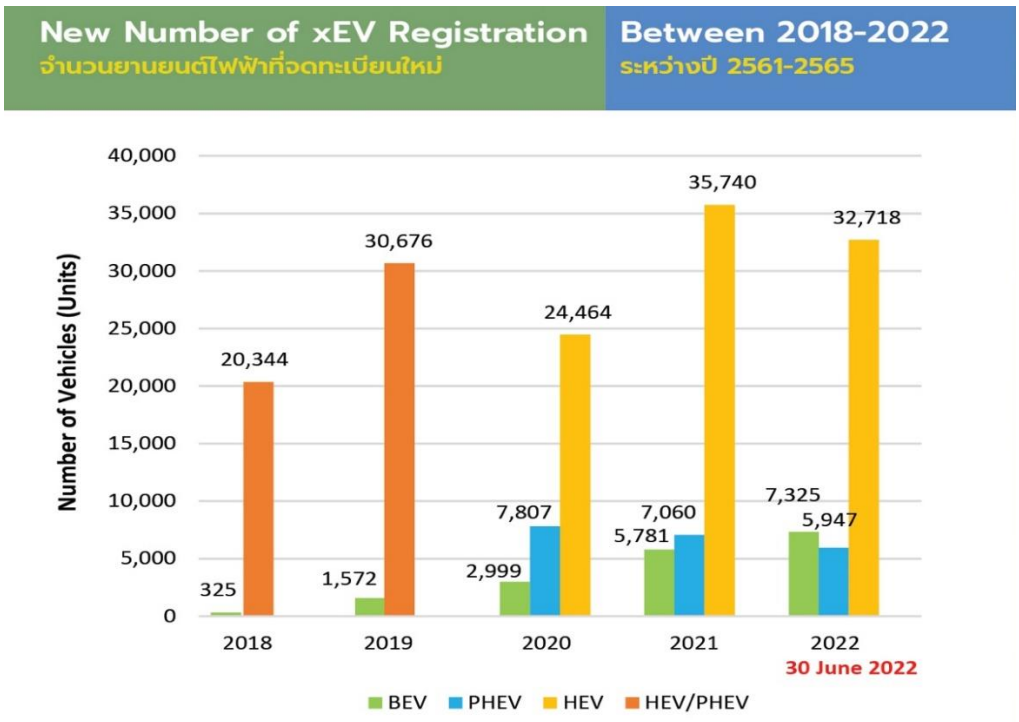

Figure 4.1 *New Number of xEV Registration between 2017 – 2022 (DLT, 2022)*

On 15 Feb 2022 the Cabinet passed a resolution to acknowledge the guidelines for supporting electric vehicles in line with the outcomes of the National Electric Vehicle Policy Committee Meetings Nos. 3/2021 and 1/2022, hoping to encourage domestic production and use of electric vehicles and achieve the goal of zero emission vehicles in all categories. This is aimed to dictate the direction of EV development in the country and drive support for EVs by putting in place short-term tariff and non-tariff support measures for 2022-2025.

- In 2022-2023, the measures will be focused on providing incentives to encourage wide-spread acceptance and use of electric vehicles in the country. These measures will cover imports of CBU cars and motorcycles, exemption or reduction of import tariffs and excise taxes for CKD electric cars/pick-up trucks/motorcycles and/or conditional subsidies. Hopefully, the measures will increase overall demands for EVs and incentivize local manufacturers to invest in the EV industry.
- In 2024 – 2025, the support measures will be focused on encouraging people to use EVs manufactured locally. Exemption and reduction of

> import tariffs for CBU vehicles will end but reduced excise taxes and/or conditional subsidies will not be halted in order to ensure that the costs of CBU electric vehicles are higher than those of CKD electric vehicles. This is expected to encourage Thailand-based manufacturers to increase their EV supplies to meet rising demands, reduce imports of parts for EVs and support domestic EV production.

There are additional measures to support domestic EV production including exemption of import tariffs for parts imported during 2022 – 2025, allowing manufacturers to count the value of imported battery cells towards domestic production costs for the calculation of domestically added value at no more than 15% of the ex-factory price. There will be ramped-up production of domestic electric vehicles to compensate for the initial imports. (In case of compensation, the production volume in 2024 should be equal to the imports of 2022 and 2023 combined. If necessary, the compensation production can be extended to 2025. And the production and use of locally made batteries in line with the stipulated conditions).

As mentioned earlier, the BEV is the most efficient energy usage, and it is probably the best choice for sustainable transport, so the research focused on BEVs. Problems of BEV users in Bangkok and vicinity are charging time (about 12-15 hours with AC), improve management system for booking or selecting electric charging points, and charging fee based on time.

Charging fee

Data from the Energy Regulatory Commission of Thailand showed that the mechanism for controlling electricity rates for charging stations had been focused on the upstream agencies, i.e. the Electricity Generating Authority of Thailand (EGAT), the Provincial Electricity Authority (PEA) and the Metropolitan Electricity Authority (MEA), which had offered a low-priority rate of 2.63 baht/unit any time of the day for areas in Bangkok. For provincial areas, the off-peak (from 10 p.m. – 9 a.m.) rate of 4.15 baht per unit and the peak-period (9 a.m. – 10 p.m.) rate of 7.15 baht per unit were offered. However, the electricity rates charged by charging stations were not regulated. They charged 6 – 8 baht per unit. The Energy Regulatory Commission of

Thailand is considering setting up an appropriate price structure that will not have a detrimental effect on EV promotion and studying price structuring models used by other countries. In many countries, electricity is not regulated in terms of price. Their authorities only ensure that there are enough charging stations.

Subsidy measures

Data from the Excise Department of Thailand showed that the package of reduce tax for EV adoption had been focused on price of electric cars. The measure was divided into two phases including the first stage (year 2022 – 2023) and the middle stage (year 2024 – 2025). **The first stage**: car price less or equal two million baht, tariff reduced 40%, excise tax reduced from 8 % to 2%, and subsidy 70,000 – 150,000 baht depend on battery size as well as car price more than two million baht, tariff reduced 20%.

The middle stage: car price less or equal two million baht, tariff BEV parts 0%, excise tax reduced from 8 % to 2%, and subsidy 70,000 – 150,000 baht depend on battery size as well as car price more than two million baht, tariff BEV parts 0%.

Management of car wrecks and used batteries

Ministry of Industry had set up a working group to study automobile wreck management to study, give opinions and propose concrete measures for car wreck management in Thailand including studying the development of continuous industries or related industries. In order to, that can be recycled as new raw materials according to the concept of circular economy to achieve a systematic car wreck management mechanism. They established criteria for setting up a vehicle recycle factory and promote investment in recycle factories, car wrecks and batteries.

4.1.2 Barriers for BEVs in Thailand

Barrier for BEVs in Thailand can be addressed from various prospective: executive of governmental agencies, manufacturing companies and independent organizations. Data were collected during October - December 2021. The study found that all respondents from 3 different stakeholder categories (Governmental/

Companies/Independent organization) as 14 persons from 14 agencies: Department of Land Transport as regulators (DLT) under Ministry of Transport, Ministry of energy, Ministry of Industry, Ministry of Finance, Pollution Control Department under Ministry of Natural Resources and Environment, Ministry of Commerce, Thailand Board of Investment (BOI), Electricity Generating Authority of Thailand (EGAT), Thailand Automotive Institute, Electric Vehicle Association of Thailand (EVAT), Toyota, Great Wall Motor, MG and BMW indicated that barrier for BEV in Thailand and researcher concluded issues in 5 terms: cars, infrastructure, motorists, government policy and economic loss. These are shown in Table 4.1 and Figure 4.2.

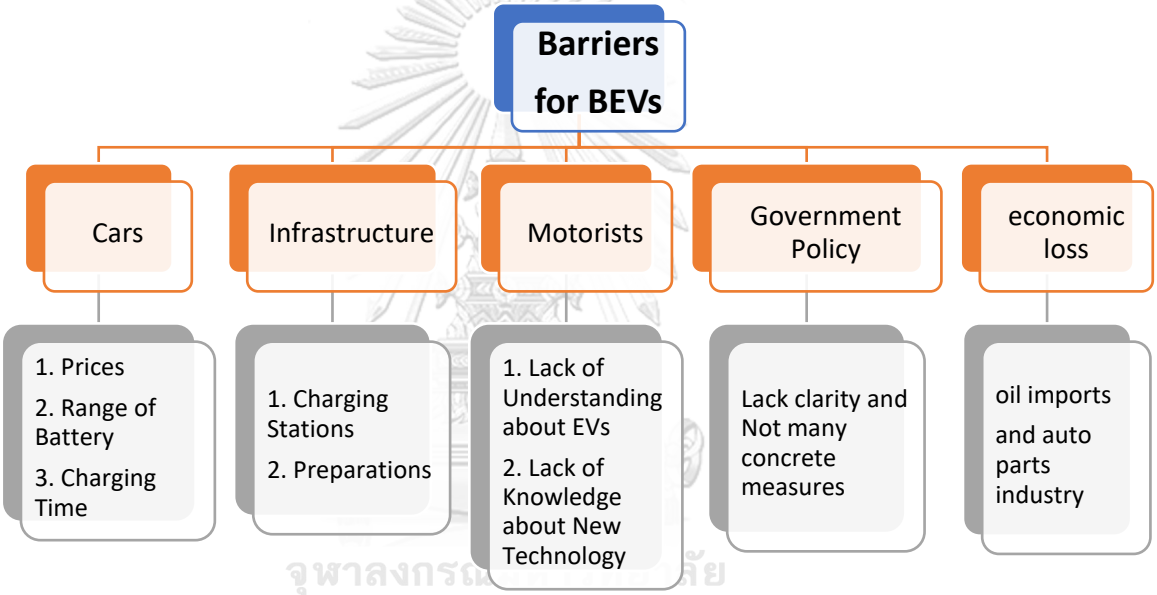

Figure 4.2 *Barriers for BEVs in Thailand*

Table 4.1 *Barrier for BEVs in Thailand*

Barrier	Cars	Infrastructure	Motorists	Government Policy	Economic loss	Stakeholders
No.1	/	/	/	/		Government
No.2	/	/	/	/	/	Government
No.3	/	/	/	/		Government
No.4	/	/	/	/	/	Government
No.5	/	/		/	/	Government
No.6	/	/		/		Government
No.7	/	/		/		Government
No.8	/	/			/	Government

Barrier	Cars	Infrastructure	Motorists	Government Policy	Economic loss	Stakeholders
No.9	/	/	/	/		Company
No.10	/	/	/	/	/	Company
No.11	/	/	/	/		Company
No.12	/	/		/	/	Company
No.13	/	/	/	/		Independent organization
No.14	/	/			/	
Total	**100 %**	**100 %**	**57.1%**	**85.7 %**	**50 %**	

- **Cars**

In term of cars, they can be classified into prices, range of BEV and charging time which 100 % of respondents mentioned. They revealed that people spend more money and longer time in travel. Egbue and Long (2012) showed that during the long journeys may not be possible on BEVs without recharging the battery (Egbue & Long, 2012). Graham-Rowe et al. (2012), Zaunbrecher et al. (2014), Noel et al. (2020) reported that long charging time was commonly viewed as dead time (Graham-Rowe et al., 2012; Noel et al., 2020; Zaunbrecher et al., 2014).

1. Prices

The prices of BEV in the Thai market are still higher than those of the non-electric varieties and only a small group of consumers can afford them. Purchase price is the most reported barrier to adoption BEVs (Axsen et al., 2013; Berkeley et al., 2018; Graham-Rowe et al., 2012; Noel et al., 2020; She et al., 2017)

2. Range of BEV

The current range of BEV is somewhat limited, so motorists still depend on non-electric vehicles and battery EVs are their second choice.

3. Charging Time

Charging a BEV takes much more time than refueling a non-electric car and adds time to the motorist's journey.

- **Infrastructure**

In terms of infrastructure, they can be classified into charging stations and preparations which 100% of respondents mentioned. People want to go to

their destination, particularly during rush hours, resulting in inconvenience in travelling. Graham-Rowe et al. (2012) and Axsen et al. (2013) showed that drivers had to plan their journeys and changed their lifestyle because of charging infrastructure. She et al. (2017) found infrastructure availability on highway as barrier of drivers. Berkeley et al. (2018) and Noel et al. (2020) showed that some residence would be unsuitable for home charging. For people who rent their dwelling, they found cost of the adaptation of the electrical system as barrier. It was unclear who should bear this expense (Patt et al., 2019).

1. Charging Stations

There are not enough charging stations and the available stations do not spread over all areas of the country. There was agreement that insufficient number of charging stations was a very important concern for most people (Berkeley et al., 2018; Noel et al., 2020; She et al., 2017). It ranked as the first most cited barrier out of five barriers. Motorists can find charging stations from the application of their service providers. However, there is no integration of data about locations of charging stations and charging prices from the public sector and the private sector. An integrated data will make it easier for EV users to find a charging station and plan their journey.

2. Preparations

Preparations need to be made before installing charging stations in houses, condominiums, apartments, and other types of housing. Such preparations take time and money and will include drafting new regulations and laws and making modifications to people's residences to accommodate EV chargers. New housing estates are built to accommodate EV users, having built-in EV chargers. Houses in old housing estates can make modifications to their electricity meters and/or electrical systems to support EV chargers, which might be costly and inconvenient. In the case of condominiums and apartments, new regulations and laws might be needed before parking spaces for charging EVs can be made. It will take time to pass those regulations and laws.

- **Motorists**

In terms of motorists, they can be classified into lack of understanding about EVs and lack of knowledge about new technology while 57.1% of respondents mentioned.

1. Lack of Understanding about BEVs

Most people still do not have confidence in the efficiency of BEVs nor in EVs in general. They have worries about issues such as EV safety, maintenance costs, the lifespan of batteries, selling prices of used EVs and service centers. These issues can be deterrents against EVs. BEV drivers lacked safety confidence in some driving situation (Graham-Rowe et al., 2012; She et al., 2017 and Noel et al., 2020).

2. Lack of Knowledge about New Technology

BEVs run on batteries, which have a longer life than those in non-EVs. This means lower maintenance costs. However, there are only a few experts about EV batteries in Thailand. Berkeley et al. (2018) showed that people belief in EVs are unreliable technology. Drivers who have more new product knowledge of battery electric vehicle would perceive more benefits.

- **Government Policy**

85.7% of respondents noted that government policy about electric vehicles still lacks clarity and there are not many concrete measures to support EVs, which does not inspire confidence in consumers. As a result, carmakers do not want to invest in the EV market in Thailand. Plötz et al. (2014) illustrated successful policies depend on knowledge about what are the characteristics and needs of early adopters (Plötz et al., 2014).

- **Economic loss**

50% respondents noted about economic loss such as oil imports and auto parts industry are one of the consequent effects. It associated with strong depreciation was acknowledged by Berkeley et al. (2018).

4.1.3 Factors supporting BEVs use in Thailand

Factors supporting BEVs use in Thailand can be addressed from various perspective: executive of governmental agencies, manufacturing companies and independent organizations. The study found that all respondents from 3 different stakeholder categories as 14 persons concluded as Table 4.2 and Figure 4.3 indicated as the following issues:

Table 4.2 *Factors supporting BEVs use in Thailand*

Factors support	**Tax**	**Infra**	**Expenses**	**Benefits**	**Charging**	**Prices**	**Promo. of BEVs**	**Standards of Pollution**	**Env. and health**	**Stake-holders**
No.1	/	/	/		/		/			Government
No.2	/	/	/	/	/					Government
No.3	/	/	/	/	/		/			Government
No.4	/	/	/	/	/		/	/	/	Government
No.5	/	/	/	/	/		/	/	/	Government
No.6	/	/	/	/	/			/	/	Government
No.7	/	/		/		/		/	/	Government
No.8	/	/	/	/		/	/	/	/	Government
No.9	/	/	/	/	/		/			Company
No.10	/	/	/	/	/	/	/			Company
No.11	/	/	/	/		/	/			Company
No.12	/	/	/	/			/	/		Company
No.13	/	/	/	/	/	/		/	/	Independent organization
No.14	/	/	/		/	/		/	/	
Total	**100 %**	**100 %**	**92.9%**	**85.7 %**	**71.4%**	**42.9%**	**64.3%**	**57.1%**	**50%**	

Note: Tax= Tax measure, Infra= Infrastructure to support BEVs, Expenses= Lower expenses for consumers, Benefits= Benefits for consumers, Charging= Longer ranges and shorter charging time, Prices= Lowering prices, Promo. of BEVs= Promotion of BEVs through various channels, Standards on Pollution= Stricter international standards on pollution, Env. and health= Environmental impacts and health problems

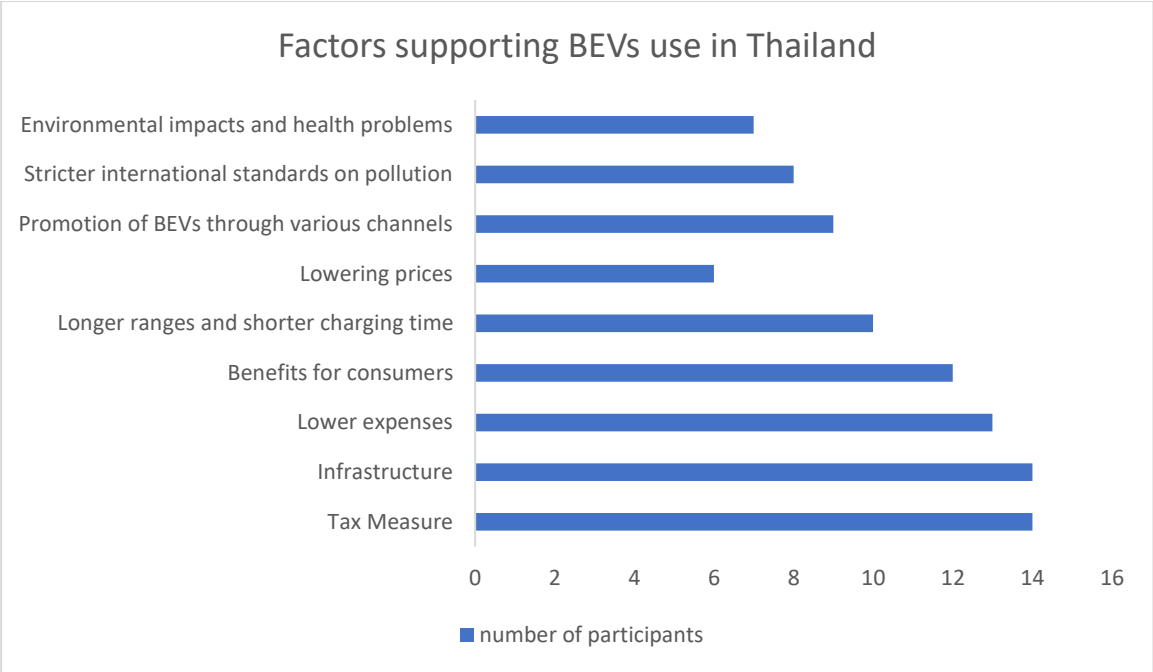

Figure 4.3 *the result of factors supporting BEVs use in Thailand*

1. Tax Measure

100 % of respondents indicated about tax measures. Tax measures can help importers of electric car parts, which will lead to lower costs for manufacturers and lower prices of electric cars. When the price of electric cars is falling, people are more interested in buying electric cars.

