Conference Proceedings

THE 17th ASIALICS &
THE 3rd SEAC-STIPM CONFERENCE

SCIENCE, TECHNOLOGY AND INNOVATION POLICY
FOR THE SUSTAINABLE DEVELOPMENT GOALS
(STI POLICY FOR SDGs)

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(Virtual Conference)

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3 November 2021

"INDUSTRY 4.0 AS THE EMERGING CHALLENGE FOR STI POLICIES"

08.00 - 09.00 (GMT+7)	**REGISTRATION**
09.00 - 09.30	**Welcoming Remark** • Dr. Dudi Hidayat, Chair of ASIALICS Indonesia • Asst. Prof. Dr. Santi Charoenpornpattana, Chair of SEAC-STIPM Thailand **Opening Remark** • Dr. Laksana Tri Handoko, Head of National Research and Innovation Agency (BRIN) (Indonesia) • Assoc. Prof. Dr. Suvit Sae Tia, President of King Mongkut's University of Technology Thonburi (Thailand)
09.30 - 09.55	**Keynote Speech 1** Title: Designing a Collaborative and Innovative Financing of R & D Activities to spur Economic Growth by Dr. Sri Mulyani Indrawati, Minister for Finance of Indonesia
09.55 - 10.20	**Keynote Speech 2** Title: Evolution of STI policy paradigms toward creating sustainable economic development by Prof. Wang Yi, Vice president Institutes of Science and Development Chinese Academy of Sciences / Environmental & Energy Policy, PRC
10.20 - 10.45	**Keynote Speech 3** Title: Frugal and leapfrogging strategy for developing countries in the era industry 4.0: application of Koreans companies' learning approach by Prof. Lim Chaisung, Chaiman, Korea Industry 4.0 Association, South Korea
10.45 - 11.00	**Acknowledgments by Dr. Dudi Hidayat** **STI POLICY FORUM : INDUSTRY 4.0 AS THE EMERGING CHALLENGE FOR STI POLICIES**
11.00 – 11.05	**Moderator** Prof. Dr. Patarapong Intarakumnerd, Professor National Graduate Institute for Policy Studies, Japan
11.05 - 11.20	**Panelist 1** Prof. Dr. Atsushi Sunami, President Ocean Policy Research Institute of The Sasakawa Peace Foundation, Japan Title: "TBA"
11.20 - 11.35	**Panelist 2** Prof. Krishnamurthy Ramanathan, Visiting Faculty The Sydney Graduate School of Management of The Western Sydney University, Australia Title: Transitioning to an Industry 4.0 Setting at the Firm Level: Readiness Assessment and Phased Implementation
11.35 - 11.50	**Panelist 3** Dr. Chia-Meng Chen, Researcher Industrial Technology Research Institute (ITRI), Taiwan Title: How Taiwan has implemented Industry 4.0
11.50 - 12.30	**Q&A Session**
12.30 - 13.30	**Lunch Break**
13.30 - 17.30	**Paper Presentation Session** Theme 1 Chair : Prof. Patarapong Intarakumnerd (Thailand) Theme 2 Chair : Dr. Dudi Hidayat (Indonesia)

4 November 2021

"STI POLICIES FOR SUSTAINABILITY DEVELOPMENT GOALS"

08.00 - 09.00 (GMT+7)	**REGISTRATION**
09.00 - 09.10	**Welcoming the Keynotes, panelists and all Participants** by Asst. Prof. Dr. Santi Charoenpornpattana
09.10 - 09.35	**Keynote Speech 1** Title: Science, Technology and Innovation (STI) Policies for Sustainability Development Goals (SDGs) by Prof. Dr. Michiko Iizuka, Professor, National Graduate Institute for Policy Studies, Japan
09.35 - 10.00	**Keynote Speech 2** Title: International Efforts on Science, Technology and Innovation (STI) Policies for Sustainability Development Goals (SDGs) by Dr. Marta Pérez Cusó, Economic Affairs Officer, United Nations ESCAP
10.00 - 10.10	**Acknowledgments by Asst.Prof.Dr.Santi Charoenpornpattana** **STI POLICY FORUM : SHARING OF NATIONAL EXPERIENCES IN IMPLEMENTING STI POLICIES FOR SDGS**
10.15 - 10.20	**Moderator** Asst. Prof. Dr. Santi Charoenpornpattana, Director Science Technology and Innovation Policy Institute, Thailand
10.20 - 10.35	**Panelist 1** Dr. Dudi Hidayat, Director, Directorate of Research Technology and Innovation Policy Formulation, National Research and Innovation Agency Title: Indonesian experiences on STI's policy for SDGs
10.35 – 10.50	**Panelist 2** Assoc. Prof. Dr. Zeeda Fatimah Binti Mohamad University of Malaya, Malaysia Title: STI Policy for Sustainable Development: Experience from Malaysia
10.50 - 11.05	**Panelist 3** Dr. Francis Mark A. Quimba Philippine Institute for Development Studies, the Philippines Title: "TBA"
11.05 - 11.20	**Panelist 4** Asst. Prof. Apiwat Ratanawaraha Chulalongkorn University, Thailand Title: Equity aspects of SDGs and the implications for STI Policy
11.20 - 11.35	**Panelist 5** Dr. Bach Tan Sinh Vietnam Institute of Science, Technology and Innovation Title: Vietnam experience in implementing STI policies for SDG in the context of uncertainties
11.35 - 12.30	**Q&A Session**
12.30 - 13.30	**Lunch Break**
13.30 - 17.30	**Paper Presentation Session** Theme 1 Chair : Dr. Shadiya Baqutayan Saleh (Malaysia) Theme 2 Chair : Dr. Marcellino Pandin (Indonesia)