2. Infrastructure to support BEVs

100 % of respondents indicated about infrastructure. This infrastructure includes ubiquitous charging stations in every part of the country, parking spaces for BEVs, charging station applications that are easy to use for consumers and can help them plan their journeys with BEVs. Berkeley et al. (2018) and Noel et al. (2020) confirmed this issue.

3. Lower expenses for consumers

92.9 % of respondents stated that travelling expenses include fuel cost and transportation fares stimulate the use of electric cars. Electricity costs can be

much lower than petroleum fuel costs. Graham-Rowe et al. (2012) reported consumers' problems assessing how much a unit of electric costs.

4. Benefits for consumers

85.7% of respondents mentioned about benefits for BEV owners. These benefits can include various tax cuts, subsidies, or expressway discounts for BEV owners. Benefit would also influence the consumer's purchase intention (Kim et al., 2018).

5. Longer Ranges and Shorter Charging Time

There are newer models of EV batteries which offer a longer distance and shorter charging time which 71.4% of respondents mentioned. They related to barrier of limited driving range and long charging time (Graham-Rowe et al., 2012; Noel et al., 2020; Schuitema et al., 2013).

6. Lowering Prices

42.9% of respondents stated that the prices of BEVs have been declining and might be lower than those of non-electric cars in the future. As mentioned earlier, purchase price is the most reported barrier to adoption BEVs (Graham-Rowe et al., 2012; Axsen et al., 2013; She et al., 2017; Berkeley et al., 2018 and Noel et al., 2020).

7. Promotion of BEVs through various channels

64.3% of respondents viewed that promotion of BEVs can encourage people to use BEVs. Replacing public vehicles in service including buses, trains and boats with electric models can instill confidence in BEVs in the public. Many social media channels in the form of campaigns can be used for the use of battery electric cars instead of combustion cars.

8. Stricter International Standards on Pollution

57.1% of respondents mentioned about stricter international standards on pollution in Thailand. Internal combustion cars are almost at the end of

their evolution in terms of pollution reduction and fuel efficiency. This can be seen from the use of electric motors to turn these cars into HEVs/PHEVs or the installation of a turbocharger in an internal combustion car. These are attempts to solve pollution issues in non-electric cars which are not in line with the current pollution and fuel efficiency standards.

9. Environmental impacts and health problems

50 % of respondents mentioned that internal combustion cars lead to increasing of air pollution and greenhouse gas emissions. The statistical data of air pollution in Bangkok monitored by the Pollution control Department (PCD) presented the concentration of particulate matter ($PM_{2.5}$ and PM_{10}) was found to be exceeding the standard in Thailand, at average 24 hours measure between 22 and 398 $\mu g/m^3$ ($PM_{2.5}$), 39 and 439 $\mu g/m^3$(PM_{10}) in the year 2020 (PCD, 2021). Due to air pollution, people would have more physical health problems such as respiratory problems and allergy.

4.1.4 Policy measures to support BEV adoption in Thailand

According to the in-depth interview for supply side, 14 interviewees from various organizations give suggestion about policy measures that they think Thailand should have to support more people use BEV car as illustrated in Table 4.3 and Figure 4.4. Exemption of car tax**,** electric car privileges and increase charging stations are the maximum of policy measures as 100 %, all stakeholders mention about these. Fast lane, parking for BEV and road tolling exemption are the example of electric car privileges. Subsidies or Discount car price is the second as 92.9 %, 13 stakeholders mention about these. Build awareness and understanding about BEV is the third as 71.4 %, 10 stakeholders mention about these. Law and regulation enforcement and increase the tax on car emissions are the fourth as 57.1 %, 8 stakeholders mention about these. Defines a limited environmental city area and integrate between departments are the fifth as 42.9 %, 6 stakeholders mention about these.

Table 4.3 *Policy measures from supply side*

Policy measures	Car tax	Car price	Law enforce	Privileges	Limit city area	Tax car emission	Increase charging	Build aware	Integrate	Stake-holders
No.1	/	/	/	/			/	/		Government
No.2	/	/		/	/		/	/	/	Government
No.3	/	/	/	/		/	/	/		Government
No.4	/	/		/	/		/	/		Government
No.5	/	/	/	/		/	/	/	/	Government
No.6	/	/	/	/			/	/	/	Government
No.7	/	/		/		/	/	/	/	Government
No.8	/	/	/	/		/	/	/		Government
No.9	/	/		/	/		/		/	Company
No.10	/	/		/	/	/	/			Company
No.11	/	/	/	/		/	/	/		Company
No.12	/	/	/	/			/	/		Company
No.13	/	/		/	/	/	/		/	Independent organization
No.14	/		/	/	/	/	/			
Total	**100 %**	**92.9 %**	**57.1%**	**100 %**	**42.9%**	**57.1%**	**100%**	**71.4%**	**42.9%**	

Note: Car tax= Exemption of car tax, Car price= Subsidies or Discount car price, Law enforce=law and regulation enforcement, Privileges =electric car privileges, Limit city area= Defines a limited environmental city area, Tax car emission=increase the tax on car emissions, Increase charging=increase charging station, Build aware= Build awareness and understanding BEV, Integrate= Integrate between departments

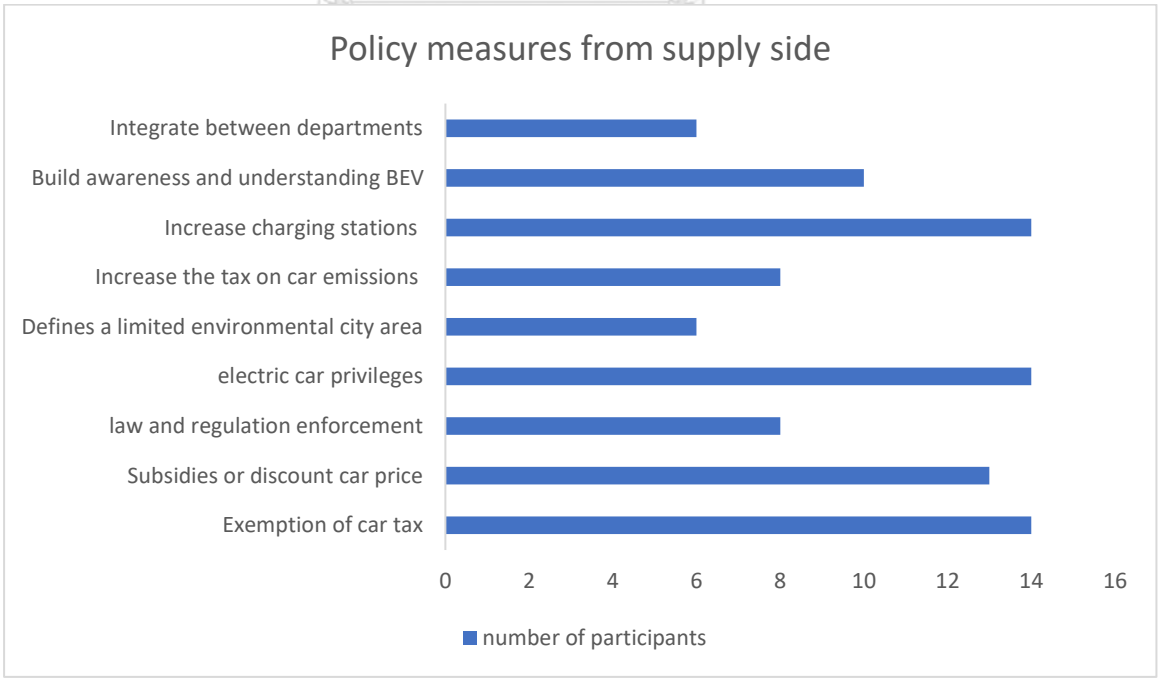

Figure 4.4 *The results of policy measures for supply side*

4.2 Finding from questionnaire of demand side

4.2.1 Factors affecting purchasing intention of BEVs in Thailand

4.2.1.1 Descriptive Statistics of Measurement Items

The data were collected via online questionnaire which went through pilot test. In pilot test, 40 people who have experience in EV and various career were invited to comment on the questionnaire design. They were asked to fill in the questionnaire and point out issues, meaning and sentences which might be unclear. As a result of this process, the questionnaire achieves reliability and validity (Hair et al.,2014). The samples were intending to buy BEV car who are living in Bangkok and vicinity. These respondents are over 18 years old with driving license of Thailand. Data were collected during October - December 2021. The questionnaire also divided in three parts. The first part requests participate demographics including gender, age, education level, occupation, income, accommodation province, number of owned cars and electric cars. The screening question about purchase intention of car is the second part. The third part requests participate give suggestion about policy measures that they think Thailand should have to support more people use BEV car.

4.2.1.2 Descriptive Statistics of Respondents

Based on the data from the online survey respondents, the sample group that meets the criteria 403 people: 210 males (52.1%) and 193 females (47.9%). The majority of respondents were aged as 26 to 33, 138 (34.2%), had completed master's degree, 185 (45.9%), were government officer/ employees, 250 (62%), had a monthly income in the range from 15,001 to 25,000 (23.3%), were living in Bangkok 285 (70.7%), had one car 299 (74.2%), and had no electric car 395 (98%). Table 4.4 shows the descriptive statistics of respondents.

Table 4.4 *the descriptive statistics of respondents*

Category	Number of sample	Percentage (%)	Standard Deviation (S.D.)
Gender			0.5
Male	210	52.1	
Female	193	47.9	
Age			1.104
18-25	13	3.2	
26-33	84	20.8	

Category	Number of sample	Percentage (%)	Standard Deviation (S.D.)
34-41	138	34.2	
42-49	91	22.6	
50 and over	77	19.1	
Education			0.682
Under Bachelor's degree	33	8.2	
Bachelor's degree	174	43.2	
Master's degree	185	45.9	
Doctor's degree	11	2.7	
Occupation			1.419
Governmentofficer/employees	250	62.0	
state enterprise employees	18	4.5	
private company employees	80	19.9	
business owners	31	7.7	
students	4	1.0	
others	20	5.0	
Income (baht)			3.078
less and 15,000	27	6.7	
15,001 – 25,000	107	26.6	
25,001 – 35,000	94	23.3	
35,001 – 45,000	58	14.4	
45,001 – 55,000	36	8.9	
55,001 – 65,000	25	6.2	
65,001 – 75,000	11	2.7	
75,001 – 85,000	14	3.5	
85,001 and over	31	7.7	
Accommodation province			1.257
Bangkok	285	70.7	
Nonthaburi	62	15.4	
Samutprakan	13	3.2	
Nakhonpathom	12	3.0	
Pathumthani	22	5.5	
Samutsakhon	9	2.2	
Number of owned cars			0.605
1	299	74.2	
2	75	18.6	
More than 2	29	7.2	
Currently owned electric cars			0.140
0	395	98.0	
1	8	2.0	
More than 1	0	0.0	

4.2.1.3 Descriptive Statistics of Variables

The questionnaire in part two was designed using a five-point Likert scale from 1 to 5, where 1 denotes high disagreement while 5 denotes high agreement. The questionnaire comprised ten variables: Performance Expectancy (PE) had 10 questions, Effort Expectancy (EE) had 4 questions, Social Influence (SI) had 6 questions, Facilitating Conditions (FC) had 7 questions, Hedonic Motivation (HM) had 4 questions, Price Value (PV) had 4 questions, Environmental Concern (EC) had 4 questions, Policy Measures (PM) had 7 questions, Purchase Intention (PI) had 6 questions and Use behavior (UB) had 3 questions. The descriptive statistics of all variables in the hypothesized model were computed. It was found that there was no missing information. The skewness and kurtosis statistic values can be analyzed through descriptive statistics to be considered normal distribution. Acceptable values of skewness are appropriate from a range of -3 to +3 and kurtosis fall between -10 and +10 (Brown, 2006). The research has acceptable values of skewness and kurtosis so it can be considered that the data has a normal distribution. The researcher collected the data with an online questionnaire and determined that every item was the information that the respondents needed to answer every question. The ten variables are described descriptive statistics as displayed in Table 4.5. Environmental Concern and Policy Measures have value of mean statistic more than other variables. Figure 4.5 – 4.14 are showed details of each question for ten variables.

Table 4.5 *Descriptive Statistics of ten variables*

Variables	Minimum	Maximum	Mean Statistic	Standard Deviation	Skewness	Kurtosis
PE	2.00	5.00	3.8558	0.54707	-0.124	0.248
EE	2.00	5.00	3.8908	0.65210	-0.037	-0.384
SI	1.00	5.00	3.4227	0.83002	-0.078	-0.119
FC	1.86	5.00	3.8618	0.60427	-0.224	-0.003
HM	1.50	5.00	3.3406	0.76976	0.363	-0.120
PV	1.00	5.00	3.4404	0.71227	0.061	0.346
EC	1.00	5.00	4.2016	0.70677	-0.649	0.272
PM	1.00	5.00	4.2311	0.74146	-0.902	0.561
PI	1.17	5.00	3.7452	0.77972	-0.161	-0.317
UB	1.33	5.00	3.6782	0.81777	-0.118	-0.483

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

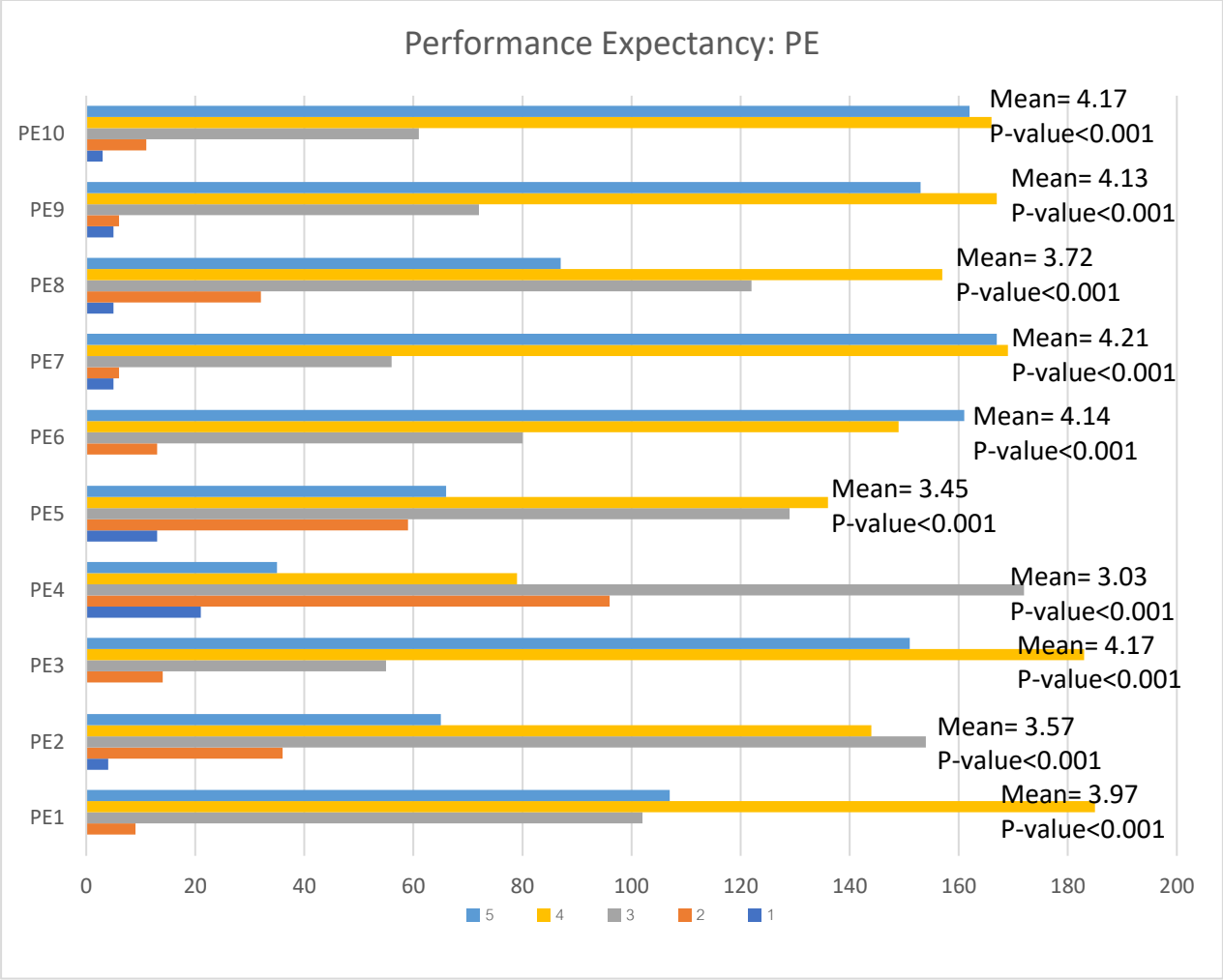

Figure 4.5 *Statistic from ten questions of Performance Expectancy (PE)*

The respondents have agreed on Performance Expectancy as follows:

- The limited distance is a major disadvantage of using a BEV. (PE7)
- Silence is a key advantage of electric vehicle technology. (PE10)
- I think using a BEV reduce energy cost per month. (PE3)
- I think safety is important to use a BEV. (PE6)
- Battery life per charge is important to the discomfort of using a BEV. (PE9)

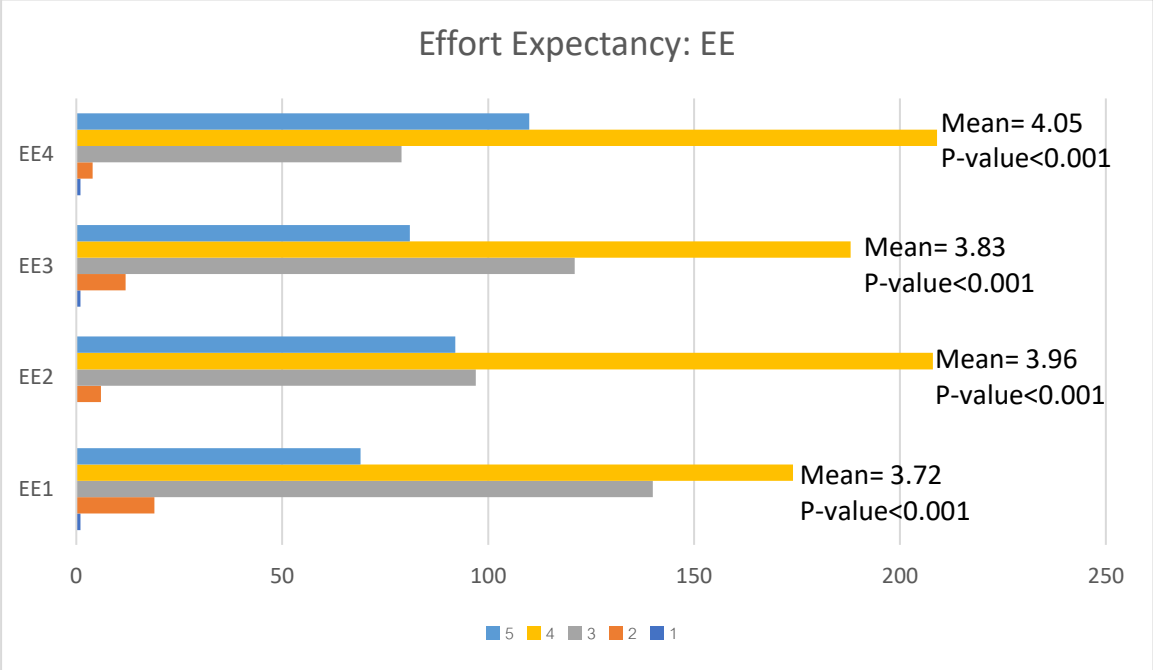

Figure 4.6 *Statistic from four questions of Effort Expectancy (EE)*

The respondents have agreed on Effort Expectancy as follows:

- It would be easy for me to become skillful at using the BEV system.(EE4)

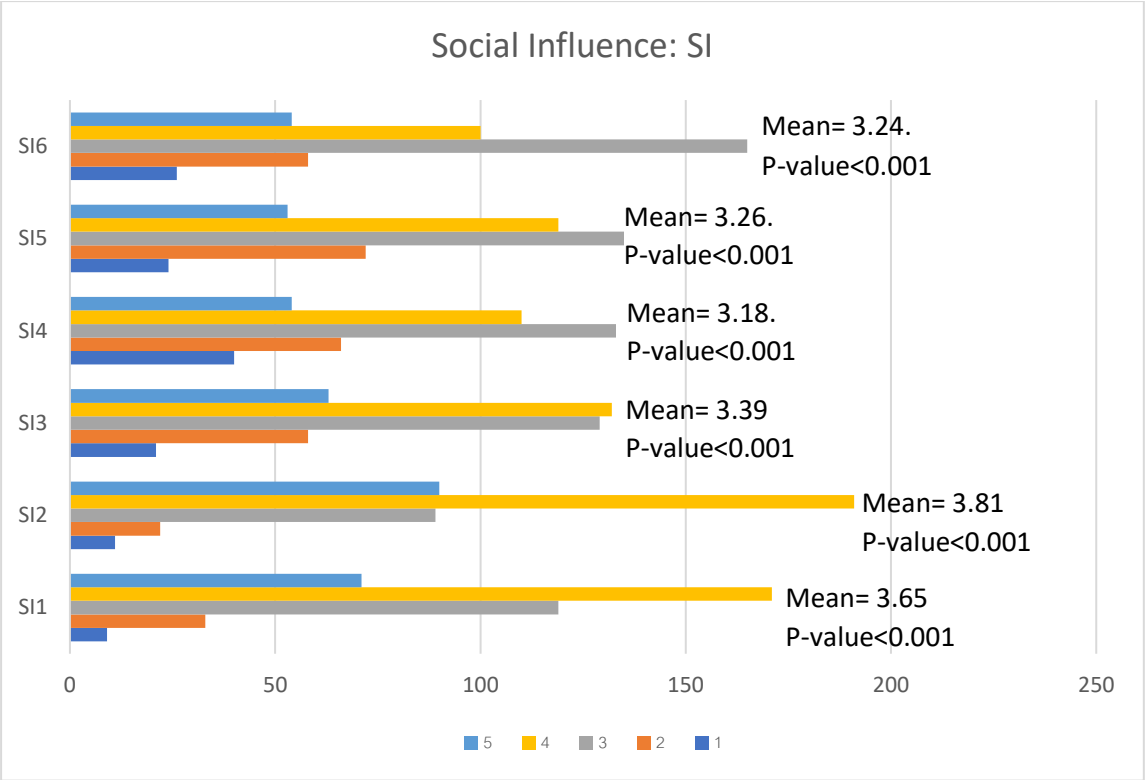

Figure 4.7 *Statistic from six questions of Social Influence (SI)*

The respondents have almost agreed Social Influence on as follows:

- I often explore what products others buy or use. (SI2)
- Social trends influence the decision to buy a BEV. (SI1)

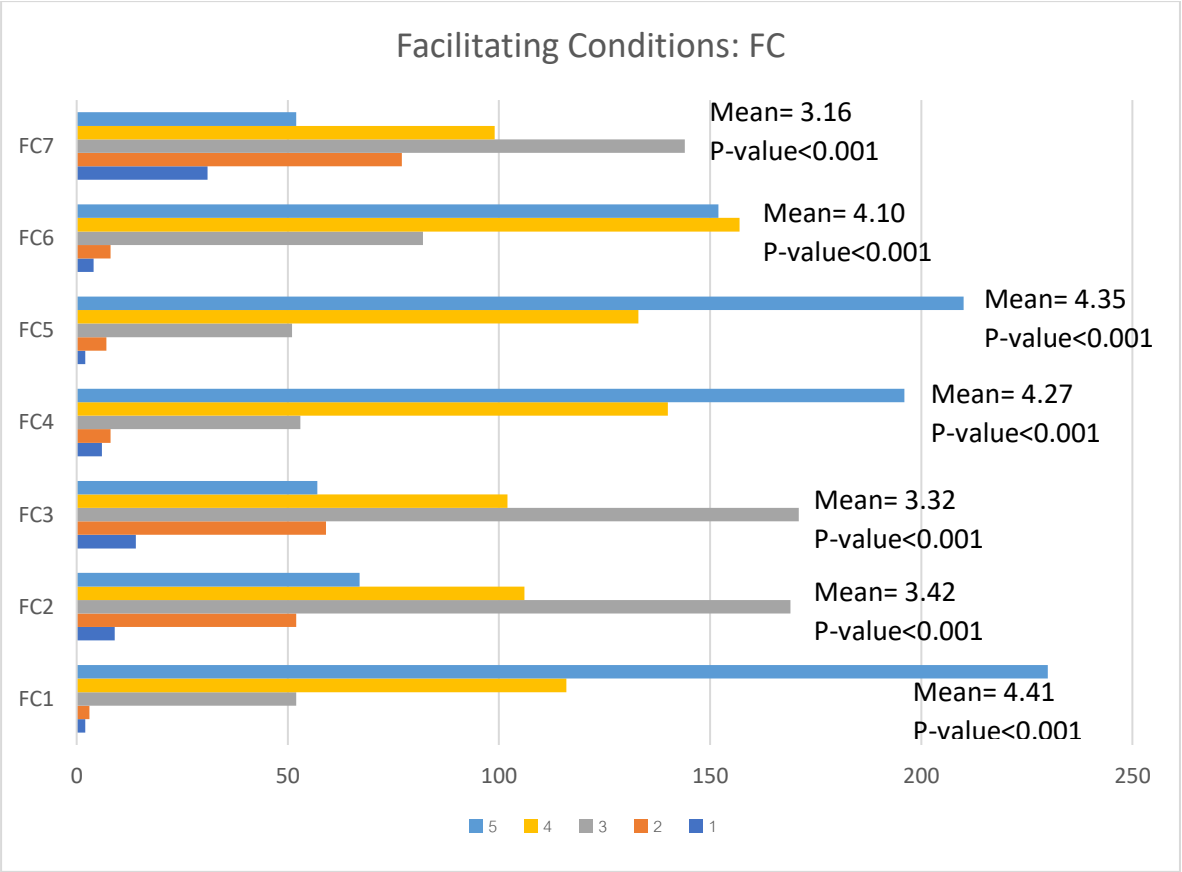

Figure 4.8 *Statistic from seven questions of Facilitating Conditions (FC)*

The respondents have agreed on Facilitating Conditions as follows:

- The resources necessary to use a BEV are existed such as charging stations, service centers. (FC1)
- The presence of electric vehicle service centers across the country that can make people don't have to worry about problem of using a BEV. (FC5)
- Having an electric vehicle charger at residence making it convenient to use a BEV. (FC4)
- 10-years battery warranty or warranty within 150,000 kilometers that can make people don't have to worry about problem of using a BEV. (FC6)

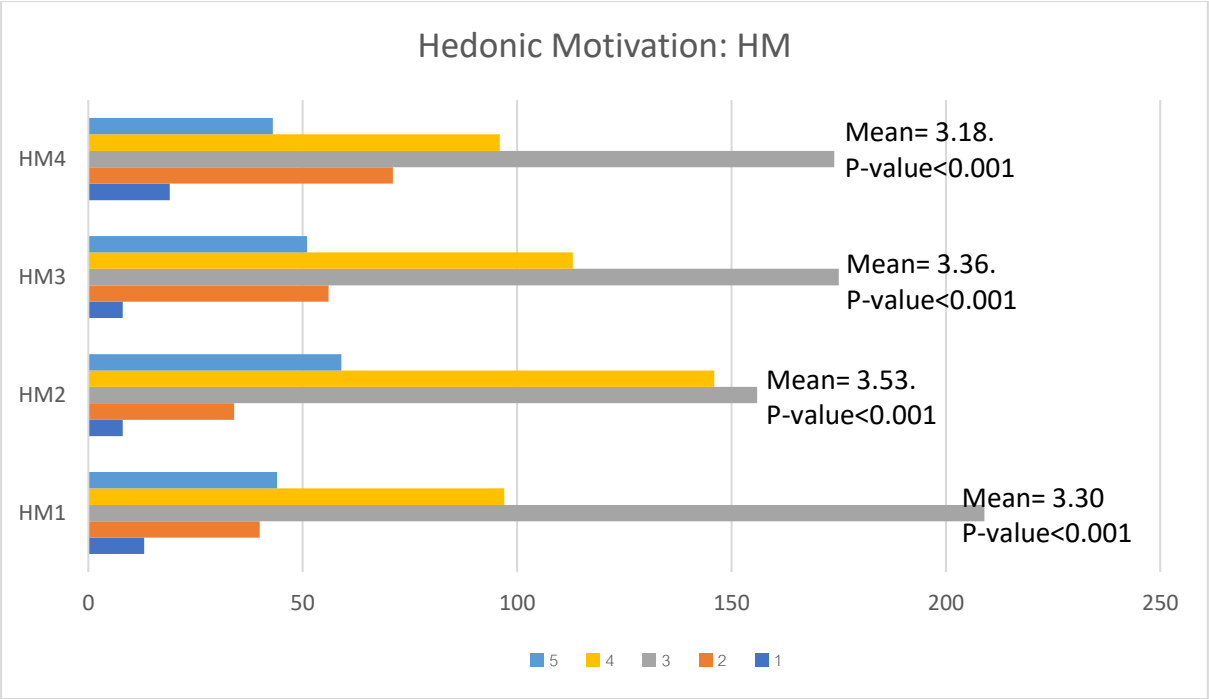

Figure 4.9 *Statistic from four questions of Hedonic Motivation (HM)*

The respondents have almost agreed Hedonic Motivation on as follows:

- Because of smoothness and high acceleration, driving a BEV is very entertaining. (HM2)

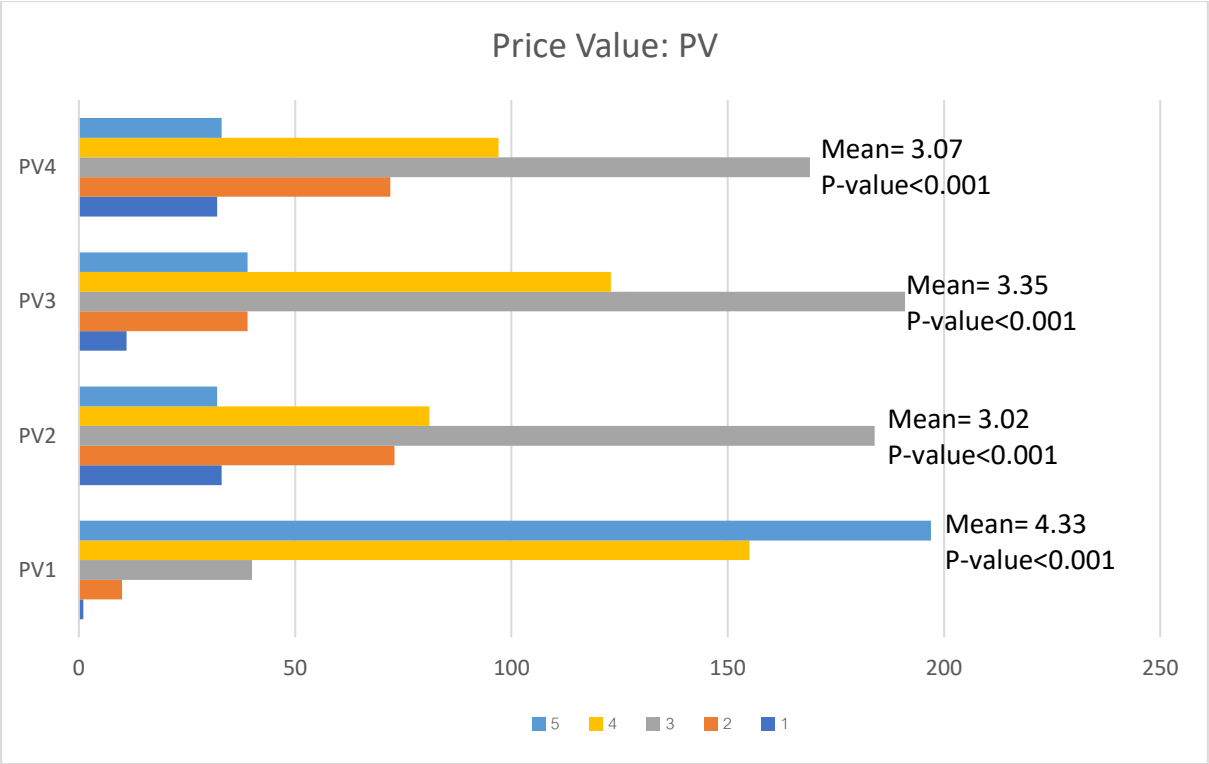

Figure 4.10 *Statistic from four questions of Price Value (PV)*

The respondents have agreed on Price value as follows:

- The price of a BEV is an important factor for buying. (PV1)

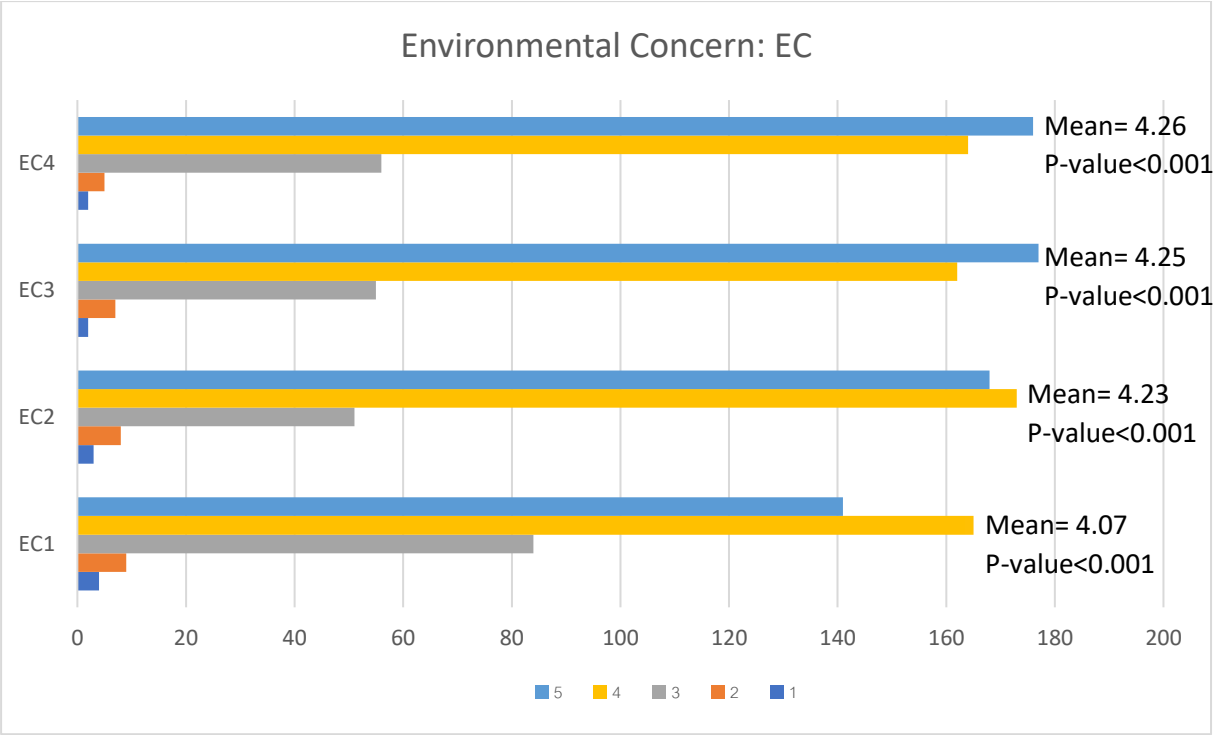

Figure 4.11 *Statistic from four questions of Environmental Concern (EC)*

The respondents have agreed on Environmental Concern as follows:

- I want to preserve energy and environment. (EC4)
- BEVs cause less pollution. (EC3)
- BEVs contributes to saving the environment for the next generation. (EC2)
- I want to buy a BEV because of air pollution crisis. (EC1)

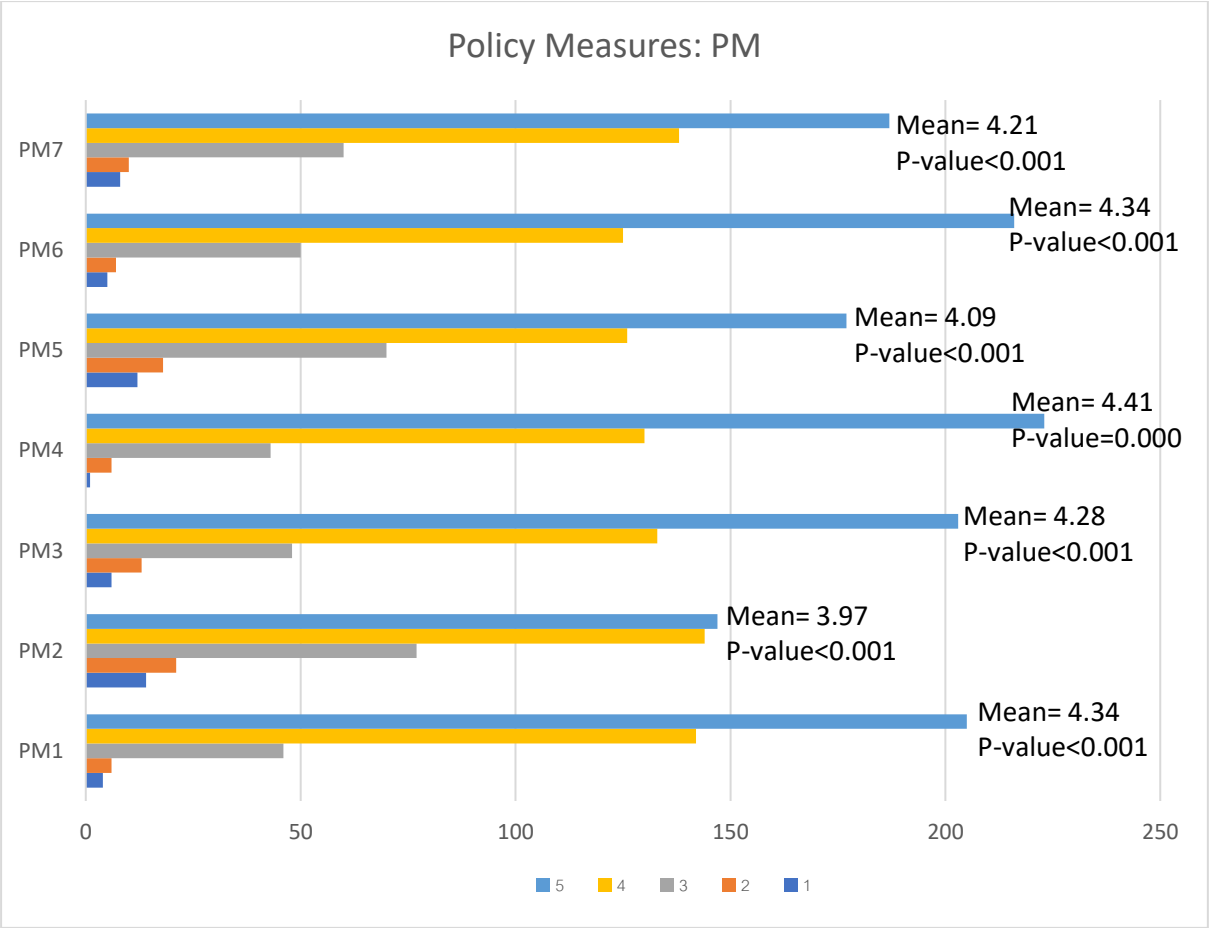

Figure 4.12 *Statistic from seven questions of Policy Measures (PM)*

The respondents have agreed on Policy Measures as follows:

- The government should have tax exemption measures. (PM4)
- The government should fund the construction of charging stations to cover the whole country. (PM6)
- Satisfaction with the following monetary incentive policy measure such as tax exemption, purchase subsidy, parking fee reduction and free charging fee. (PM1)
- The government should announce measures about subsidizing the purchase of electric car. (PM3)
- The government should have measures to exempt charging fees for electric vehicle users. (PM7)
- The government should give special privileges to electric vehicle users such as parking or reduce toll fees. (PM5)

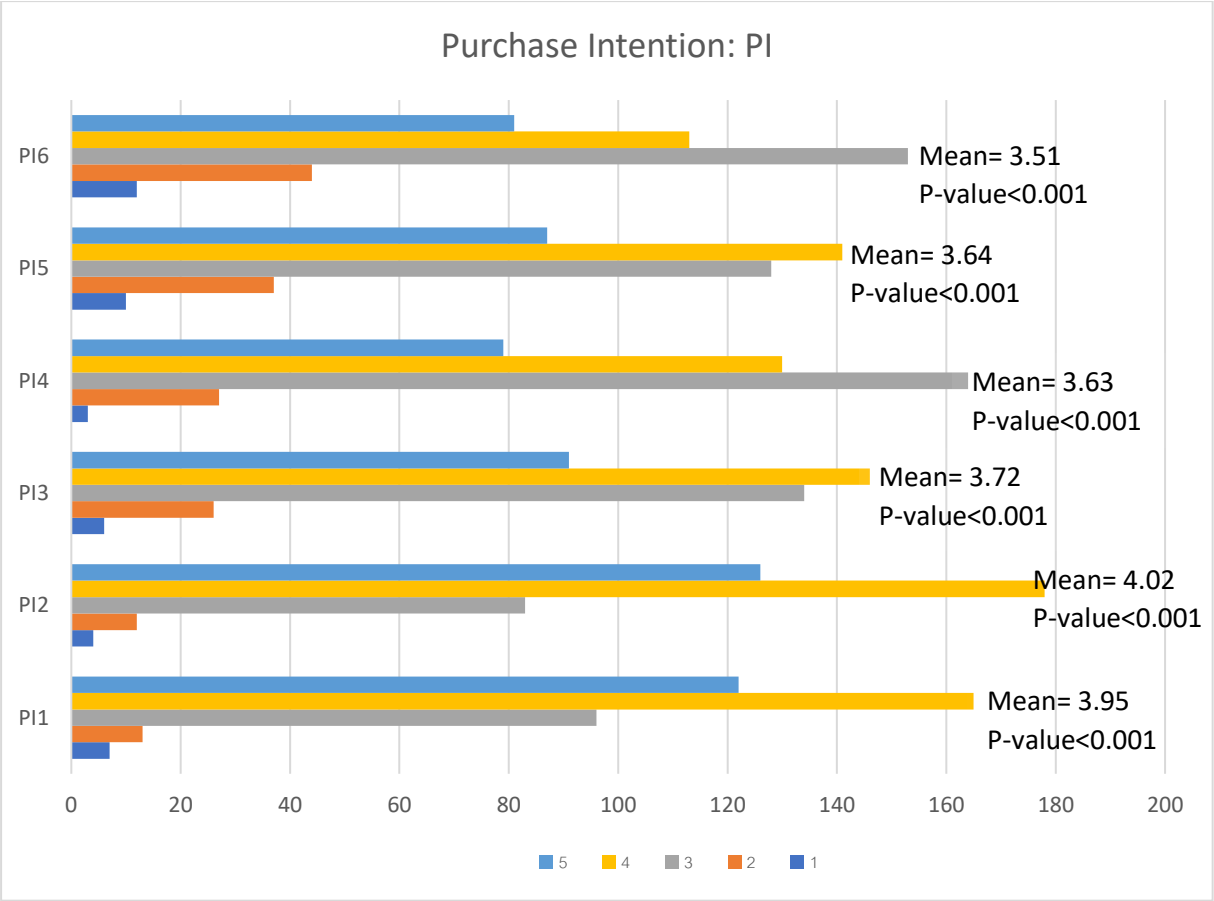

Figure 4.13 *Statistic from six questions of Purchase Intention (PI)*

The respondents have agreed on Purchase Intention as follows:

- If I have the chance, I will buy a BEV. (PI2)

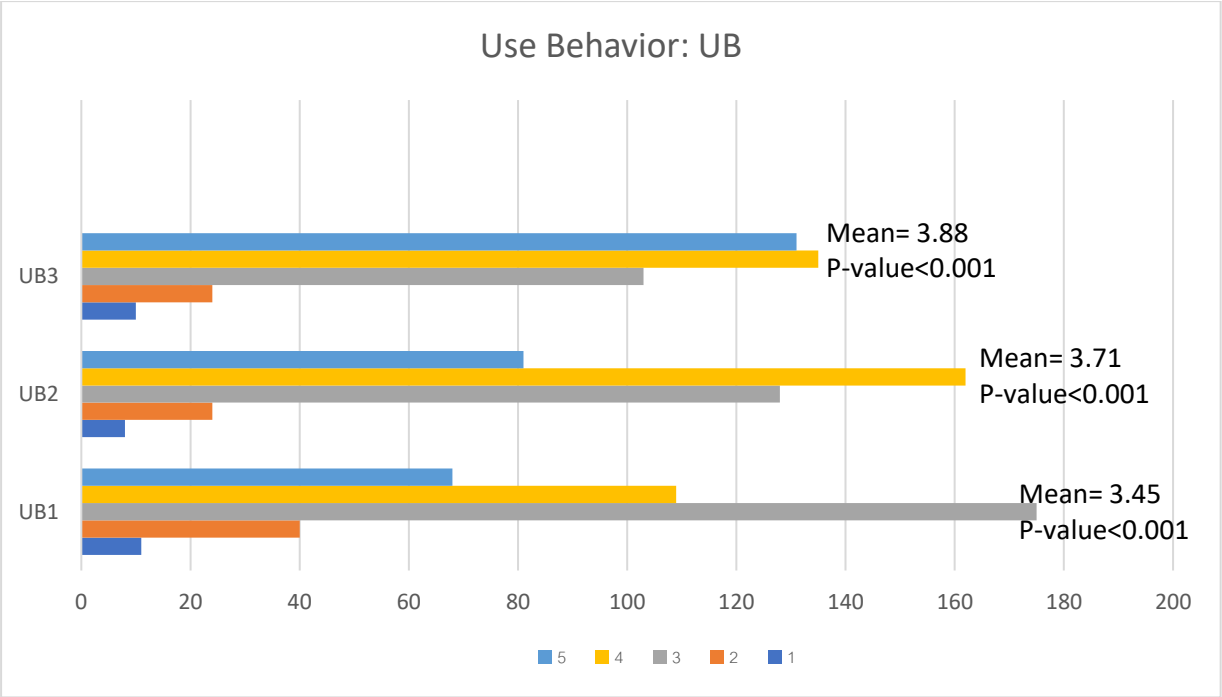

Figure 4.14 *Statistic from three questions of Use Behavior (UB)*

The respondents have almost agreed on Use Behavior as follows:

- I will only use a BEV car in the next 10 years. (UB3)
- I will only use a BEV car in the next 5 years. (UB2)

4.2.2 Measurement Model Evaluation

Conceptual framework for analyzing the relationship of all hypothetical latent variables by using a structural equation model with a total of 10 latent variables: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), Environmental Concern (EC), Policy Measures (PM), Purchase Intention (PI) and Use Behavior (UB) as shown in Figure 4.15. The research models separated into 2 groups of respondents (n=400), combustion car group (n=395) and electric car group (n=8).

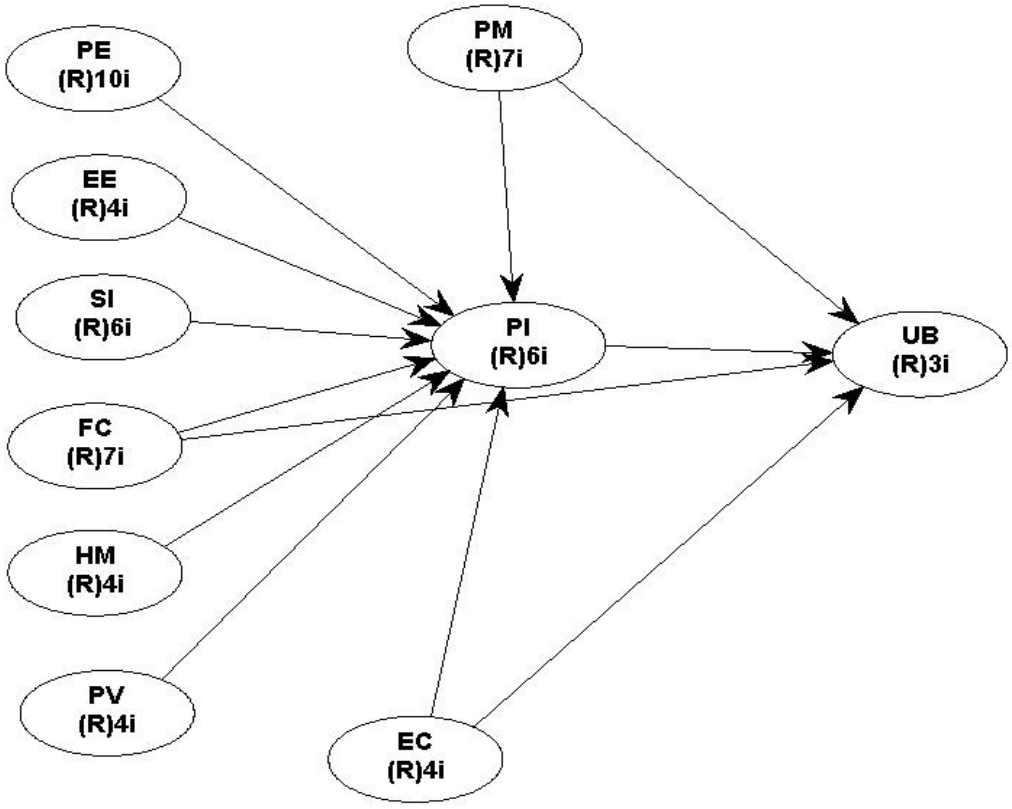

Figure 4.15 *Conceptual framework with 10 latent variables*

The measurement model evaluation involves testing the reliability and validity of the measuring tool. The tool was tested using WarpPLS 7.0 developed by Kock (Kock, 2021). PLS is the statistical means for testing structural equation models, not require normal-distributed input data, few sample size and found in many research of technology those using UTAUT and UTAUT2 (Chang et al., 2019; Venkatesh et al., 2012). The latent variable reliability test criterion is Cronbach's alpha and Composite Reliability. The validity test is to assess construct validity in 2 aspects: Convergent validity and Discriminant validity. The details are as follows.

1. Indicator Reliability

In this research, cronbach's alpha and composite reliability were used to test the quality and reliability of research instruments. An acceptable value for a study should be above 0.7 (Nunnally, 1978; Fornell & Larcker, 1981; Hair et al.,2014). Cronbach's alpha and composite reliability of ten latent variables are greater

than 0.7 as shown in Table 4.6. Ten latent variables were performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price value (PV), environmental concern (EC), policy measures (PM), purchase intention (PI) and use behavior (UB). There were cronbach's alpha value between 0.737-0.957 and composite reliability value between 0.845-0.969. Therefore, it was concluded that all latent variables used in the study were reliable excluding policy measures of electric car group.

2. Convergent validity

The statistic used to measure convergence validity is Average Variance Extract (AVE). The value of AVE should be > 0.5 show latent variable can explain variance of variable more than 50 % (Hair et al.,2014). From Table 4.6, it was found that eight latent variables had AVE value higher than the specified threshold (> 0.5) with statistical significance (p=0.000). Eight latent variables were effort expectancy (EE), social influence (SI), hedonic motivation (HM), price value (PV), environmental concern (EC), policy measures (PM), purchase intention (PI) and use behavior (UB). Although, two latent variables: Performance Expectancy (PE) and Facilitating Conditions (FC) had AVE value less than 0.5 but Composite Reliability (CR) value were greater than 0.6 then they accepted (Fornell & Larcker, 1981). Moreover, The CR value of all variables must be greater than all AVE values assumes that convergent validity meets the specified criteria. It concluded that all latent variables can be validity described or measured for that indicator variable excluding policy measures of electric car group.

3. Discriminant validity

This research used discriminant validity analysis to test the indicator variable or measure whether that variable measured clearly. It was considered by two types of criteria: Fornell-Larcker Criterion and Cross loadings.

a. Fornell-Larcker Criterion

Discriminative validity analysis with Fornell-Larcker Criteria uses the square root of Average Variance Extract (AVE) was compared between

latent variables and other latent variables. The Fornell-Larcker value of each latent variable was found to be greater than that of the latent variable's relationship to other latent variables. Nine latent variables of combustion car group had value more than the latent variables as shown in Table 4.7. For the performance expectancy (PE) - purchase intention (PI) construct and the performance expectancy (PE) - effort expectancy (EE), there was little disputes. However, the difference was too small, each with 0.05 and can be ignored (Rahim and Magner, 1995). Consequently, ten latent variables: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price value (PV), environmental concern (EC), policy measures (PM), purchase intention (PI) and use behavior (UB) supported the discriminative validity. From electric car group, the result found three latent variables: performance expectancy (PE), facilitating conditions (FC), and purchase intention (PI) were not supported the discriminative validity of electric car group as shown in Table 4.8.

b. Cross loadings

Discriminant validity test at the observation variable level considered the relationship between component loading index of the latent variable and component loading index and other latent variables in the model. Each of latent variable was component loading more than other latent variables; not less than 0.7 (Hair et al., 2014). The value can less than 0.7 but not less than 0.5 and positive value (Lee et al., 2011). The result calculated only combustion cars group because the value of indicator reliability, convergent validity, and discriminant validity for electric cars group did not meet the criteria. A small sample size of electric cars group also affects the reliability of a survey's result, which may lead to bias. From Table 4.9, it was found that the weight of the latent variable component was not less than 0.5 and was greater than the element weight of the indicator and the other latent variables in the model; 52 values. These explain that each indicator or each question was a question that can measure each latent variable. A value less than 0.5 (PE7, FC7 and PV1) explains that each indicator or each question is a question that cannot measure individual latent variables.

Table 4.6 *Composite reliability and convergent validity of combustion car group (CC) (n=395) and electric car group (EC) (n=8)*

Latent variables	Cronbach's alpha		Composite Reliability		Average Variance Extracted (AVE)	
	CC	EC	CC	EC	CC	EC
Performance Expectancy (PE)	0.825	0.941	0.865	0.951	0.395	0.666
Effort Expectancy (EE)	0.877	0.957	0.916	0.969	0.732	0.888
Social Influence (SI)	0.884	0.923	0.912	0.945	0.634	0.750
Facilitating Conditions (FC)	0.786	0.916	0.845	0.934	0.450	0.671
Hedonic Motivation (HM)	0.832	0.937	0.888	0.957	0.666	0.849
Price Value (PV)	0.740	0.834	0.847	0.893	0.623	0.685
Environmental Concern (EC)	0.899	0.893	0.930	0.929	0.768	0.769
Policy Measures (PM)	0.921	0.258	0.937	0.038	0.679	0.394
Purchase Intention (PI)	0.911	0.895	0.931	0.922	0.694	0.669
Use Behavior (UB)	0.800	0.737	0.883	0.855	0.717	0.668

Table 4.7 *Discriminant validity (Fornell-Larcker Criterion) of combustion car group (CC)*

	PE	EE	SI	FC	HM	PI	EC	UB	PM	PV
PE	0.629									
EE	0.651	0.856								
SI	0.495	0.386	0.796							
FC	0.574	0.503	0.375	0.671						
HM	0.559	0.504	0.579	0.447	0.816					
PI	0.654	0.577	0.532	0.514	0.598	0.833				
EC	0.516	0.414	0.371	0.505	0.387	0.572	0.876			
UB	0.516	0.471	0.528	0.437	0.508	0.741	0.449	0.847		
PM	0.565	0.421	0.367	0.556	0.338	0.492	0.519	0.423	0.824	
PV	0.444	0.421	0.472	0.353	0.585	0.458	0.344	0.448	0.212	0.789

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.8 *Discriminant validity (Fornell-Larcker Criterion) of electric car group (EC)*

	PE	EE	SI	FC	HM	PI	EC	UB	PM	PV
PE	0.816									
EE	0.802	0.942								
SI	0.669	0.603	0.866							
FC	0.863	0.925	0.686	0.819						
HM	0.915	0.858	0.558	0.822	0.921					
PI	0.892	0.901	0.507	0.892	0.608	0.818				
EC	0.891	0.783	0.475	0.866	0.836	0.867	0.877			
UB	0.677	0.733	0.314	0.684	0.658	0.859	0.706	0.818		
PM	0.566	0.622	0.509	0.525	0.499	0.469	0.260	0.143	0.824	
PV	0.606	0.403	0.858	0.578	0.544	0.440	0.377	0.102	0.499	0.828

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.9 *Discriminant validity (Cross Loadings) of combustion car group (CC)*