5 November 2021

"STI POLICIES AND MANAGEMENT AFTER COVID-19 PANDEMIC"

08.00 - 09.00 (GMT+7)	**REGISTRATION**
09.00 - 09.10	**Welcoming the Keynotes, panelists and all Participants** by Dr. Dudi Hidayat
09.10 - 09.35	**Keynote Speech 1** Title: Evidence Based STI Policy and Management Beyond Pandemic Prof. Satryo Soemantri Brodjonegoro, President, The Indonesian Academy of Sciences
09.35 - 10.00	**Keynote Speech 2** Title: New STI policies and practices after Covid-19 pandemic Dr. Pun-Arj Chairatana, Director, National Innovation Agency, Thailand
10.00 - 10.10	**Acknowledgments by Asst.Prof.Dr.Santi Charoenpornpattana** **STI POLICY FORUM : ASEAN STI POLICIES AND MANAGEMENT AFTER COVID-19**
10.15 - 10.20	**Moderator** Asst. Prof. Dr. Santi Charoenpornpattana, Director Science Technology and Innovation Policy Institute, Thailand
10.20 - 10.40	**Panelist 1** Prof. Erman Aminullah, Senior Researcher Research Center for Economics National Agency for Research and Innovation, Indonesia Title: Exploring STI strategy for long-term economic growth in the post-Covid-19 Pandemic
10.40 – 11.00	**Panelist 2** Prof. Dr. Patarapong Intarakumnerd, Professor National Graduate Institute for Policy Studies (Japan) Title: ASEAN's policies to revitalize businesses and stimulate innovation in response to Covid 19
11.00 - 11.20	**Panelist 3** Prof. Zamri Mohamed PERDANA Centre for STI Policy, Universiti Teknologi Malaysia (Malaysia) Title: STI initiatives for post-COVID-19
11.20 - 12.30	**Q&A Session**
12.30 - 13.30	**Lunch Break**
13.30 - 16.30	**Paper Presentation Session** Theme 1 Chair : Dr. Bach Tan Sinh (Vietnam) Theme 2 Chair : Assoc. Prof. Dr. Nor Ashikin BT Mohamed Yusof (Malaysia)
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MODEL FOR THE INITIAL MANAGEMENT OF TECHNOLOGY AND THE DEVELOPMENT OF SERVICES POLICY: CASE STUDY OF ELECTRIC VEHICLES

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Abstract

The electric vehicle industries in several Asian countries are included in an emerging category. These industries generally have the characteristics of being driven by new technologies, market uncertainty, and weak industrialization systems. Investigating the characteristics and factors that influence people's intention to buy electric vehicles (EV) is an action of technology management to determine the required customer services. This study investigates the factors that influence consumers' intention to purchase an EV using the extended Theory of Planned Behavior (TPB). This paper uses the Meta-Analytic Structural Equation Modeling (MASEM) approach and focuses on cases in Asian countries. We conducted a systematic search of the Scopus, Web of Science, and IEEE databases in the last ten years between 2012 – 2021, then prepared the dataset following the PRISMA statement. There are 11 articles included in this study. The paper finds that attitude is the most prominent motivation for Asian customers to buy EVs. This study provides new insights into a model for the initial management and services policy development as consumers in Asian countries face emerging technologies that change new mobility paradigms.

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Keywords: Asian Countries, Electric Vehicles, Initial Technology Management, Meta-Analytic Structural Equation Modelling, Services Provision Policies

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1 INTRODUCTION

Technology management is required to align one's use of technology with one's values and goals' (Tammelin & Alakärppä, 2021). Understanding the motivations that influence the use of technology is useful for planning the services to potential customers to strengthen the market. Likewise, the electric vehicle (EV) market, which is still in its early stages of development, especially in several developing countries in Asia, needs to be managed for good service planning to strengthen the market. The strong EV market is beneficial for strengthening the EV industry in several developing Asian countries and positively impacts environmental friendliness, long-term economic benefits, and the growth of innovative features in the technology.

Many studies using Structural Equation Modeling (SEM) have been carried out to investigate the various motivations influencing consumers' intentions to buy EVs. These studies commonly used a limited number of respondents (less than 500 respondents). Actually, integrating several studies will produce research with a more significant number of respondents. The approach is known as the meta-analytic SEM (MASEM). It is a quantitative research design that systematically assesses previous studies. This method has several advantages, such as being more objective in reviewing previous research, assessing the strength of research evidence, increasing the accuracy of conclusions, resolving the contradictive results among researchers, and generating new hypotheses (Haidich, 2010). The growth of meta-analytic studies (also called a quantitative literature review) using secondary data is remarkable. It is due to the availability of many methodological options, besides having important implications in terms of meta-analytic results and contributing to the theory and application. Presumably, this approach will become more popular as practitioners and researchers seek more cost-effective but credible sources, guidelines and tools for evidence-based research design (Aguinis et al., 2011).

Based on the best of authors' knowledge, research with the MASEM method to measure the factors that encourage potential consumers to purchase EVs is still missing. It is time to integrate the research considering that SEM research on EVs has been carried out since 2013. In order to fill in the gap, this paper aims to apply Meta-Analytic Structural Equation Modelling (MASEM) to identify significant motivations of consumer intention to purchase EVs in several Asian countries. This study focuses on the advanced version of the Theory of Planned Behavior (TPB) on SEM approach-based electric vehicles development, developed over ten years. The TPB is a psychological theory that discusses the relationship between a person's beliefs and behavior. The second objective of this paper is the implementation of the two-stage approach developed by Cheung and Chan (2005) by building a composite correlation matrix based on the path coefficients (β values). This paper used the beta values instead to build a composite correlation matrix, considering that most of the papers on the datasets present this value.

2 THEORETICAL BACKGROUND AND HYPOTHESES

2.1 Theory of Planned Behavior

In the human behavior context, the intention or desire for something influences a person's decision, ultimately resulting in an action. Human behavior designs each activity to achieve particular desires or intentions within a certain period. Theory of Planned Behavior (TPB) is a theory that describes the intention into action developed by Ajzen (1985). In TPB, three interrelated variables perform the intention and become a behavior to achieve what is planned in the intention. These variables are attitude toward the behavior, subjective norm, and perceived behavior control.

In general, attitude is defined as something that is shown by someone as respect for whom people might interact, for example, to organizations and institutions (churches, public housing, and student government). It can also be to a person (a Black person, a fellow student) or minority groups (Blacks, Jews, Catholics) (Ajzen, 1991). Meanwhile, social norms called subjective norms by Ajzen (1991) are social pressures that influence decision-making in carrying out behavior. Normative beliefs about whether most people think in the cultural context about the behavior relate to the individual's decision to engage the behavior (Ajzen, 1985). Next, perceived behavioral control measures the expected process control of individuals when participating in a behavior. It defines a person's perception of the ease or difficulty of performing the behavior of interest. Perceived behavioral control varies across situations and actions, which results in a person having varying perceptions of behavioral control depending on the situation (Ajzen, 1985). Perceived behavior control represents the individual's perception of the difficulty of performing a particular behavior (Kraft et al., 2005). It refers to a customer's perception of the ease or difficulty of performing in purchasing electric vehicles. Depends on the situations and actions individual's perceptions of behavioral, the more resources and opportunities the individual thinks he has, the stronger the perceived behavior control will be (Yan et al., 2019).

The TPB has been used in many behaviors and intentions, including new technology adoption such as electric vehicles. The TPB determines behavioral achievement based on cognitive ability in the electric vehicles purchase intention. The development of TPB in the study of the potential consumers of electric vehicles consists of three fundamental variables of this theory (Ajzen et al., 2011). The adoption of TPB to build a framework for studying the intention to buy electric cars has been carried out in various countries such as China, Taiwan, Malaysia, Hong Kong and Thailand. Table 1 shows the various ways of adopting TPB in electric vehicles purchase intention.

Table 1: TPB adoption in Electric Vehicle Purchase Intention of customers.

Author	Research Aim	TPB adoption	Determinants
Afroz et al. (2015a)	This paper examines whether attitudes towards electric vehicles (ATEVs), subjective norms (SNs) and perceived behavioral control (PBC) have significant associations with consumer purchase intention (PI) and the purchase behavior of environmentally friendly vehicles (EFVs).	The study added components of TPB from two to five in designing and developing a questionnaire. The Study adopted TPB with extension in Attitude variable Two attitudinal variables were considered in this model, namely individual consequences (ICs) and environmental consequences (ECs) adopted from Ramayah et al. (2010).	*Added to the framework* - Environmental consequences (EC) - Individual consequences (IC) *TPB* - Attitude towards EV - Subjective norms (SNs) - Perceived behavior control (PBC) - Purchase intention (PIN) - Purchase behavior (PB)
Afroz et al. (2015b)	To examine how attitudes as measured by environment consequences and individual consequences are related to environmentally responsible purchase intention of electronic vehicles.	In this model, the variables are set in a 'values–attitude–purchase intention' format. Values are represented by self-transcendence (SVN), conservation (CVN) and self-enhancement values (SEVN). While attitudes consist of two dimensions, attitudes towards ECNs and attitude towards ICNs of purchasing an EVs that is represented by PIN.	*Values format*: - Self-transcendence value (SVN) - Conservation values (CVN) - Self-enhancement values (SVEN) *Attitude format*: - Environmental consequences (ECN) - Individual consequences (ICN) *Purchase format*: - Purchase intention (PIN)
Wang et al. (2017)	To investigate the situation in seven Chinese geographical regions and 22 Provinces and to analyze the factors affecting the new energy vehicles (NEV) purchasing intentions of residents.	An extended TPB model is used in this work to account for the willingness of citizens to purchase NEVs in China. The existing theory on consumer behavior provides a support basis for consumer preference research. Measuring consumers' environmental concern and financial benefit consideration which embodies the consumers' attitude in TPB model. Measuring preferential policies which can be regarded as subjective norms; and measuring consumers' perceived infrastructure readiness and vehicles' cruising range, which is in line with perceived control.	*Attitude* - Environmental concern - Financial benefit *Subjective norms* - Policy privilege *Perceived behavior control* - Infrastructure readiness - Cruising range
Ng et al. (2018)	To develop a model to identify relationships between perceived values, green attitudes, normative factors, and self-expressive benefits and purchase intention of EVs	Propose a model integrating attitudinal factors, normative factors and self-control to explain the purchase of electric vehicles (EVs) by consumers. Adopted different theoretical	- Perceived value - Environmental concern - Trust - Personal norms - Self-expressive benefits - Responsive efficacy