	PE	**EE**	**SI**	**FC**	**HM**	**PV**	**EC**	**PM**	**PI**	**UB**
PE1	(0.762)	0.070	-0.090	-0.052	0.170	-0.206	-0.073	-0.024	-0.005	0.117
PE2	(0.695)	-0.058	0.109	-0.156	0.262	0.030	-0.091	-0.087	0.149	-0.081
PE3	(0.754)	0.100	-0.083	-0.116	-0.138	-0.062	0.109	0.052	-0.146	0.091
PE4	(0.543)	-0.087	0.223	-0.128	0.348	0.292	-0.233	-0.126	0.210	-0.091
PE5	(0.611)	-0.037	-0.103	-0.077	0.115	0.225	-0.279	-0.104	0.402	-0.060
PE6	(0.640)	0.010	-0.019	0.050	-0.134	-0.073	0.169	0.136	-0.277	0.123
PE7	(0.455)	-0.069	0.118	0.227	-0.522	0.016	0.047	0.083	-0.101	-0.119
PE8	(0.648)	0.102	-0.172	0.008	0.178	-0.032	-0.019	-0.065	0.056	0.060
PE9	(0.524)	0.037	0.058	0.202	-0.350	-0.019	0.067	0.112	-0.205	-0.069
PE10	(0.586)	-0.135	0.064	0.180	-0.129	-0.073	0.310	0.050	-0.096	-0.071
EE1	0.098	(0.770)	-0.032	-0.119	0.254	0.038	0.049	0.032	0.048	-0.090
EE2	-0.063	(0.896)	0.005	0.066	0.001	-0.093	0.022	0.028	-0.082	0.130
EE3	-0.022	(0.897)	0.057	-0.031	-0.011	0.069	-0.036	-0.063	0.057	-0.079
EE4	0.000	(0.853)	-0.036	0.070	-0.219	-0.008	-0.030	0.007	-0.017	0.027
SI1	0.132	0.002	(0.788)	0.057	-0.079	-0.100	0.130	-0.090	-0.042	0.007
SI2	0.183	0.011	(0.730)	0.034	-0.311	-0.127	0.114	-0.068	-0.068	0.032
SI3	0.101	-0.147	(0.827)	0.032	-0.145	0.109	-0.030	0.026	-0.064	0.002
SI4	-0.149	0.027	(0.833)	-0.072	0.213	0.009	-0.038	0.000	0.043	-0.068
SI5	-0.201	0.131	(0.814)	-0.055	0.239	-0.015	-0.063	0.154	-0.096	-0.004
SI6	-0.042	-0.023	(0.782)	0.011	0.048	0.111	-0.099	-0.033	0.228	0.039
FC1	0.077	-0.047	0.125	(0.698)	-0.353	-0.196	0.127	0.076	-0.014	-0.054
FC2	-0.166	0.386	-0.065	(0.524)	0.236	0.209	-0.300	-0.070	0.221	0.031
FC3	-0.127	0.195	0.076	(0.576)	0.192	0.267	-0.186	-0.224	0.223	-0.089
FC4	0.225	-0.021	-0.081	(0.757)	-0.141	-0.068	0.078	0.015	-0.187	-0.002
FC5	0.012	-0.169	-0.040	(0.817)	-0.137	-0.133	0.123	0.129	-0.169	0.106
FC6	-0.009	-0.217	-0.003	(0.812)	0.025	-0.044	0.020	0.083	0.012	-0.034
FC7	-0.166	0.120	0.000	(0.399)	0.530	0.174	0.001	-0.178	0.088	0.039
HM1	0.031	0.004	0.236	-0.055	(0.836)	-0.003	-0.037	0.036	0.000	-0.091
HM2	0.089	0.084	0.161	0.108	(0.769)	-0.216	-0.088	0.206	-0.189	-0.052
HM3	-0.017	-0.022	-0.182	0.030	(0.830)	0.014	0.113	-0.162	0.014	0.085
HM4	-0.097	-0.060	-0.205	-0.076	(0.826)	0.191	0.006	-0.065	0.162	0.056

	PE	EE	SI	FC	HM	PV	EC	PM	PI	UB
PV1	0.104	0.077	-0.066	0.347	-0.102	(0.171)	0.279	0.256	-0.078	-0.061
PV2	-0.009	-0.033	0.048	-0.025	-0.022	(0.914)	-0.079	-0.051	-0.033	0.009
PV3	-0.041	0.011	-0.005	-0.025	0.007	(0.888)	0.043	0.036	0.112	0.002
PV4	0.029	0.008	-0.030	-0.016	0.034	(0.916)	-0.015	-0.032	-0.061	0.000
EC1	-0.090	0.022	0.053	-0.012	-0.005	0.085	(0.865)	-0.117	0.156	-0.003
EC2	0.091	-0.085	-0.005	0.003	-0.004	-0.042	(0.903)	0.038	-0.069	0.094
EC3	0.063	0.016	-0.040	-0.002	0.013	-0.049	(0.863)	0.054	-0.148	0.063
EC4	-0.067	0.050	-0.008	0.010	-0.003	0.009	(0.873)	0.023	0.062	-0.156
PM1	0.181	0.028	-0.153	0.067	-0.174	0.030	0.126	(0.779)	0.001	-0.013
PM2	-0.092	-0.068	0.050	-0.034	0.150	0.110	-0.108	(0.759)	0.052	-0.007
PM3	-0.077	-0.044	0.025	0.006	0.081	-0.042	-0.003	(0.863)	0.012	0.003
PM4	0.062	0.072	-0.156	0.086	-0.153	-0.062	0.144	(0.855)	0.059	-0.020
PM5	-0.083	-0.007	0.091	-0.076	0.129	0.048	-0.131	(0.821)	-0.045	0.025
PM6	0.065	-0.022	0.041	0.052	-0.130	-0.023	0.032	(0.856)	-0.031	0.052
PM7	-0.055	0.038	0.100	-0.106	0.106	-0.044	-0.067	(0.830)	-0.045	-0.042
PI1	-0.062	-0.012	0.074	0.084	0.024	-0.113	0.079	0.211	(0.734)	-0.101
PI2	0.046	0.064	-0.086	0.055	-0.102	-0.094	0.108	0.079	(0.838)	0.012
PI3	-0.031	-0.039	-0.053	-0.058	-0.019	0.097	0.005	-0.051	(0.896)	-0.081
PI4	-0.027	-0.017	0.113	-0.058	0.037	0.007	-0.062	0.032	(0.877)	-0.097
PI5	0.111	0.078	-0.012	-0.093	0.011	0.003	-0.021	-0.105	(0.789)	0.017
PI6	-0.034	-0.066	-0.029	0.079	0.052	0.078	-0.095	-0.141	(0.852)	0.244
UB1	-0.010	-0.053	-0.008	-0.018	0.068	0.120	-0.056	-0.148	0.428	(0.846)
UB2	-0.018	0.002	-0.006	0.006	-0.078	0.033	0.060	-0.043	0.037	(0.921)
UB3	0.033	0.057	0.016	0.013	0.019	-0.172	-0.010	0.215	-0.517	(0.767)

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

4.2.3 Structural Model Assessment

This part is the implementation of hypothesis testing to demonstrate that the conceptual model has an acceptable data as follow:

4.2.3.1 Variance Inflation Factors (VIF)

It is tested through variance inflation factors (VIF) for all constructs to assess the aspect of multicollinearity in the model. Variance Inflation Factors (VIF) needed to be lower than 5 to ensure that the sample was not influenced by common method bias (Kock, 2015; Kock and Lynn, 2012). The VIF value of each variable is lower than 5 (1.700 – 3.302) ensure that the sample was not influenced by common method bias. Table 4.10 shows that obtained values of every construct in the model.

4.2.3.2 Coefficient of determinant (R^2)

The structural model assessment of this research was based on 2 variables of decision coefficients: Purchase Intention (PI) and Use behavior (UB).

- Purchase Intention (PI)

Purchase Intention has value of coefficient of determinant (R^2) 0.587 and the value of adjusted coefficient of determination (R^2 Adjusted) 0.579 as illustrated value in Table 4.11. Accuracy is moderate, influenced by eight variables: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), Environmental Concern (EC), Policy Measures (PM). All eight variables above can explain the variance in purchase intention of consumer 58.7 percentage.

- Use behavior (UB)

Use behavior has value of coefficient of determinant (R^2) 0.558 and the value of adjusted coefficient of determination (R^2 Adjusted) 0.553 as illustrated value in Table 4.11. Accuracy is moderate, influenced by nine variables: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), Environmental Concern (EC), Policy Measures (PM) and Purchase Intention (PI). All nine variables above can explain the variance in use behavior of consumer 55.8 percentage.

Table 4.10 *Variance Inflation Factors (VIF) of combustion car group (CC)*

Variables	VIF
Performance Expectancy (PE)	2.647
Effort Expectancy (EE)	1.965
Social Influence (SI)	1.789
Facilitating Conditions (FC)	1.866
Hedonic Motivation (HM)	2.207
Price Value (PV)	1.700
Environmental Concern (EC)	1.746
Policy Measures (PM)	1.848
Purchase Intention (PI)	3.302
Use Behavior (UB)	2.409

Table 4.11 *Coefficient of Determinant-R Square of combustion car group (CC)*

	R^2	R^2 Adjusted
Purchase Intention (PI)	0.587	0.579
Use Behavior (UB)	0.558	0.553

4.2.3.3 Model fit and quality indices

Ten global model fit and quality indices are provided: Average path coefficient (APC), Average R-squared (ARS), Average adjusted R-squared (AARS), Average block VIF (AVIF), Average full collinearity VIF (AFVIF), Tenenhaus GoF (GoF), Sympson's paradox ratio (SPR), R-squared contribution ratio (RSCR), Statistical suppression ratio (SSR) and Nonlinear bivariate causality direction ratio (NLBCDR) (Kock, 2015; 2021). Table 4.12 reports ten global model fit and quality indices of this study. P values for APC, ARS and AARS are equal to or lower than 0.05 (Kock, 2021). Both of AVIF and AFVIF are equal to or lower than 5 (Kock and Lynn, 2012). The square root of the product between the average communality index and the ARS is defined as GoF (Tenenhaus et al., 2005). The value of GoF is small if equal to or greater than 0.1, medium if equal to or greater than 0.25 and large if equal to or greater than 0.36 (Wetzels & Odekerken, 2009). WarpPLS suggests a value of 0.603 for GoF, presenting that the model has reasonably large explanatory power. Acceptable values of SPR, RSCR, SSR and NLBCDR are equal to or greater than 0.7, 0.9, 0.7 and 0.7 respectively (Kock, 2021). All reported finding in Table 4.12 met suggested cut-off values, showing that the model has good statistical results.

Table 4.12 *Model fit and quality indices of combustion car group (CC)*

Measure	Value	p-values
Average path coefficient (APC)	0.150	P<0.001
Average R-squared (ARS)	0.572	P<0.001
Average adjusted R-squared (AARS)	0.566	P<0.001
Average block VIF (AVIF)	1.928	acceptable if <= 5, ideally <= 3.3
Average full collinearity VIF (AFVIF)	2.148	acceptable if <= 5, ideally <= 3.3
Tenenhaus GoF (GoF)	0.603	small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)	0.917	acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)	1.000	acceptable if >= 0.9, ideally = 1

Measure	Value	p-values
Statistical suppression ratio (SSR)	1.000	acceptable if >= 0.7
Nonlinear bivariate causality direction ratio (NLBCDR)	1.000	acceptable if >= 0.7

4.2.3.4 Path coefficients

The hypothesis testing of the PLS-SEM structural model equation analysis uses WarpPLS software for test of statistical significance by considering the path coefficient at the significance level 0.001***(p<0.001), 0.01**(p<0.01) and 0.05*(p< 0.05). This shows Path coefficients support research hypothesis as shown in Table 4.13. There can be described by relationship group as follows:

Hypothesis 1: Performance expectancy (PE) has a significant positive effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.20 and the P value was lower than 0.001 (p<0.001**). This shows performance expectancy (PE) has a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 1 cannot be rejected.

Hypothesis 2: Effort expectancy (EE) has a significant positive effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.14 and the P value was 0.003 (p< 0.01**). This shows effort expectancy (EE) has a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 2 cannot be rejected.

Hypothesis 3: Social influence (SI) has a significant positive effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.13 and the P value was 0.005 (p< 0.01**). This shows social influence (SI) has a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 3 cannot be rejected.

Hypothesis 4a: Facilitating Conditions (FC) has a significant positively effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0 . 04 and the P value was 0 . 2 4 (p>0.05). This shows facilitating conditions (FC) has not a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 4a can be rejected.

Hypothesis 4b: Facilitating Conditions (FC) has a significant positively effect on use behavior (UB).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0 . 05 and the P value was 0 .17 (p>0.05). This shows facilitating conditions (FC) has not a significant positive effect on use behavior. Therefore, the hypothesis 4b can be rejected.

Hypothesis 5: Hedonic motivation (HM) has a significant positively effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0 .20 and the P value was lower than 0.001 (p<0.001***). This shows hedonic motivation (HM) has a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 5 cannot be rejected.

Hypothesis 6: Price value (PV) has a significant positively effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of -0 . 001 and the P value was 0 . 50 (p>0.05). This shows price value (PV) has not a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 6 can be rejected.

Hypothesis 7a: Environmental concern (EC) has a significant positively effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0 .22 and the P value was lower than

0.001 (p<0.001***). This shows environmental concern (EC) has a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 7 cannot be rejected.

Hypothesis 7b: Environmental concern (EC) has a significant positively effect on use behavior (UB).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.01 and the P value was 0.43 (p>0.05). This shows environmental concern (EC) has a significant positive effect on use behavior (UB). Therefore, the hypothesis 7 can be rejected.

Hypothesis 8a: Policy measures (PM) have a significant positively effect on BEV purchase intention (PI).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.08 and the P value was 0.07 (p>0.05). This shows policy measures (PM) has not a significant positive effect on BEV purchase intention (PI). Therefore, the hypothesis 8 can be rejected.

Hypothesis 8b: Policy measures (PM) have a significant positively effect on use behavior (UB).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.07 and the P value was 0.09 (p>0.05). This shows policy measures (PM) has not a significant positive effect on use behavior (UB). Therefore, the hypothesis 8 can be rejected.

Hypothesis 9: BEV purchase intention (PI) has a significant positively effect on use behavior (UB).

From Table 4.13, the research was considering the path coefficient. It was found that the coefficient of 0.68 and the P value was lower than 0.001 (p<0.001***). This shows BEV purchase intention (PI) has a significant positively effect on use behavior (UB). Therefore, the hypothesis 9 cannot be rejected.

Table 4.13 *Path Coefficients of combustion car group (CC)*

Hypothesis	Path Coefficient	P Values
H1. PE → PI	0.20	<0.001***
H2. EE → PI	0.14	<0.01**
H3. SI → PI	0.13	<0.01**
H4a. FC → PI	0.04	0.24
H4b. FC → UB	0.05	0.17
H5. HM → PI	0.20	<0.001***
H6. PV → PI	-0.00	0.50
H7a. EC → PI	0.22	<0.001***
H7b. EC → UB	0.01	0.43
H8a. PM → PI	0.08	0.07
H8b. PM → UB	0.07	0.09
H9. PI → UB	0.68	<0.001***

Significance at p<0.001, p<0.01, p<0.05.

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

The causal relationship between latent variables and hypotheses has been analyzed above. The researcher would like to summarize the research hypothesis test results as shown in Figure 4.16 and Table 4.14.

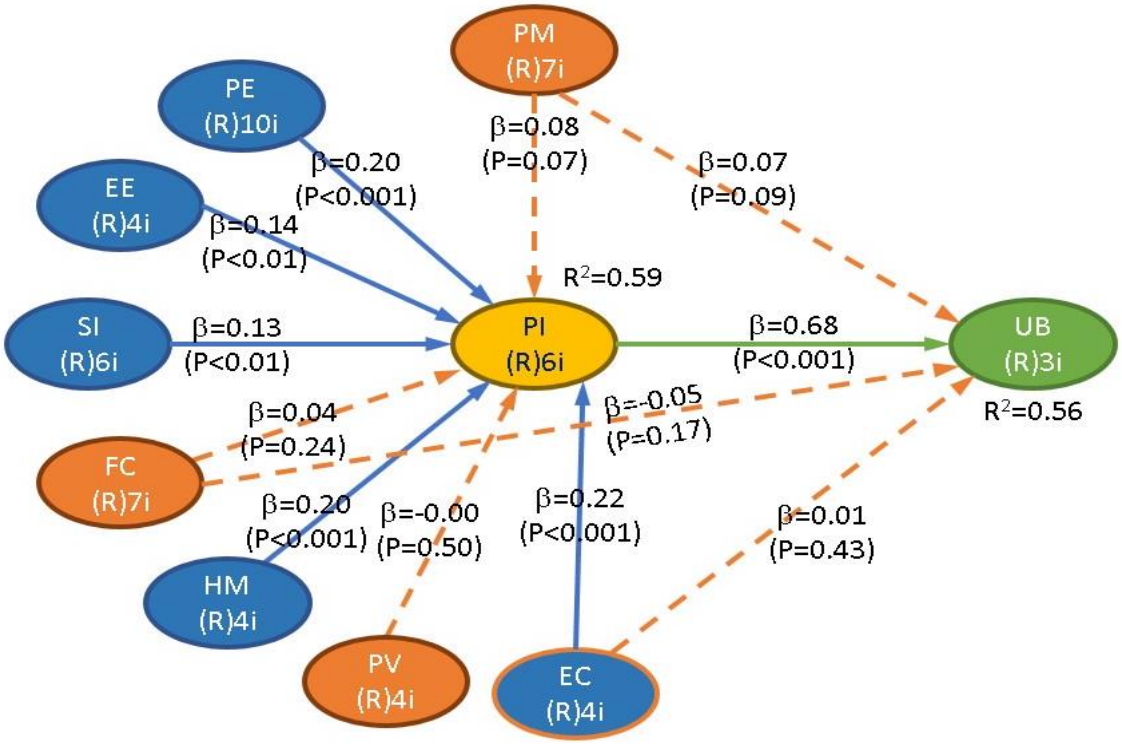

Figure 4.16 *Statistical results from the process significance test*

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.14 *Conclusion research hypothesis*

Hypothesis		Test Results
1	Performance expectancy (PE) has a significant positive effect on BEV purchase intention (PI).	Supported
2	Effort expectancy (EE) has a significant positive effect on BEV purchase intention (PI).	Supported
3	Social influence (SI) has a significant positive effect on BEV purchase intention (PI).	Supported
4a	Facilitating Conditions (FC) has a significant positively effect on BEV purchase intention (PI).	Not supported
4b	Facilitating Conditions (FC) has a significant positively effect on use behavior (UB).	Not supported
5	Hedonic motivation (HM) has a significant positively effect on BEV purchase intention (PI).	Supported

Hypothesis		Test Results
6	Price value (PV) has a significant positively effect on BEV purchase intention (PI).	Not Supported
7a	Environmental concern (EC) has a significant positively effect on BEV purchase intention (PI).	Supported
7b	Environmental concern (EC) has a significant positively effect on use behavior (UB).	Not Supported
8a	Policy measures (PM) have a significant positively effect on BEV purchase intention (PI).	Not Supported
8b	Policy measures (PM) have a significant positively effect on use behavior (UB).	Not Supported
9	BEV purchase intention (PI) has a significant positively effect on use behavior (UB).	Supported

Additionally, the effects of socio-demographic variables on purchase intention and use behavior for BEVs were conducted to test by multi-group analyses on Warp PLS 7.0. Purchase Intention and use behavior are affected by age, gender and experience within UTAUT2 model (Lin & Wu, 2018; Venkatesh et al., 2012). Gender, age, education, occupation, income, and accommodation province were the socio-demographic variables for this research. Gender was found not significant differences as shown in Table 4.15. Age, education, occupation, income, and accommodation province were found to have significant differences as shown in Table 4.16 - 4.25. Respondents were categorized into five groups for age: Group 1: 18-25 years old, Group 2: 26-33 years old, Group 3: 34-41 years old, Group 4: 42-49 years old and Group 5: 50 years old and over. The results indicated a statistically significant difference in purchase intention with variables of age group as Table 4.16 – 4.20. We found significant differences in performance expectancy – purchase intention, social influence – purchase intention, environmental concern – purchase intention, policy measures – purchase intention, and policy measures – use behavior. Group 2 (26-33 years old) and group 3 (34-41 years old) significantly affect the relationship between policy measures and purchase intention with a standardized path coefficient ($\beta = 0.27$, $p=0.02$), environmental concern and purchase intention with a standardized path coefficient ($\beta = 0.26$, $p=0.02$) as shown in Table 4.16. From Table

4.17, group 2 (26-33 years old) and group 5 (50 years old and over) significantly affect the relationship between policy measures and use behavior with a standardized path coefficient (β = 0.25, p=0.04). Group 3 (34-41 years old) and group 4 (42-49 years old) significantly affect the relationship between environmental concern and purchase intention with a standardized path coefficient (β = 0.32, p=0.00) as well as social influence and purchase intention with a standardized path coefficient (β = 0.24, p=0.03) as shown in Table 4.18. From Table 4.19, group 3 (34-41 years old) and group 5 (50 years old and over) significantly affect the relationship between performance expectancy and purchase intention with a standardized path coefficient (β = 0.22, p=0.04). Group 4 (42-49 years old) and group 5 (50 years old and over) significantly affect the relationship between performance expectancy and purchase intention with a standardized path coefficient (β = 0.27, p=0.03) as well as policy measures and use behavior with a standardized path coefficient (β = 0.35, p=0.01) as shown in Table 4.20. For education, we found bachelor's degree and master's degree significantly affect the relationship between hedonic motivation and purchase intention with a standardized path coefficient (β = 0.22, p=0.01) as shown in Table 4.21. For occupation, we found government officer/employees and private company employees significantly affect the relationship between effort expectancy and purchase intention with a standardized path coefficient (β = 0.27, p=0.01), facilitating conditions and use behavior with a standardized path coefficient (β = 0.26, p=0.02), purchase intention and use behavior with a standardized path coefficient (β = 0.21, p=0.03) as shown in Table 4.22. For income, we found significant differences in performance expectancy – purchase intention, effort expectancy – purchase intention, and hedonic motivation – purchase intention. As Table 4.23-4.24, income (15,001-25,000 baht) and income (25,001-35,000 baht) significantly affect the relationship between performance expectancy and purchase intention with a standardized path coefficient (β = 0.27, p=0.02), effort expectancy and purchase intention with a standardized path coefficient (β = 0.37, p=0.00), hedonic motivation and purchase intention with a standardized path coefficient (β = 0.31, p=0.01). Moreover, income (25,001-35,000 baht) and income (35,001-45,000 baht) significantly affect the relationship between performance expectancy and purchase intention with a standardized path coefficient (β = 0.38, p=0.01). For accommodation province, we

found Bangkok and Nonthaburi significantly affect the relationship between performance expectancy and purchase intention with a standardized path coefficient (β = 0.24, p=0.04), effort expectancy and purchase intention with a standardized path coefficient (β = 0.25, p=0.04), social influence and purchase intention with a standardized path coefficient (β = 0.33, p=0.01) as shown in Table 4.25.