Author	Research Aim	TPB adoption	Determinants
		perspectives with which to predict environmental behaviors, including the TPB and the norm-activation model.	- Willingness to pay - Purchase intention
Chen et al. (2019)	To explore the influence of supportive policy, price factor, functional value and service value on consumer purchase intentions of new energy vehicles, based on the theory of customer perceived value. How does Chinese socio-culture (fragile and mianzi) affect consumer behavior in purchasing electric vehicles.	Cognitive behavior adopted from TPB and combining socio-cultural elements in Chinese culture (mianzi and fragile) incorporating socio-culture elements into cognitive behavior models. The Price factor, functional quality, and service quality become customer perceived value which is the basis for intention assessment as an attitude toward behavior.	*Customer perceived value (attitude towards behavior):* - Price factor - Functional quality - Service quality *Socio norms:* - Mianzi - Fragile - Purchase intention
Xu et al. (2019)	This study aims to contribute toward streamlining marketing and planning activities to introduce strategic policies that stimulate the purchase and use of BEVs.	This study considers the nature of human behavior by extending the TPB model to identify its predictors, as well as its non-linear relationship with customers' purchase intention. TPB can be developed by discussing new variables such as environmental performance, price value, non-monetary incentive policy (NMIP) and monetary incentive policy (MIP) measures that influence consumers' purchase intention.	*TPB*: - Attitude - Social norms - Perceived behavior control *Extended TPB variable*: - Environmental performance - Price value - Non-monetary Incentive Policy - Monetary Policy
Yan et al. (2019)	To promote the further development of electric cars in China, this paper based on the TPB theoretical research framework, investigates potential consumers in typical areas of Beijing and collects a large amount of data through the design of paper and electronic questionnaires.	The determinants of TPB have positive and negative attributes. Attitude has positive and negative attributes meanwhile social norms and perceived behavior control variables have just only positive attributes.	*Positive attributes* - Attitude - Subjective norms - Perceived control behavior *Negative attribute* - Attitude
Tu & Yang (2019)	This paper establishes a theoretical framework based on the theory of planned behavior (TPB), technology acceptance model (TAM) and Innovation Diffusion Theory (IDT), and explores the key factors influencing consumers' purchase of electric vehicles. .	Integrating TPB with other theories and dividing the theoretical framework of the factors influencing consumers' intention of purchasing electric vehicles into first-order dimensions (perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influence, external influence, attitude towards behavior, subjective norm, self-control	First order *TAM* - Perceived usefulness - Perceived ease of use *IDT* - Compatibility - Personal innovativeness a Extended TPB (Subjective norm) - Interpersonal influence - External influence*TPB* - Attitude towards behavior

Author	Research Aim	TPB adoption	Determinants
		ability, and behavioral intention) and second-order dimensions (self-efficacy, facilitating conditions, and perceived behavioral control).	- Subjective norm - Behavioral intention Second order - Self-efficacy - Facilitating condition - Perceived behavioral control
Promphat & Deebhijar (2019)	To examine the direct and indirect effects of attitude, external environment, marketing mix, subjective norms, and customer perception on purchase intentions.	The external environment exerts a social forces strong enough to form an attitudinal precursor to purchasing intention (Ajzen, 1991). Marketing mix refers to the multiple processes involved in promoting and selling and augmenting and sustaining the presence of a product. As a tool (Kotler & Keller, 2006)	- External environment - Marketing mix - Customer perception - Attitude - Subjective norms
Huang & Ge (2019)	This study introduced consumer cognitive status, product perception, and incentive policy measures (non-monetary incentive policy measures and monetary incentive policy measures) to build a purchase intention influence mechanism model for EVs	This study adds consumers' cognition status of EVs and related incentive policy measure consumers' perception and evaluation of EV product attributes, and EV-related incentive policy measures based on the TPB. Cognition status refers to consumers' knowledge about EVs and related EV incentive policy measures. Product perception, in this case, refers to consumers' subjective psychological evaluation of specific product attributes of EV To explore the impact of differe types of policy measures on consumers' purchase intention towards EV, divide incentive policy measures into non-monetary incentive policy measures and monetary incentiv policy measures.	- Attitude - Subject norm - Perceived behavioral control - Cognitive status - Purchase intention - Product perception - Non-monetary incentive policy measures - Monetary incentive policy measures
Wang et al. (2021)	Integrates incentive policy perceptions and consumer social attributes into the research model to analyze purchase intention. The model constructs a "perception-attitude-behavior" research framework for analyzing the influence of these factors on consumers' BEV attitudes and purchase intentions.	Built theoretical models based on TPB, and design research frameworks that consider consumer's policy perceptions to discover which policies are effective and why. According to TPB, incentive policies involve actual benefits provided to consumers by the government (Wang et al., 2017)	*Incentive policy perceptions* - Perceptions of financial policies - Perceptions of information provision policies - Perceptions of convenience policies *Consumer social attributes* - Environmental concern - Social norms - Face consciousness - Attitudes towards BEVs - Purchase Intention BEVs

2.2 Hypothesis

Based on the expanded TPB model, the following is a description of this papers' hypothesis.

Attitude (ATT)

Attitude (ATT) is defined as an individual's overall evaluation of participating in a particular behavior. In the TPB framework, this variable has a significant influence on purchase intention. However, based on the SEM test in the previous studies, this variable has a different level of significance. It is reported that attitude is an important variable that affects purchase intention (Afroz et al., 2015b; Huang & Ge, 2019; Tu & Yang, 2019; Wang et al., 2021; Yan et al., 2019). Therefore, this paper makes the following assumption.

H1: Consumer's attitude has a significant and positive effect on their intention topurchase EV

Perceived Behavioral Control (PBC)

Similar to the attitude variable, the variable of Perceived Behavioral Control (PBC) is included in the TPB framework that significantly influences purchase intention. According to Huang and Ge (2019); Xu et al. (2019), this variable was the most crucial variable influencing the purchase intention of EVs. The variable also has a prominent effect on purchasing intention (Afroz et al., 2015b; Yan et al., 2019). Then this study composes an assumption as follow.