Table 4.15 *Multi-group Analysis with gender (male and female)*

Hypothesis	Path Coefficient differences (male VS female)	New P Values (male VS female)
H1. PE → PI	0.12	0.11
H2. EE → PI	0.04	0.36
H3. SI → PI	0.04	0.33
H4a. FC → PI	0.02	0.44
H4b. FC → UB	0.05	0.32
H5. HM → PI	0.02	0.44
H6. PV → PI	0.10	0.15
H7a. EC → PI	0.11	0.14
H7b. EC → UB	0.03	0.39
H8a. PM → PI	0.16	0.06
H8b. PM → UB	0.06	0.27
H9. PI → UB	0.11	0.10

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.16 *Multi-group Analysis with age group 2 and group 3*

Hypothesis	Path Coefficient differences (age group 2 - group 3)	New P Values (age group 2 VS group 3)
H1. PE → PI	0.01	0.47
H2. EE → PI	0.10	0.23
H3. SI → PI	0.11	0.20
H4a. FC → PI	0.07	0.30
H4b. FC → UB	0.08	0.27
H5. HM → PI	0.14	0.14
H6. PV → PI	0.08	0.27
H7a. EC → PI	0.26	0.02
H7b. EC → UB	0.07	0.29
H8a. PM → PI	0.27	0.02
H8b. PM → UB	0.09	0.27
H9. PI → UB	0.05	0.33

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.17 *Multi-group Analysis with age group 2 and group 5*

Hypothesis	Path Coefficient differences (age group 2 - group 5)	New P Values (age group 2 VS group 5)
H1. PE → PI	0.24	0.05
H2. EE → PI	0.10	0.26
H3. SI → PI	0.09	0.29
H4a. FC → PI	0.00	0.49
H4b. FC → UB	0.17	0.14
H5. HM → PI	0.15	0.15
H6. PV → PI	0.07	0.32
H7a. EC → PI	0.13	0.20
H7b. EC → UB	0.07	0.32
H8a. PM → PI	0.19	0.10
H8b. PM → UB	0.25	0.04
H9. PI → UB	0.06	0.34

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.18 *Multi-group Analysis with age group 3 and group 4*

Hypothesis	Path Coefficient differences (age group 3 - group 4)	New P Values (age group 3 VS group 4)
H1. PE → PI	0.05	0.35
H2. EE → PI	0.10	0.22
H3. SI → PI	0.24	0.03
H4a. FC → PI	0.16	0.12
H4b. FC → UB	0.01	0.48
H5. HM → PI	0.11	0.20
H6. PV → PI	0.10	0.23
H7a. EC → PI	0.32	0.00
H7b. EC → UB	0.03	0.41
H8a. PM → PI	0.08	0.27
H8b. PM → UB	0.18	0.08
H9. PI → UB	0.03	0.40

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.19 *Multi-group Analysis with age group 3 and group 5*

Hypothesis	Path Coefficient differences (age group 3 - group 5)	New P Values (age group 3 VS group 5)
H1. PE → PI	0.22	0.04
H2. EE → PI	0.00	0.50
H3. SI → PI	0.03	0.42

Hypothesis	Path Coefficient differences (age group 3 - group 5)	New P Values (age group 3 VS group 5)
H4a. FC→ PI	0.07	0.31
H4b. FC→UB	0.08	0.28
H5. HM→ PI	0.01	0.47
H6. PV → PI	0.01	0.47
H7a. EC→ PI	0.13	0.16
H7b. EC→ UB	0.00	0.49
H8a. PM→ PI	0.08	0.29
H8b. PM→ UB	0.16	0.11
H9. PI → UB	0.11	0.19

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.20 *Multi-group Analysis with age group 4 and group 5*

Hypothesis	Path Coefficient differences (Age group 4 - group 5)	New P Values (Age group 4 VS group 5)
H1. PE→PI	0.27	0.03
H2. EE→ PI	0.10	0.25
H3. SI → PI	0.21	0.07
H4a. FC→ PI	0.09	0.28
H4b. FC→UB	0.09	0.28
H5. HM→ PI	0.12	0.21
H6. PV → PI	0.11	0.23
H7a. EC→ PI	0.19	0.10
H7b. EC→ UB	0.03	0.41
H8a. PM→ PI	0.00	0.49
H8b. PM→ UB	0.35	0.01
H9. PI → UB	0.14	0.14

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.21 *Multi-group Analysis with education (bachelor's degree and master's degree)*

Hypothesis	Path Coefficient differences (bachelor VS master)	New P Values (bachelor VS master)
H1. PE→PI	0.16	0.06
H2. EE→ PI	0.11	0.13
H3. SI → PI	0.00	0.50
H4a. FC→ PI	0.02	0.42
H4b. FC→UB	0.09	0.20
H5. HM→ PI	0.22	0.01
H6. PV → PI	0.02	0.44
H7a. EC→ PI	0.15	0.08
H7b. EC→ UB	0.03	0.38
H8a. PM→ PI	0.06	0.29

Hypothesis	Path Coefficient differences (bachelor VS master)	New P Values (bachelor VS master)
H8b. PM→ UB	0.10	0.16
H9. PI → UB	0.10	0.13

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.22 *Multi-group Analysis with occupation (government officer/employees and private company employees)*

Hypothesis	Path Coefficient differences (government officer VS company employees)	New P Values (government officer VS company employees)
H1. PE →PI	0.04	0.38
H2. EE→ PI	0.27	0.01
H3. SI → PI	0.14	0.13
H4a. FC→ PI	0.04	0.37
H4b. FC→UB	0.26	0.02
H5. HM→ PI	0.08	0.26
H6. PV → PI	0.07	0.30
H7a. EC→ PI	0.03	0.42
H7b. EC→ UB	0.02	0.45
H8a. PM→ PI	0.06	0.32
H8b. PM→ UB	0.08	0.26
H9. PI → UB	0.21	0.03

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.23 *Multi-group Analysis with income (15,001-25,000 and 25,001-35,000 baht)*

Hypothesis	Path Coefficient differences (15,001-25,000 and 25,001-35,000 baht)	New P Values (15,001-25,000 and 25,001-35,000 baht)
H1. PE →PI	0.27	0.02
H2. EE→ PI	0.02	0.45
H3. SI → PI	0.37	0.00
H4a. FC→ PI	0.00	0.49
H4b. FC→UB	0.03	0.40
H5. HM→ PI	0.31	0.01
H6. PV → PI	0.00	0.47
H7a. EC→ PI	0.09	0.24
H7b. EC→ UB	0.04	0.40
H8a. PM→ PI	0.06	0.33
H8b. PM→ UB	0.04	0.39
H9. PI → UB	0.10	0.20

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.24 *Multi-group Analysis with income (25,001-35,000 and 35,001-45,000 baht)*

Hypothesis	Path Coefficient differences (25,001-35,000 and 35,001-45,000 baht)	New P Values (25,001-35,000 and 35,001-45,000 baht)
H1. PE → PI	0.38	0.01
H2. EE → PI	0.18	0.13
H3. SI → PI	0.19	0.12
H4a. FC → PI	0.07	0.33
H4b. FC → UB	0.16	0.17
H5. HM → PI	0.08	0.30
H6. PV → PI	0.05	0.38
H7a. EC → PI	0.01	0.49
H7b. EC → UB	0.08	0.32
H8a. PM → PI	0.00	0.50
H8b. PM → UB	0.11	0.26
H9. PI → UB	0.13	0.16

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

Table 4.25 *Multi-group Analysis with accommodation province (bangkok and nonthaburi)*

Hypothesis	Path Coefficient differences (bangkok and nonthaburi)	New P Values (bangkok and nonthaburi)
H1. PE → PI	0.24	0.04
H2. EE → PI	0.25	0.04
H3. SI → PI	0.33	0.01
H4a. FC → PI	0.08	0.29
H4b. FC → UB	0.13	0.17
H5. HM → PI	0.06	0.34
H6. PV → PI	0.07	0.31
H7a. EC → PI	0.11	0.20
H7b. EC → UB	0.21	0.07
H8a. PM → PI	0.01	0.48
H8b. PM → UB	0.12	0.19
H9. PI → UB	0.04	0.37

Note: PE=Performance Expectancy EE=Effort Expectancy SI=Social Influence FC=Facilitating Conditions HM=Hedonic Motivation PV=Price Value EC=Environmental Concern PM=Policy Measures PI=Purchase Intention UB=Use Behavior

4.2.4 Policy measures to support BEV adoption in Thailand

According to the questionnaire survey for demand side, the third part of the questionnaire requested 403 respondents give suggestion about policy measures that they think Thailand should have to support more people use battery electric cars

as illustrated in Table 4.26 and Figure 4.17. Exemption of car tax is the majority of policy measures as 359 respondents (88.6 %). Free charging fee is the second as 281 respondents (69.7 %). Subsidies or Discount car price is the third as 241 respondents (59.8 %). Reduce or Free toll fee as 158 respondents (39.2 %), Defines a limited environmental city area as 149 respondents (37 %), Defines not to use combustion cars in the future 145 respondents (36 %) and Reduce or Free parking fee 142 respondents (35.2 %) respectively. Moreover, 60 respondents (14.9 %) suggested others such as increase charging stations, subsidies maintenance cost, support research and development about EV technology in domestic, defines EV law and regulation about infrastructure and waste and integrate between departments.

Table 4.26 *Policy measures from demand side*

Policy measures	**Number of respondents**	**Percentage**
Exemption of car tax	357	88.6%
Subsidies or Discount car price	241	59.8%
Reduce or Free parking fee	142	35.2%
Reduce or free toll fee	158	39.2%
Free charging fee	281	69.7%
Increase the tax on car emissions	166	41.2%
Defines a limited environmental city area	149	37%
Defines not to use combustion cars in the future	145	36%
Others	60	14.9%

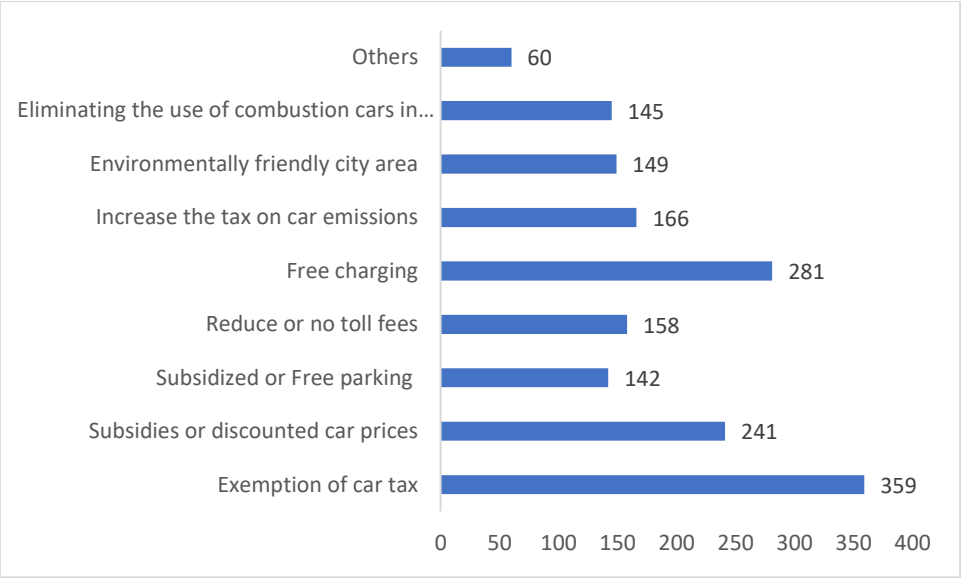

Figure 4.17 *The results of policy measures for demand side*

4.3 Discussion of Results

The empirical results demonstrated that the extended UTAUT2 theoretical model had good illustrative power in the context of car drivers adopting BEV cars. The adjusted R^2 values accounted 57.9% for purchase intention and 55.3% for use behavior and both exceed the recommended values. UTAUT has been proved to be more effective than other TAM and it explains until 70% of variance in the organizational context (Venkatesh et.al.,2003). As a result, the analysis of the paths revealed that six of the nine structural hypotheses could be supported (see Table 4.13 - 4.14). Significant positive relationships were found between performance expectancy (PE) and purchase intention (PI) (confirming H1) , effort expectancy (EE) and purchase intention (PI) (confirming H2), social influence (SI) and purchase intention (PI) (confirming H3), facilitating conditions (FC) and purchase intention (PI) (rejecting H4a), facilitating conditions (FC) and use behavior (UB) (rejecting H4b), hedonic motivation (HM) and purchase intention (PI) (confirming H5), price value (PV) and purchase intention (PI) (rejecting H6), environmental concern (EC) and purchase intention (PI) (confirming H7a), environmental concern (EC) and use behavior (UB) (rejecting H7b), policy measures (PM) and purchase intention (PI)

(rejecting H8a), policy measures (PM) and use behavior (UB) (rejecting H8b), and purchase intention (PI) and use behavior (UB) (confirming H9).

The results confirmed a positive significant association between performance expectancy (PE) and purchase intention (PI), effort expectancy (EE) and purchase intention (PI), social influence (SI) and purchase intention (PI), hedonic motivation (HM) and purchase intention (PI), environmental concern (EC) and purchase intention (PI) and purchase intention (PI) and use behavior. Previous studied that use UTAUT as the basis of their conceptual models, performance expectancy was an important factor, influencing purchase intention in innovation technology (Madigan et al., 2017; Xu et al., 2018). Electric vehicle technology used different technical aspects to perform its specific tasks. Battery electric vehicles had a limited distance, which concerned the respondents the most. To support future purchases of battery electric cars, suppliers must develop the efficiency of electric cars. Some BEV drivers found that poor acceleration was the worse performance of BEVs (Graham-Rowe et al., 2012; Axsen et al., 2013; Noel et al., 2020). The effort expectancy was an impactful determinant in the technology adoption (Rahi et al., 2018). In developing country, effort expectancy has been documented to be more influential in the purchase intention of new technologies than in developed countries. Users would prefer a battery electric car that is easy to use. Social Influence and Hedonic Motivation also played the significant roles in purchase intention in new technologies (Buckley et al., 2018; Madigan et al., 2017; Moták et al., 2017). This result was in accordance with the UTAUT model from previous studies (Madigan et al., 2017; Zhang et al., 2011). The social aspect was a precious force in remolding human behaviors and intentions towards adoption of EV technology, particularly regarding the developing country. EV technology drove hedonic consumption for individual users which will be willing to adopt EV technology. Using electric vehicles was quiet and comfortable and good experience. It will encourage consumers to buy electric cars (Lee et al., 2019). Electric car growth sparked environmental concern. Thus, environmental concern affected purchase intention in electric cars (Razak et al., 2014). Nowadays, the environmental concern and social influence has embraced social media as campaigns and movements locally and globally. A lot of social media channels can use to spread

normative messages to encourage use battery electric car instead of combustion car. Moreover, social influencer who have numerous followers and huge credibility can build environmental awareness and support to use battery electric car by reviewing battery electric cars on their channels. The empirical analysis confirms the significant correlation between purchase intention and use behavior (Venkatesh, et al., 2012). Purchase intention is a major determinant of use behavior. Moreover, the path coefficient was the highest, which showed that drivers who have a more positive intent towards the purchase and use of battery electric vehicles (Huang & Ge, 2019; Tu & Yang, 2019).

The results rejected a positive significant association between facilitating conditions (FC) and purchase intention (PI), facilitating conditions (FC) and use behavior (UB), price value (PV) and purchase intention (PI), environmental concern (EC) and use behavior (UB), policy measures (PM) and purchase intention (PI). The influence of facilitating conditions on purchase intention and use behavior became significant when users had experience with electric vehicles, which appeared in many existing studies on adopting electric vehicles in UK and Sweden (Langbroek et al., 2016; Serradilla et al., 2017). The charging facility was a key factor affecting the purchase intention of electric vehicles. Graham-Rowe et al. (2012) Berkeley et al. (2018) confirmed. Lack of maintenance and repair service was spotted. Participates concerned the necessary resources of battery electric vehicle such as charging station and service center. Electric cars are a new technology in Thailand, so the facilities have limited especially charging station. It is necessary to satisfy as much charging demand as possible with a limited number of charging stations and to develop charging facility that respond the demand of users. Most of participates had no experience in using battery electric vehicles. For price value, it is a key concern for car drivers, which determines their decision to adopt electric cars (Bjerkan et al., 2016). Purchase price is the most reported barrier to adoption BEVs (Graham-Rowe et al., 2012; Axsen et al., 2013; She et al., 2017; Berkeley et al., 2018 and Noel et al., 2020). The price of electric cars is higher than that of combustion cars at present. BEVs were few brands and expensive so small group can afford them. If people prefer it, they will buy it whose price is double another one (Levrini & Jeffman dos

Santos, 2021). The government has plan and implement measures to subsidies or discount car price for attracting the purchase of electric cars. The incentive policies including purchasing subsidies, convenience measures and charging facilities have an important factor in purchase intention and use behavior of using electric vehicle (Wang et al., 2017). The consumers chose EVs mainly because economic incentives which can support people to save money such as tax credit, subsidies, exemption car tax (Bjerkan et al., 2016; Liao et al., 2017). In previous studies, government supports were found that financial and non-financial policies positively affected EV adoption intention (Bjerkan et al., 2016; Lieven, 2015; Wang et al., 2017). The Thai government has developed incentives to promote the use of electric cars, but the policy measures are unstable. People become uncertain, even if the same incentive policies will differ to their different psychological perceptions. Clear policies of government should help lead to support and widespread adoption EVs (Kim et al., 2018).