H2: Perceived Behavioural Control has a significant and positive effect on their intention to purchase EV

Subject Norm (SN)

It is one of the independent variables with a significant and positive relationship with the strength of belief and motivation in influencing EV purchase intention. Subject norm is also one of the behavioral controls perceived by predictors and consumer confidence in the brand. In Chinese culture, the subject norm is not only influenced buying behavior, but also influences image values, so it is considered a factor to give a good impression in the perception of essential people in their social circle (Xu et al., 2019; Yan et al., 2019). The consumer's subject norm on EV has a significant positive effect on purchase intention. However, EV's personal innovation and consumer's interpersonal influence did not positively impact the subject's norms (Tu & Yang, 2019). Variable subject norm refers to the various processes involved in promoting and selling and adding and maintaining the existence of a product as a tool (Promphat & Deebhijarn, 2019). The subject norm that influences purchase intention is closely related to alternative variables such as fuel efficiency, fuel consumption (convenience of recycling or battery charging), vehicle comfort and budget (Afroz et al., 2015b). Therefore, it is concluded that:

H3: Subject norm has a significant and positive effect on their intention to purchase EV

Perceived Value (PV)

Perceived value is also one of the key factors that positively and significantly affect purchasing EVs. Consumers will tend to make purchases if they feel they can get many benefits from that product, also depending on perceived quality, maintenance services and equipment such as charging stations (Afroz et al., 2015a; Ng et al., 2018; Wang et al., 2021). Several variables that can measure perceived value are demographic variables such as age, gender, education level, income, and car ownership in a household. The level of convenience or difficulty felt by consumers regarding product ownership also greatly influences perceived value (Chen et al., 2019; Huang & Ge, 2019; Promphat & Deebhijarn, 2019; Tu & Yang, 2019). From this discussion, it can be concluded:

H4: Perceived Value has a significant and positive effect on their intention to purchase EV

Environmental Concern (EC)

Environmental concern (EC) is a general understanding and awareness of environmental problems such as temperature changes, air pollution, and the international energy crisis, and the problem of motor vehicle pollution that has become a global problem (Afroz et al., 2015a; Ng et al., 2018). The variable contributes to environmental sustainability, promotes reducing environmental pollution, and is vital to save natural resources (Xu et al., 2019). Environmental concern affects purchase intention positively on BEVs (Wang et al., 2021). Environmental concern is one of the good factors used to promote NEV's purchase (Wang et al., 2017). Overall, the paragraph above concludes that:

H5: Environmental concern has a significant and positive effect on their intention to purchase EV

Incentive policy measures (IPM)

Incentive policy measures (IPM) is a perception of financial incentive policy, Perception of information provision policy, Perception of convenience policy. Which is one of the key factors in influencing the intention to purchase BEV (Wang et al., 2021; Xu et al., 2019). The incentive policy consists of non-monetary incentive policy (NMIP) and monetary incentive police (MIP). Both have a positive effect on BEV attitude and purchase intention. The variable of NMIP is separate allocations of BEVs license plates, abolish traffic restrictions on BEVs, implement the right to use bus lanes. The variable of MIP is implement purchase subsidy for BEVs, increase the allowable loan amounts for purchasing BEVs, implement tax exemption policy for the purchase of BEVs, provide preferential insurance policy for the purchase of BEVs (Chen et al., 2019; Wang et al., 2017; Xu et al., 2019). This explanation concludes that:

H6: Incentive policy measures has a significant and positive effect on their intention to purchase EV

Charging Infrastructure (CI)

Charging infrastructure is a construction that plays an important role in the popularization of electric vehicles, so it is very positive influential on purchase intention (Wang et al., 2017). Charging infrastructure should be provided and supported by the government so that it can be promoted to the private sector (Huang & Ge, 2019). The perfection of NEV charging infrastructure is supported by several variables such as charging stations, battery stations, charging stations and ventilation stations (Wang et al., 2017).

H7: Charging infrastructure measures has a significant and positive effect on their intention to purchase EV

Financial Benefit (FB)

Financial benefit is a consideration for companies to increase savings for consumers to reduce usage costs, such as providing new energy car battery rental, replacement, fast/slow charging, and other services. So that consumers feel they are getting real financial benefits by buying new energy vehicles (Chen et al., 2019). Significantly influences purchase Intention for NEV, it is also a privilege for consumers, and Policies significantly affects Environmental Awareness for its consumers (Wang et al., 2017). The variables that can be used for financial benefits is supportive policy, price factor, functional value/quality, service quality, frugality, concept of "mianzi", psychology concept of

"mianzi" (Chen et al., 2019). From this paragraph the concluded is.

H8: Financial benefit measures has a significant and positive effect on their intention to purchase EV

Willingness to pay a premium (WTP)

Willingness to pay (WTP) is a significant and positive relationship between consumers and AV purchase intentions, so that consumers are willing to pay a premium to buy EVs. The variables underlying WTP are, environmental concern (green energy), perceived value of EV, self-expression benefits, personal norms, responsiveness efficacy, trustworthiness, price-premium, and location of the cars. The premium price for an EV depends on the location of the car due to its striking green environmental conservation status. Because people who live in a green environment are looking for status so they dare to pay a high premium, while people who are outside a green environment will not dare to pay expensive (Ng et al., 2018; Thananusak et al., 2017). Therefore:

H9: Willingness to pay has a significant and positive effect on their intention to purchase EV

External environment (EE)

External environment is directly related to the purchase intention of EPV among drivers, it also brings a further prospect to influence purchase intention indirectly, such as through one's attitude towards the product. The external environment is also very helpful in developing a person's subjective or attitude in supporting or not supporting EPV, based on a person's general evaluation of the vehicle (for example, as an energy efficient, environmentally friendly, and economically and socially beneficial technology). External environmental variables consist of macro-level political, economic, socio-cultural, and technological factors (Promphat & Deebhijarn, 2019). From this paragraph, it is concluded that:

H10: External environment has a significant and positive effect on their intention to purchase EV

Marketing mix (MM)

Marketing mix is the multiple processes involved in promoting and selling, as well as adding and maintaining a product's presence. Which purpose to communicate effectively a series of coherent messages in various ways to build a product, such as EPV, as an asset and a needed. So that it makes other people want to buy the product. Thus the marketing mix is indirectly related to a person's purchase intention which is influenced by attitude of EPV between drivers. The marketing mix variables consist of product, price, place (how the product will be distributed), and promotion (marketing communication strategy) (Promphat & Deebhijarn, 2019). Thus it is can be concluded that.

H11: Marketing mix has a significant and positive effect on their intention to purchase EV

3 METHODOLOGY

We use the meta-analytic structural equation modeling (MASEM) method to test our theoretical model. MASEM is a statistical technique to fit hypothesized models on sets of variables from multiple independent studies (Cheung 2015, 2019, 2021). MASEM combines the strengths of meta-analysis (systematic synthesis of study-results) and structural equation modeling (SEM; fitting models with intricate relations between observed and latent variables) (Cheung, 2021). Compared to the primary study, MASEM has several advantages such as increasing the number of samples, thereby

strengthening the statistical power and increasing accuracy by correcting the sampling errors (Montazemi & Qahri-Saremi, 2015).

3.1 Data collection

We collected papers from database of Scopus, Web of Science (WoS), and IEEE Access in June 2021. Table 1 shows the searching strategy for each database. Briefly, we searched with the terms of 'structural equation modelling' and'electric vehicles' in the title, abstract, and keywords. This study determined the following criteria: published in 2012-2021; affiliated Asian countries based on United Nations Statistics Division (UNSD) (UNSTAT, 2021); and English language articles only.

Table 2: Search Result.

Database	Query Details Terms	Number of articles
Scopus	TITLE-ABS-KEY ('structural' AND 'equation' AND 'modelling' OR 'sem') AND TITLE-ABS-KEY ('electric' AND 'vehicles')	94
WoS	(AB=('structural equation modelling') AND AB='electric vehicles')	37
IEEE Access	("Abstract":'Structural equation modelling') AND ("Abstract":'electric vehicles')	8
	Total	139

Figure 1 shows the Preferred Reporting Items for Systematic Review and Meta- Analyses (PRISMA), a guideline aimed at standardizing the writing of systematic review (Selcuk, 2019). The process begins by removing the duplicate articles, then selecting the appropriate paper by reading title and abstract. The criteria of next selections are the suitability of the dependent variable, namely Purchasing Intention (PI) and the availability of path correlation by reading the full paper. Then we collect 40 constructs that have a significant and positive effect on purchase intention. Furthermore, the researcher merged the variables that were considered to have the same definition, so that 11 latent variables were obtained.

3.2 Data Analysis

The unit of analysis in this study is a paper discussing purchase intention using SEM. The input is the path coefficient (standardized regression weight) or commonly called effect size. The paper observed the relationship between Attitude (ATT) and Purchase Intention (PI), Perceived Behavior Control (PBC) with Purchase Intention (PI), Subject Norm (SN) with Purchase Intention (PI), Charging Infrastructure (CI) with Purchase Intention (PI), Environmental Concern (EC) with Purchase Intention (PI), Financial Benefit (FB) with Purchase Intention (PI), External Environment (EE) with Purchase Intention (PI), Marketing Mix (MM) with Purchase Intention (PI), Willingness To Pay A Premium (WTP) with Purchase Intention (PI), Incentive Policy Measures (IPM) with Purchase Intention (PI), and Perceived Value (PV) with Purchase Intention (PI). This paper tested the effect sizes for homogeneity and estimated the combined of effect sizes.

This paper extracted the standard regression coefficient (β) to create a composite correlation matrix. We applied a 2-stage structural equation modelling (TSSEM) method suggested by (Cheung & Chan, 2005). The method consists of two stages. At the first stage, we tested the homogeneity of

the effect size and estimated the Pooled Correlation Matrix. Then we fitted the SEM analysis at the second stage. In this study, we use metaSEM package (Cheung, 2015) in R Software to estimates combined effect size and fitted SEM test. In first stage, tsemm1() function with Generalized Least Square (GLS) approach (Becker, 1992) is used to estimate the combined effect size by pooling correlation matrices from 11 articles. After the matrices are pooled then we used it to second step of MASEM, fitted SEM analysis, by calling tsemm2() function with interval type is likelihood-based CI since the number of studies is relatively small. The steps and formula based on Cheung and Chan (2005) are as follows.