As our findings show, the effect of some demographic variables which is consistent with purchase behavior of battery electric vehicles: age, education, occupation, income, and accommodation province were significant difference in purchase intention and use behavior. The results suggested a positive association between this factor and purchase intention. For age, people group 2: 26-33 years old and group 3: 34-41 years old were more willing to pay for environmental concern and policy measures. Group 3: 34-41 years old and group 4: 42-49 years old were more willing to pay for social influence and environmental concern. Group 3: 34-41 years old and group 5: 50 years old and over, group 4: 42-49 years old and group 5: 50 years old and over were more willing to pay for performance expectancy. For education, people graduated bachelor's degree and master's degree were more willing to pay for hedonic motivation. For occupation, government officer/employees and private company employees were more willing to pay for effort expectancy. For income, 15001-25,000 baht and 25,001-35,000 baht were more willing to pay for performance expectancy, effort expectancy, and hedonic motivation. 25,001-35,000 baht and 35,001-45,000 baht were more willing to pay for performance expectancy. For accommodation province, bangkok and nonthaburi were more willing to pay for

performance expectancy, effort expectancy and social influence. Moreover, the results suggested a positive association between this factor and use behavior. For age, people group 2: 26-33 years old and group 5: 50 years old and over, group 4: 42-49 years old and group 5: 50 years old were more willing to pay for policy measures. For occupation, government officer/employees and private company employees were more willing to pay for facilitating conditions and purchase intention. Adopting battery electric cars was supported by drivers from different demographic have the different perception.

Practically, the government, car manufacturers and the private sector should raise awareness of the importance of battery electric cars, such as environmental impact, reducing energy use. Car manufactures should speed up the development of electric cars to improve their performance, reduce costs, supply services, and advertise their cars. Furthermore, the government should measure monetary and non-monetary policies of electric cars to promote consumers' purchasing intention and actual behavior as well as make overall plan for charging resources and stations to raise the consumption potential of battery electric cars in the future.

Policy measures between demand side and supply side have been analyzed as previously mentioned. They were separated into monetary and non-monetary policy measures (Lieven, 2015; Zhu et al., 2016). The researcher would like to summarize the policy measures as shown in Table 4.27. Government incentives and regulations can help reduce barriers, stimulate adoption BEV. Participants paid attention to monetary policy measures. Jenn et al. (2020) confirmed this issue (Jenn et al., 2020). Previous researches found monetary issues especially purchase cost reduction to be the strongest incentive in promoting BEV adoption such as Norway and Denmark (Bakker & Jacob Trip, 2013; Bjerkan et al., 2016). They chose the first priority in exemption of car tax as a policy measure that should be implemented urgently. Both demand and supply side have the same opinion about car tax. Car tax affects car price. Nowadays, Electric cars are quite expensive in Thailand. Subsidies or Discount car price is a policy measure that Thai people are interests in BEVs. Moreover, increase the tax on car emissions and electric car privileges should be

considered as policy measures to support BEV adoption in Thailand. Example of electric car privileges were free charging fee, reduce or free toll fee, reduce or free parking fee and fast lane (Bjerkan et al., 2016; Brückmann & Bernauer, 2020; Hardman, 2019; Kester et al., 2018; Sierzchula et al., 2014; Zhuge & Shao, 2019). China and Japan have production support for the industrial and infrastructure, Europe and South Korea have supporting measures to give privileges for electric cars (Figenbaum et al., 2014; Helveston et al., 2015; Krupa et al., 2014; Lieven, 2015; Nandanpawar, 2017) i.e. Paris (FR) and Milan (IT) have free parking. People thought about non-monetary policy measures that support together with monetary policy measures. There are 6 non-monetary policy measures, namely defines a limited environmental city area, law, and regulation enforcement (combustion cars, infrastructure, waste), increase charging stations, build awareness and understanding BEV, integrate between departments and support research and development about EV technology. Many countries define a limited environmental city area especially Europe and England i.e. Berlin (GER) and London (UK) have low emission zone as well as combustion car pay high parking fees in this zone. Law and regulation enforcement was necessary to prepare for the introduction of BEVs like Norway announced the ban of combustion vehicles by 2025 while other European countries aim for a ban in 2030 (Haustein et al., 2021). It will help management of car user and manufacturer. The increase of charging station is sufficient for the increasing number of EV users. Government should support of public and private infrastructure: subsidy or tax rebate i.e. Amsterdam (NL), Oslo (NO), Copenhagen (DK), and Paris (FR). The most effective in promoting EVs and reducing CO_2 emission is supported infrastructure investments (Ledna et al., 2022). Build awareness and understanding BEV is the basic thing that supply side mentioned because most people still lack knowledge and understanding about BEVs. Berkeley et al. (2018) showed that people belief in EVs are unreliable technology. One problem in Thailand is the lack of integration between departments, making it a hindrance in its implementation. EV are a new technology so Thailand must support research and development both in terms of personnel and techniques to be proficient to support in this regard.

Table 4.27 *summary of policy measures*

Policy measures	**Demand side**	**Supply side**	**Countries**
Monetary	Exemption of car tax	Exemption of car tax	- Purchase cost reduction is the strongest incentive in promoting BEV adoption such as Norway and Denmark (Bakker & Jacob Trip, 2013; Bjerkan et al., 2016). - Europe and South Korea have supporting measures to give privileges for electric cars (Figenbaum et al.,2014; Krupa et al.,2014; Helveston et al.,2015; Lieven,2015 and Nandanpawar, 2017) i.e. Paris (FR) and Milan (IT) have free parking.
	Subsidies or Discount car price	Subsidies or Discount car price	
	Increase the tax on car emissions	Increase the tax on car emissions	
	Free charging fee	Electric car privileges	
	Reduce or free toll fee		
	Reduce or free parking fee		
Non-monetary	Defines a limited environmental city area	Defines a limited environmental city area	- Many countries define a limited environmental city area especially Europe and England i.e. Berlin (GER) and London (UK) have low emission zone as well as combustion car pay high parking fees in this zone. - Norway announced the ban of combustion vehicles by 2025 while other European countries aim for a ban in 2030 (Haustein et al., 2021). - Increasing charging stations • subsidy for public charging infrastructure like Amsterdam (NL) and Oslo (NO). • Tax rebate like Copenhagen (DK) and Paris (FR)
	Defines not to use combustion cars in the future	Law and regulation enforcement	
	defines EV law and regulation about infrastructure and waste		
	Increase charging stations	Increase charging stations	
	-	Build awareness and understanding BEV	
	Integrate between departments	Integrate between departments	
	Support research and development about EV technology	-	

Chapter 5
CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

Battery electric car adoption in Thailand has not been thoroughly investigated in the previous literature. To bridge the gap, this research studied current situation of EV cars, characterized factors using the expanded UTUAT model, and found the effective policy to stimulate EV adoption in Thailand. Data collected from demand side and supply side. The findings showed that current situation of EV cars in Thailand including barriers and contributing factors of adoption of BEV cars, identify factors affecting consumer purchasing behavior of BEV cars in Thailand including propose policy recommendations to stimulate BEV adoption in Thailand.

Results on supply side found Thailand is actively promoting the use of battery electric cars in the present. By starting to show clearer on the policy measures to stimulate domestic demand and manufacturing industry. There are additional measures to support domestic EV production including exemption of import tariffs for parts imported during 2022 – 2025, allowing manufacturers to count the value of imported battery cells towards domestic production costs for the calculation of domestically added value at no more than 15% of the ex-factory price. Moreover, the National Electric Vehicle Policy Committee established sub-committees in all 4 areas: EV and EV Parts Manufacturing Industry Promotion, Infrastructure and Battery Development, EV Promotion Effects on Fossil Fuel and Greenhouse Gases and EV Use Promotion in accordance with the context of Thailand. The research analyzed barrier issues in 5 terms: cars (prices/ range of BEV/ charging time), infrastructure (charging stations/ preparations), motorists (lack of understanding about BEVs/ lack of knowledge about new technology), government policy, and economic loss and 9 factor support issues: tax measure, infrastructure to support BEVs, lower expenses for consumers, benefits for consumers, longer ranges and shorter charging time, lowering prices, promotion of BEVs through various channels, stricter international standards on pollution, and environmental impacts and health problems.

In order to identify factors affecting consumer purchasing behavior of BEV cars in Thailand, this study collected the data from 403 respondents: 395 combustion cars group and 8 electric cars group, living in bangkok and vicinity of Thailand and pay attention to BEV cars. This study characterized factors using the expanded UTAUT model by adding policy measures, hedonic motivation, price value, and environmental concerns. The sample size of electric cars group was too small, so the value of measurement model evaluation did not meet the criteria. The research was analyzed only combustion cars group. The results showed that the research model had good explanatory power. Performance expectancy, effort expectancy, social influence, hedonic motivation, and environmental concern were significant factors of purchase intention. Purchase intention was significant factors of use behavior. On the contrary, facilitating conditions, price value, and policy measures were not found to have a significant effect on purchase intention. Environmental concern and policy measures were not found to have a significant effect on use behavior. Thai drivers expect high performance, the availability of charging facilities, ease and convenience of use, safety, cost savings, environmental protection, and enjoyment when using battery electric cars.

The limited distance and charging stations are significant disadvantages of using battery electric cars. In addition, the prices of battery electric vehicles and their parts are still much higher than those of vehicles with engines. This is a solid barrier to motivating consumers to use battery electric vehicles. Purchase intention was reflected by respondents' actual behavior towards battery electric cars. Moreover, facilitating conditions is not a significant factor in use behavior. The impact of performance expectancy, social influence, environmental concern, policy measures on purchase intention and policy measures on use behavior was moderated by age. Moreover, the impact of hedonic motivation on purchase intention was moderated by education. The impact of effort expectancy on purchase intention and facilitation conditions, purchase intention on use behavior was moderated by occupation. The impact of performance expectancy, effort expectancy, hedonic motivation on purchase intention was moderated by income including performance expectancy, effort expectancy, social influence was moderated by accommodation province.

Policy measures are necessary to attract more users, including the exemption of car tax, subsidy policies, and free charging and tolls. The government must develop necessary laws and regulations for electric cars and facilities. Moreover, relevant organizations in the public and private sectors should invest more in electric vehicle studies and research and development. Examples include how the efficiency of battery electric vehicles can be improved, how to use battery electric vehicles within organizations, and how to make preparations to manage charging stations and prepare facilities to support EVs. In fact, the perception of this technology is constantly changing over time. These changes can possibly lead to different conclusions.

5.2 Policy Recommendations

EV promotion would require determination and a clear-cut policy from the government. In Thailand, there is no clear policy to support the use and production of electric vehicles. Agencies working with the sector have not collaborated to give tangible support for EV promotion. The findings of this study can offer many practical benefits for adoption BEV and contribute to an understanding of drivers. We can design our policymaking institutions and measures to more effectively. Policy measures have separated into 2 stages as follows.

5.2.1. Short term

The prices of EVs and their parts are still much higher than those of vehicles with engines. This is a strong barrier against motivating consumers to use EVs. Firstly, government have to reduce car price as the existing policies on purchase subsidy or tax measure for BEVs. This issued by Ministry of Finance of Thailand. In present, they have initiated car price less or equal two million baht, subsidy 70,000 – 150,000 baht depend on battery size. For example, Japan provided subsidies in the amount of 7,800 USD for the difference in price of EVs and combustion cars, UK provided subsidies in the amount of 6,300 USD to buy BEVs, Sweden refunded 4,400 USD for private car released less than 50 grams per kilometer, France refunded 7,100 USD for private car (BEV) released less than 20 grams per kilometer. Moreover, exemption of import tax can reduce car price. This issued by Ministry of Industry, Thailand Board of Investment (BOI), Ministry of Finance, Ministry of Commerce,

Ministry of Foreign Affairs. They have initiated the first stage: car price less or equal two million baht, tariff reduced 40%, excise tax reduced from 8 % to 2%, as well as car price more than two million baht, tariff reduced 20%. The middle stage: car price less or equal two million baht, tariff BEV parts 0%, excise tax reduced from 8 % to 2%, as well as car price more than two million baht, tariff BEV parts 0%. For example, China reduced excise tax and acquisition tax in the amount of 6,000-10,000 USD, Norway: purchase tax exemption in the amount of 12,000 USD, Portugal: car tax exemption 1,400 USD. These policies are promoting BEV sales.

Secondly, the Electricity Generating Authority of Thailand, the Metropolitan Electricity Authority, and the Provincial Electricity Authority, Ministry of Energy, Ministry of Finance, and private sector's companies. they expanded public and private charging stations using local and foreign technology. The most effective in promoting EVs and reducing CO_2 emission is supported infrastructure investments (Ledna et al., 2022). Government should support of public and private infrastructure: subsidy or tax rebate for infrastructure investment i.e. Amsterdam (NL), Oslo (NO), Copenhagen (DK), and Paris (FR).

Thirdly, most people are still quite unfamiliar with BEVs and have never had the experience of driving a BEV. Consequently, there is little knowledge about BEVs, technology, charging facilities, and benefits. The government, car manufacturers and private sector should raise awareness of the importance of battery electric cars' benefits, such as environmental impact, reduce energy expenditure. This issued by Ministry of Energy, Ministry of Industry, Office of the Prime Minister, Electricity Generating Authority of Thailand, Metropolitan Electricity Authority, Provincial Electricity Authority have to provide information on various channels such as social media, website and people can ask about it.

Fourthly, electric car privileges were free charging fee, reduce or free toll fee, reduce or free parking fee and fast lane (Bjerkan et al., 2016; Brückmann & Bernauer, 2020; Hardman, 2019; Kester et al., 2018; Sierzchula et al., 2014; Zhuge & Shao, 2019). This issued by Ministry of Energy, Ministry of Finance, Ministry of Transport, Electricity Generating Authority of Thailand, Metropolitan Electricity Authority, Provincial Electricity Authority, Ministry of Interior, and Bangkok metropolitan

administration. South Korea, France, Italy, Hungary, Portugal, and Norway have supporting measures to give privileges for electric cars (Figenbaum et al.,2014; Krupa et al.,2014; Helveston et al.,2015; Lieven,2015 and Nandanpawar, 2017). In case of Thailand, they regulated only charging fee of the Electricity Generating Authority of Thailand (EGAT), the Provincial Electricity Authority (PEA) and the Metropolitan Electricity Authority (MEA), which had offered a low-priority rate of 2.63 baht/unit any time of the day for areas in Bangkok. For provincial areas, the off-peak (from 10 p.m. – 9 a.m.) rate of 4.15 baht per unit and the peak-period (9 a.m. – 10 p.m.) rate of 7.15 baht per unit were offered. However, the electricity rates charged by charging stations were not regulated. They charged 6 – 8 baht per unit.

Finally, the law and regulations enforcement issued by Department of Land Transport under Ministry of Transport and Ministry of Natural Resources and Environment in use are not suitable for battery electric vehicles. For example, the law and regulations of the department specify the size of the motor and the minimum speed of battery electric vehicles. Also, there are no standards for safety and products related to battery electric vehicles. For example, there are no standards for BEVs, batteries, disposal, charging systems and standards. Nor are there standards for management of used EV batteries. The government is also advised to revise laws and regulations in line with international standards. Battery disposal is more environmentally damaging than the combustion vehicle and concerns battery degradation (Axsen et al., 2013; Berkeley et al., 2018; Noel et al., 2020). Pollution Control Department under Ministry of Natural Resources and Environment had guidelines for defining electric vehicle battery products in the Waste Electrical Appliances and Equipment Management Act. Electric cars (not more than 7 passenger seats) are regulated by Motor Vehicle Act (1979) in present. Moreover, Department of Land Transport prepare increasing the tax on car emission in the future.

All of these have initiated some plans and projects to support the use of electric vehicles, but these are still in the beginning stages and are not comprehensive.

5.2.2. Long term

Firstly, the limited distance and charging stations are significant disadvantages of using battery electric cars. Organizations in the public and private sectors: the Metropolitan Electricity Authority, the Provincial Electricity Authority and the Ministry of Higher Education, Science, Research, and Innovation, Thailand Automotive Institute, Electric Vehicle Association of Thailand have conducted studies and R&D work and launched plans and projects that provide research grants to educational and research institutions to study how to improve the efficiency of BEVs, how to make preparations to manage charging stations and prepare facilities to support BEVs that fit with each region's potential are also being conducted. The results of these studies or projects will be used to prepare for more EV use in the future. Promotion of EV use will help us create a new industry from the manufacturing base of internal combustion vehicles and will lead to more tangible R&D work for EVs. There will be more development of EVs and charging stations as well as more personnel and researchers who are ready to do R&D work on EVs and their paraphernalia such as motors, batteries, various electronic systems, and control programs. However, the government needs to come up with a concrete policy to support EVs, work with the automobile industry and continuously provide grants to researchers.

Secondly, many countries define a limited environmental city area especially Europe and England i.e. Berlin (GER) and London (UK) have low emission zone as well as combustion car pay high parking fees in this zone. In Thailand, it issued by Ministry of Interior, Bangkok metropolitan administration, Ministry of Transport. It is difficult to plan and implement in each province of Thailand especially bangkok. Bangkok area is quite dense and have a lot of traffic.

5.3 Limitations and Future Directions

This study has some limitations that should be explored in further research. Firstly, the number of people using battery electric cars is relatively small. It was difficult to gather real users in this study. For this reason, future research should focus on existing battery electric car users to study the influencing factors of the actual

purchasing behavior of battery electric cars. Secondly, purchase intention and use behavior can be affected by various factors other than those mentioned in this study. Future research should include some new factors, such as use experience, fuel efficiency, and brand loyalty. Thirdly, other parts of Thailand should be examined to expand and potentially reaffirm our findings. Fourthly, most of demand respondents were government officers or employees. Finally, Thai government has issued policy measures for supporting user and car manufacturer in the present so the future study will be affected the results of this study.

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APPENDICES

APPENDIX A

CERTIFICATE OF RESEARCH APPROVAL

Office of the Research Ethics Review Committee for Research Involving Human Subjects:
The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts
Chamchuri 1 Building, Room 114, Phayathai Road, Wang Mai Sub-district,
Pathum Wan District, Bangkok 10330
Telephone number 0 2218 3210-11 E-mail curec2.ch1@chula.ac.th

COA No. 250/2564

Certificate of Research Approval

Research Project Number 205/64 CONSUMER PREFERENCES AND POLICY ASSESSMENT ON ELECTRIC VEHICLE ADOPTION IN THAILAND

Principal Researcher Miss Phasiri Manutworakit

Affiliation Environment Development and Sustainability, Graduate School, Chulalongkorn University

The Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts at Chulalongkorn University, based on Declaration of Helsinki, the Belmont report, CIOMS guidelines and the Principle of the international conference on harmonization – Good clinical practice (ICH-GCP) has approved the execution of the aforementioned research project.