Stage 1: Testing Homogeneity of the Correlation Matric and Estimating the Pooled Correlation Matrix

We plot the beta values from the study K into the following $G = \left[G^{(1)T} \middle| G^{(2)T} \middle| \ldots \middle| G^{(K)T} \right] \middle]^T$

The correlation vector can be expressed by assuming a linear combination of the correct correlation vector and the sampling error, which is as follows:

$$r = G\rho + e$$

where $r = \left[r^{(1)T} \middle| r^{(2)T} \middle| \ldots \middle| r^{(K)T} \right] \middle]^T$ and e is a random error, then the estimated value using GLS is:

$$\hat{\rho} = \left(G^T \Omega^{-1} G \right)^{-1} G^T \Omega^{-1} r$$

where $\Omega = diag\left[\Omega^{(1)}, \Omega^{(2)}, \ldots, \Omega^{(K)} \right]$ and $\Omega^{(g)} = \Omega\left(r^{(g)} \right)$. The estimated asymptotic covariance matrix of $\hat{\rho}$ is:

$$\hat{V} = \left(G^T \Omega^{-1} G \right)^{-1}$$

We used the following formula to test the homogeneity of all correlation matrices across K studies,

$$Q_{GLS} = r^T \left[\Omega^{-1} - \Omega^{-1} G \left(G^T \Omega^{-1} G \right)^{-1} G^T \Omega^{-1} \right] r$$

If it is known that $p^{(g)}$ is a vector $p^{(g)} \times 1$ and $\Sigma^{(g)}$ is the population covariance matrix $p^{(g)} \times p^{(g)}$ in gth studies, where $p^{(g)}$ is the number of observed variables. Note that $p^{(g)}$ is equal to p only if all the variables are shown in the study. Furthermore, with the choice matrix $M^{(g)}$ of size $p^{(g)} \times p^{(g)}$ with values 0 and 1 corresponding to the elements, incomplete data that can be viewed directly with the complete data.

$$x^{(g)} = M^{(g)} x$$

Stage 2: Fitting SEM

After the homogeneity test was carried out using the assumption of fixed effects or random effects, an estimation of the combined correlation matrix r and the asymptotic covariance matrix V

was carried out. The matrix was then used as a weight to calculate SEM. The main diagonal element of the combined correlation matrix is the number 1.0, so the correlation structure is analyzed using the following equation:

$$F(\gamma) = \left(\mathbf{r}^* - \rho(\gamma)\right)^T \hat{V}^{-1} \left(\mathbf{r}^* - \rho(\gamma)\right)$$

Where $\mathbf{r}^*$ and $\rho(\gamma)$ are the $p´ \times 1$ vector of $p' = \dfrac{p(p-1)}{2}$ elements obtained by stringing out the lower triangular elements, excluding the diagonals in the sample and the implied correlation matrices R and $\rho(\gamma)$, respectively. $\hat{V}$ is the $p´ \times p´$ weight matrix estimated from the first stage and γ is a structural parameter vector.
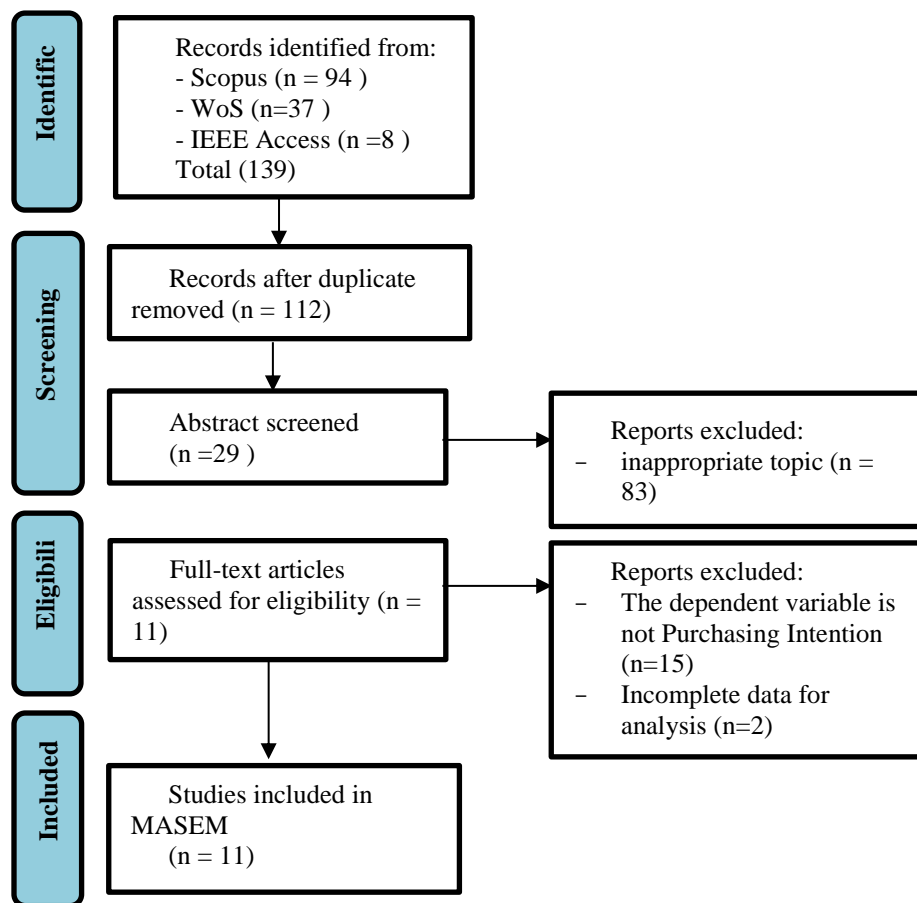

Figure 1. PRISMA

4 RESULTS AND DISCUSSION

The first step in MASEM is a homogeneity test for effect size. This homogeneity test is to understand the effect size of literature, that is, homogeneous or heterogeneous. The proposed hypothesis is as follows:

$$H_0 : \boldsymbol{\rho}_1 = \boldsymbol{\rho}_2 = \cdots = \boldsymbol{\rho}_{12}$$

H1: At least one pair of correlation matrices is not equal

A hypothesis test is carried out by comparing the value of Q-statistics to that of χ^2_{tabel} with the degree of freedom of the number of samples minus the number of correlations. If the value of Q-statistics is greater than that of χ^2_{tabel} , then H0 is rejected, means the effect size among literature is not homogeneous. Conversely, if the value of Q-statistics is smaller than that of χ^2_{tabel} , then H0 is not rejected, means the effect size among the literature is homogeneous.