Signature Theraphan Luangthongkum
(Theraphan Luangthongkum, Ph.D.)
Chair

Signature นุชนาถ รังคพันธุ์สุมฤทธิ์
(Nunghatai Rangponsumrit, Ph.D.)
Secretary

Research Project Review Category: Expedited Review

Date of approval: 7 October 2021 **Expiry date:** 6 October 2022

Documents approved by the Committee

1. The research proposal
2. The researcher CV
3. The information sheets for research participants
4. The informed consent form
5. The questionnaire and guide questions for interview

Office of the Research Ethics Review Committee for Research Involving Human Subjects The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts

Protocol No. 205/64
Date of Approval - 7 OCT 2021
Approval Expiry Date - 6 OCT 2022

Conditions

1. *The researcher has acknowledged that it is unethical if he/she collects information for the research before the application for an ethics review has been approved by the Research Ethics Review Committee.*
2. *If the certificate of the research project expires, the research execution must come to a halt. If the researcher wishes to reapply for approval, he/she has to submit an application for a new certificate at least one month in advance, together with a research progress report.*
3. *The researcher must conduct the research strictly in accordance with what is specified in the research project.*
4. *The researcher must **only** use documents that provide information for the research sampling population participants, their letters of consent and the letters inviting them to take part in the research (if any) **that have been endorsed with the seal of the Committee.***
5. *If any seriously untoward incident happens to the place where the research information, which has requested the approval of the Committee, is kept, the researcher must report this to the Committee within five working days.*
6. *If there is any change in the research procedure, the researcher must submit the change for review by the Committee before he/she can continue with his/her research.*
7. *For a research project of less than one year the researcher must submit a report of research termination (AF 03-13) and an abstract of the research outcome within thirty days of the research being completed. For a research project which is a thesis, the researcher must submit an abstract of the research outcome within thirty days of the research being completed. This is to be used as evidence of the termination of the project.*
8. *A research project which has passed the Exemption Review, must observe only the conditions in 1, 6 and 7.*

APPENDIX B
QUESTIONNAIRE

แบบสอบถามผู้ใช้รถยนต์ที่มีความสนใจซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่ (BEV)

ในเขตกรุงเทพมหานครและปริมณฑล

แบบสอบถามนี้เป็นส่วนหนึ่งของการทำวิทยานิพนธ์ของนิสิตปริญญาเอก หลักสูตร สิ่งแวดล้อม การพัฒนา และความยั่งยืน บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย เรื่อง การศึกษาความคิดเห็นผู้บริโภคและการประเมินนโยบายต่อการส่งเสริมการใช้รถยนต์ไฟฟ้าในประเทศไทย โดยแบบเสอบถามนี้มีทั้งหมด 3 ส่วน ได้แก่

ส่วนที่ 1 ข้อมูลส่วนบุคคล

ส่วนที่ 2 ปัจจัยที่มีอิทธิพลต่อการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ (BEV)

ส่วนที่ 3 ข้อเสนอแนะมาตรการนโยบาย

ขอขอบคุณที่ให้ความร่วมมือในการตอบแบบสอบถามนี้ คำตอบของท่านจะเป็นไปด้วยความ สมัครใจและท่านสามารถเลือกตอบได้อย่างอิสระ โดยคำตอบของท่านจะถูกเก็บเป็นความลับและใช้วิเคราะห์สำหรับการศึกษาวิจัยเชิงวิชาการเท่านั้น

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ส่วนที่ 1 ข้อมูลส่วนบุคคล

คำชี้แจง กรุณาใส่เครื่องหมาย √ ในช่อง ☐ ที่ตรงกับคำตอบของท่าน

1. เพศ

☐ ชาย ☐ หญิง

2. อายุ

☐ 18 – 25 ปี ☐ 26 – 33 ปี

☐ 34 – 41 ปี ☐ 42 – 49 ปี

☐ 50 ปีขึ้นไป

เลขที่โครงการ	205/64
วันที่รับรอง	7 ต.ค. 64
วันหมดอายุ	6 ต.ค. 65

3. ระดับการศึกษาสูงสุด

☐ ต่ำกว่าปริญญาตรี ☐ ปริญญาตรีหรือเทียบเท่า

☐ ปริญญาโท ☐ ปริญญาเอก

4. รายได้เฉลี่ยต่อเดือน

☐ ต่ำกว่าหรือเท่ากับ 15,000 บาท ☐ 15,001 – 20,000 บาท

☐ 20,001 – 25,000 บาท ☐ 25,001 – 30,000 บาท

☐ 30,001 – 35,000 บาท ☐ 35,001 บาท ขึ้นไป

5. ท่านพักอาศัยอยู่ในจังหวัดใด

☐ กทม. ☐ นนทบุรี ☐ สมุทรปราการ ☐ นครปฐม

☐ ปทุมธานี ☐ สมุทรสาคร ☐ อื่นๆ โปรดระบุ .....

6. จำนวนรถยนต์ส่วนตัวของท่าน

☐ ไม่มี ☐ 1 คัน ☐ 2 คัน ☐ มากกว่า 2 คัน

7. ท่านมีรถยนต์ไฟฟ้าหรือไม่

☐ ไม่มี ☐ 1 คัน ☐ มากกว่า 1 คัน

ส่วนที่ 2 ปัจจัยที่มีอิทธิพลต่อการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ (BEV)

คำชี้แจง กรุณาประเมินตามความเป็นจริง โดยเลือกระดับคะแนนที่ท่านเห็นว่าตรงกับคำตอบของท่านมากที่สุด โดยมีเกณฑ์ในการพิจารณาแบ่งเป็น 5 ระดับคะแนน ประกอบด้วย

ระดับคะแนน 1 หมายถึง ไม่เห็นด้วยอย่างยิ่ง

ระดับคะแนน 2 หมายถึง ไม่เห็นด้วย

ระดับคะแนน 3 หมายถึง ปานกลาง

ระดับคะแนน 4 หมายถึง เห็นด้วย

ระดับคะแนน 5 หมายถึง เห็นด้วยอย่างยิ่ง

ข้อ	คำถาม	ระดับคะแนน				
		1	2	3	4	5
ความคาดหวังในประสิทธิภาพ						
1	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่มีประโยชน์ต่อการเดินทางของท่าน					
2	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ช่วยให้การเดินทางสะดวกสบายมากขึ้น					

ข้อ	คำถาม	ระดับคะแนน				
		1	2	3	4	5
3	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ช่วยลดค่าใช้จ่ายในการเดินทางต่อเดือน เช่น ค่าเชื้อเพลิง					
4	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่จะช่วยให้ถึงจุดหมายปลายทางได้เร็วขึ้น					
5	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่จะช่วยให้ประหยัดค่าใช้จ่ายในการซ่อมบำรุง					
6	ท่านคิดว่าความปลอดภัยเป็นสิ่งสำคัญของการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่					
7	ระยะทางที่จำกัดถือเป็นข้อเสียที่สำคัญในการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่					
8	ระยะทางที่รถยนต์ไฟฟ้าเดินทางได้เพียงพอต่อความต้องการใช้งานประจำวันของท่าน					
ความคาดหวังในความพยายาม						
9	ท่านคิดว่าการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ง่ายต่อการใช้งาน					
10	ท่านสามารถเรียนรู้การใช้งานรถยนต์ไฟฟ้าแบบแบตเตอรี่ได้ง่ายและรวดเร็ว					
11	ระบบการทำงานของรถยนต์ไฟฟ้าแบบแบตเตอรี่ชัดเจนและสามารถเข้าใจได้					
12	ท่านสามารถสร้างทักษะในการใช้รถพลังงานไฟฟ้าได้ไม่ยาก					
อิทธิพลของสังคม						
13	กระแสสังคมมีอิทธิพลต่อการตัดสินใจซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่มาใช้ในชีวิตประจำวัน					
14	ท่านมักจะสำรวจว่าผู้อื่นซื้อและใช้ผลิตภัณฑ์อะไรหรือไม่เพื่อให้แน่ใจว่าท่านซื้อผลิตภัณฑ์ที่ถูกต้อง					
15	ท่านจะตัดสินใจซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่เมื่อเพื่อนและครอบครัวของท่านใช้					
16	การใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่สามารถดึงดูดความสนใจจากผู้อื่นได้มีความสำคัญต่อท่าน					
17	การเป็นเจ้าของรถยนต์ไฟฟ้าแบบแบตเตอรี่ จะทำให้ผู้อื่นมองว่าท่านเป็นผู้นำด้านเทคโนโลยี					

เลขที่โครงการ 205/64
วันที่รับรอง 7 ต.ค. 64
วันหมดอายุ 6 ต.ค. 65

ข้อ	คำถาม	ระดับคะแนน				
		1	2	3	4	5
18	บุคคลที่สำคัญของท่าน เห็นด้วยว่าท่านควรจะเป็นเจ้าของรถยนต์ไฟฟ้าแบบแบตเตอรี่					
สภาพสิ่งอำนวยความสะดวกในการใช้งาน						
19	ท่านคิดว่าการเตรียมพร้อมของโครงสร้างพื้นฐานมีความจำเป็นต่อการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ เช่น จำนวนสถานีชาร์จไฟ, ศูนย์ซ่อมบำรุง ฯลฯ					
20	ท่านมีความรู้ที่จำเป็นสำหรับการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่					
21	ท่านสามารถได้รับความช่วยเหลือจากคนอื่นเมื่อท่านมีปัญหาในการใช้งานรถยนต์ไฟฟ้าแบบแบตเตอรี่					
22	การมีอุปกรณ์ชาร์จรถยนต์ไฟฟ้าที่บ้าน ทำให้สะดวกต่อการชาร์จไฟในตอนกลางคืน					
23	การมีศูนย์บริการรถยนต์ไฟฟ้าทั่วประเทศ ทำให้ท่านไม่กังวลเกี่ยวกับปัญหาในการใช้งานรถยนต์ไฟฟ้า					
24	การรับประกันแบตเตอรี่ 10 ปี หรือรับประกันภายในระยะทาง 150,000 กิโลเมตร ทำให้ท่านไม่กังวลเกี่ยวกับปัญหาในการใช้งานรถยนต์ไฟฟ้า					
25	ท่านไม่กังวลเกี่ยวกับเวลาในการชาร์จไฟฟ้าที่นานกว่าเติมน้ำมัน					
แรงจูงใจด้านความบันเทิง						
26	การขับรถยนต์ไฟฟ้าแบบแบตเตอรี่เป็นสิ่งที่สนุกสนาน และเพลิดเพลิน					
27	อัตราเร่งและความเร็วสูงสุดเป็นแรงจูงใจให้สนุกกับการขับรถยนต์ไฟฟ้าแบบแบตเตอรี่					
28	ท่านพอใจในระยะทางที่รถยนต์ไฟฟ้าแบบแบตเตอรี่เดินทางได้					
29	ท่านรู้สึกเดินทางด้วยรถยนต์ไฟฟ้าแบบแบตเตอรี่ได้อย่างอิสระ แม้รถยนต์ไฟฟ้าวิ่งได้ระยะทางที่จำกัด					
มูลค่าราคา						
30	ราคาของรถยนต์ไฟฟ้าเป็นสิ่งสำคัญในการเลือกซื้อรถยนต์ไฟฟ้า					
31	ปัจจุบันรถยนต์ไฟฟ้าแบบแบตเตอรี่มีราคาสมเหตุสมผล					
32	รถยนต์ไฟฟ้าแบบแบตเตอรี่มีคุณค่าคุ้มกับเงินที่จ่ายไป					
33	ปัจจุบันราคาของรถยนต์ไฟฟ้าเป็นราคาที่ยอมรับได้					

เลขที่โครงการ 205/64

วันที่รับรอง 7 ต.ค. 64

วันหมดอายุ 6 ต.ค. 65

ข้อ	คำถาม	ระดับคะแนน				
		1	2	3	4	5
ความกังวลด้านสิ่งแวดล้อม						
34	ท่านต้องการซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่เพราะวิกฤติปัญหามลพิษทางอากาศ					
35	รถยนต์ไฟฟ้าแบบแบตเตอรี่จะช่วยรักษาสิ่งแวดล้อมให้กับคนรุ่นหลังได้					
36	รถยนต์ไฟฟ้าแบบแบตเตอรี่ก่อให้เกิดมลพิษทางสิ่งแวดล้อมที่น้อยลง					
37	ท่านให้ความสำคัญเกี่ยวกับการอนุรักษ์พลังงานและการอนุรักษ์สิ่งแวดล้อม					
38	ท่านมีความตระหนักถึงภารกิจในการอนุรักษ์พลังงานและการอนุรักษ์สิ่งแวดล้อม					
มาตรการนโยบาย						
39	ท่านเห็นด้วยว่ามาตรการนโยบายด้านการเงินเป็นแรงจูงใจให้คนสนใจใช้รถยนต์ไฟฟ้า เช่น ยกเว้นภาษีรถยนต์ไฟฟ้า, เงินอุดหนุนสำหรับซื้อรถยนต์ไฟฟ้า, ลดค่าจอดรถสำหรับรถยนต์ไฟฟ้า, ฟรีค่าธรรมเนียมชาร์จไฟ, มีส่วนลดค่าทางด่วน เป็นต้น					
40	ท่านเห็นด้วยว่ามาตรการนโยบายด้านอื่นเป็นแรงจูงใจให้คนสนใจใช้รถยนต์ไฟฟ้า เช่น รถยนต์ไฟฟ้าสามารถวิ่งในช่องจราจรพิเศษ, ท้ายทะเบียนสำหรับรถยนต์ไฟฟ้า เป็นต้น					
41	ภาครัฐควรประกาศมาตรการเกี่ยวกับการให้เงินช่วยเหลือในการซื้อรถยนต์ไฟฟ้า					
42	ภาครัฐควรมีมาตรการยกเว้นภาษี เช่น ภาษีในการขาย และภาษีสรรพสามิตสำหรับรถยนต์ไฟฟ้า					
43	ภาครัฐควรให้สิทธิพิเศษกับผู้ใช้รถยนต์ไฟฟ้า เช่น ส่วนลดค่าทางด่วน ที่จอดรถสำหรับรถยนต์ไฟฟ้า ช่องจราจรพิเศษ					
44	ภาครัฐควรให้เงินช่วยเหลือในการสร้างสถานีชาร์จรถยนต์ไฟฟ้าให้ครอบคลุมทั่วประเทศ					
ความตั้งใจซื้อ						
45	ถ้าท่านมีรถยนต์ไฟฟ้าแบบแบตเตอรี่ ท่านเลือกที่จะขับมากกว่ารถยนต์ปกติ					
46	ถ้าท่านมีโอกาส ท่านตั้งใจที่จะซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่					

ข้อ	คำถาม	ระดับคะแนน				
		1	2	3	4	5
47	ถ้าท่านจะเปลี่ยนรถของท่าน ท่านจะพิจารณารถยนต์ไฟฟ้าแบบแบตเตอรี่เป็นอันดับแรก					
48	ท่านจะแนะนำผู้อื่นให้ซื้อรถยนต์ไฟฟ้าแบบแบตเตอรี่					
49	ท่านเคยศึกษาข้อมูลและวางแผนที่จะหารถพลังงานไฟฟ้าแบบแบตเตอรี่มาใช้ในอนาคต					
50	รถคันต่อไปที่ท่านจะซื้อภายใน 3 ปีนี้ จะเป็นรถพลังงานไฟฟ้าแบบแบตเตอรี่					
พฤติกรรมการใช้						
51	ท่านเลือกที่จะใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ในอนาคต					

ส่วนที่ 3 ข้อเสนอแนะมาตรการนโยบาย

ท่านคิดว่าประเทศไทยควรมีมาตรการนโยบายอย่างไรที่จะช่วยสนับสนุนการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่

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APPENDIX C

IN-DEPTH INTERVIEW QUESTIONS

แบบสัมภาษณ์สถานการณ์เชิงลึกและมาตรการนโยบายที่ส่งเสริมการใช้

รถยนต์ไฟฟ้าแบบแบตเตอรี่ (BEV)

แบบสัมภาษณ์นี้เป็นส่วนหนึ่งของการทำวิทยานิพนธ์ของนิสิตปริญญาเอก หลักสูตร สิ่งแวดล้อม การพัฒนา และความยั่งยืน บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย เรื่อง การศึกษาความคิดเห็นผู้บริโภคและการประเมินนโยบายต่อการส่งเสริมการใช้รถยนต์ไฟฟ้าในประเทศไทย โดยแบบสอบถามนี้มีทั้งหมด 2 ส่วน ได้แก่

ส่วนที่ 1 ข้อมูลเกี่ยวกับผู้ให้สัมภาษณ์

ส่วนที่ 2 คำถามเชิงลึก ประกอบด้วย 5 หัวข้อ ดังนี้

1. สถานการณ์ปัจจุบันของรถยนต์ไฟฟ้าแบบแบตเตอรี่หรือ BEV ของประเทศไทย
2. มิติด้านสังคม
3. มิติด้านเศรษฐกิจ
4. มิติด้านสิ่งแวดล้อม
5. การประเมินนโยบายภาครัฐที่ใช้สนับสนุนรถยนต์ไฟฟ้าแบบแบตเตอรี่

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ส่วนที่ 1 ข้อมูลเกี่ยวกับผู้ให้สัมภาษณ์

1. ประสบการณ์ในการทำงานที่เกี่ยวข้องด้านนโยบาย .....ปี
2. จากข้อ 1 ขอให้ท่านยกตัวอย่างนโยบายที่ได้ร่วมดำเนินการในหน่วยงานของท่านจนประสบความสำเร็จตามเป้าหมายที่วางไว้

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ส่วนที่ 2 คำถามเชิงลึก จำนวน 7 ข้อ

1. สถานการณ์ปัจจุบันของรถยนต์ไฟฟ้าแบบแบตเตอรี่ในประเทศไทยเป็นอย่างไร

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2. ในความคิดของท่าน ปัจจัยที่มีความสำคัญในการสนับสนุนการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ในประเทศไทยคืออะไร พร้อมเหตุผล

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3. ในความคิดของท่าน ปัญหาและอุปสรรคในการปรับเปลี่ยนพฤติกรรมของคนไทยในการใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่คืออะไร

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4. ในความคิดของท่าน ปัจจัยที่กระตุ้นและจูงใจให้คนไทยปรับเปลี่ยนพฤติกรรมมาใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่คืออะไร

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5. ในความคิดของท่าน การใช้รถยนต์ไฟฟ้าแบบแบตเตอรี่ที่เพิ่มขึ้น ส่งผลกระทบทั้งทางด้านบวกและด้านลบในด้านเศรษฐกิจกับประเทศไทยยังไง

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6. หน่วยงานของท่านเกี่ยวข้องกับนโยบายสนับสนุนการใช้รถยนต์ไฟฟ้า เพื่อลดการปล่อยก๊าซเรือนกระจกของประเทศไทย อย่างไร

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7. จากมาตรการนโยบายต่าง ๆ ในการช่วยสนับสนุนใช้รถยนต์ไฟฟ้าที่ใช้ในปัจจุบันจากหน่วยงานภาครัฐและภาคเอกชน

7.1 ปัจจัยที่ทำให้การดำเนินมาตรการนโยบายดังกล่าวมีความสำเร็จคืออะไร

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7.2 ปัญหาและอุปสรรคในการดำเนินมาตรการนโยบายดังกล่าวมีอะไรบ้าง และหน่วยงานของท่านมีวิธีแก้ไขอย่างไร

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7.3 ข้อเสนอแนะที่อยากให้มีการปรับปรุง เพิ่มเติม ทั้งในด้านมาตรการนโยบายและการบังคับใช้ เพื่อส่งเสริมการใช้รถยนต์ไฟฟ้าในประเทศไทยให้มีประสิทธิภาพสูงสุด

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VITA

NAME	Phasiri Manutworakit
DATE OF BIRTH	28 Sep 1986
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	Graduate School Environment, Development and sustainability Program
HOME ADDRESS	293/584 moobansintrani2 soi1/1 ramintra119 road minburi bangkok 10510
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