The homogeneity test shows that the obtained value of Q-statistics was 2121.301 with $\chi^2_{5\%,726}$ was 720.876, means rejecting H0. In other words, the effect size among literature was not homogeneous. Thus, the combined effect size was carried out with an assumption of the random effect. Table 3 shows the estimation results of the combined effect size. The result is the first stage of MASEM which is then used as input on the SEM fitted test in the second stage.

Table 3: The results of the combined effect size estimation.

Correlation	Effect size
Attitude (ATT)<--> Purchase intention (PI)	0.167087827
Subject norm (SN) <--> Purchase intention (PI)	0.150473358
Perceived behavioral control <--> Purchase intention (PI)	0.131974248
Charging infrastructure (CI) <--> Purchase intention (PI)	0.055546724
Environmental concern (EC) <--> Purchase intention (PI)	-0.032239633
Financial benefit (FB) <--> Purchase intention (PI)	0.057145961
External environment (EE) <--> Purchase intention (PI)	0.046191870
Marketing mix (MM) <--> Purchase intention (PI)	0.059914885
Willingness to pay a premium (WTP) <--> Purchase intention (PI)	0.008707501
Incentive policy measures (IPM) <--> Purchase intention (PI)	0.093154494
Perceived Value (PV) <--> Purchase intention (PI)	0.161928005

Source: R output

The results of SEM Fitted test showed that the model was feasible with Chi-Square value = 14.8419; RMSEA = 0.000; Probability = 1.000 and TL1 = -0.4856. These outputs indicated that in general the hypothesized model are able to represent the facts in the field well. Thus, it was concluded that the model could be acceptable to explain the phenomenon of Purchase Intention (PI) influenced by the proposed variables. Table 4 provides the Goodness of Fit and Cut off Values.

Table 4: Goodness of Fit and Cut off Values.

Criteria	Model Evaluation Results	Cut off Values	Description
Chi-square	14.8419	$X^2_{0.05,54} = 72.153$	Not Significant
Probabilitas *Chi-square*	1.000	≥ 0.05	Not Significant
RMSEA	0.000	≤ 0.08	Good
TLI	-0.4856	≥ 0.9	Not Good

Source: R output

Table 5 presents the results of the causality test to show the causality confidence interval. If the confidence interval does not pass zero (0) then the exogenous variable is declared to have a significant effect on the endogenous variable. Conversely, if the confidence interval passes zero (0), then the causality is not significant.

Table 5: The results of causality test.

Causality	β	Lower bound	Upper bound	Effect	Remarks
ATT → PI	0.0421544	0.0189128	0.0662303	Positive	Significant
SN → PI	-0.0070298	-0.0202802	0.0046027	Negative	Not significant
PBC → PI	-0.0019381	-0.0125483	0.0086873	Negative	Not significant
CI → PI	-0.0020347	-0.0133457	0.0092110	Negative	Not significant
EC → PI	-0.0018770	-0.0139454	0.0102271	Negative	Not significant
FB → PI	-0.0017384	-0.0149203	0.0113553	Negative	Not significant
EE → PI	-0.0018806	-0.0161342	0.0123473	Negative	Not significant
MM → PI	-0.0015712	-0.0174057	0.0142431	Negative	Not significant
WTP → PI	-0.0013536	-0.0196466	0.0168783	Negative	Not significant
IPM → PI	0.0028423	-0.0192914	0.0249793	Positive	Not significant
PV → PI	-0.0034287	-0.0350976	0.0280820	Negative	Not significant

Source: R output

The structural equation for purchase intention is as follows:

$$PI = \beta_1 AT + \beta_2 SN + \beta_3 PBC + \beta_4 CI + \beta_5 EC + \beta_6 FB + \beta_7 EE +$$
$$\beta_8 MM + \beta_9 WTP + \beta_{10} IPM + \beta_{11} PV$$

$$PI = 0.0421544AT - 0.0070298SN - 0.0019381PBC - 0.0020347CI$$
$$- 0.0018770EC - 0.0017384FB - 0.0018806EE - 0.0015712WTP$$
$$+ 0.0028423IPM - 0.0034287PV$$

Based on the structural equation and confidence interval, Attitude (ATT) has a significant positive effect on purchase intention (PI), with an estimated path coefficient of 0.0421544. This means that if the ATT improves, the PI will increase significantly. Meanwhile, Incentive Policy Measures (IPM) is not significant with an estimated path coefficient of 0.0028423 but has a positive effect to PI. The other 10 variables are declared insignificant and give a negative effect.

4.1 Discussion

The application of TPB in research EVs has extended the theory from three main variables to 41 variables. This paper studies that the extension of the theory occurs over 10 years in the following ways.

- **Combining TPB with other theories or models into a new framework/model:** This strategy has been widely practiced during its 10 years of development in EVs researches. Afroz et al. (2015b) adopted the questionnaires of TPB for Theory of Reasoned Action (TRA) development. TPB was also combined with theory in Chinese culture to explore the influence of that culture on the purchase intention of new energy vehicles (Chen et al., 2019). In addition, TPB, the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) were merged to explores the key factors influencing consumers' purchase of EVs (Tu & Yang, 2019). Moreover, Ng et al. (2018) extended the TPB by combining this theory with the norm activation model.
- **Extending the main variables:** Among the three main variables, ATT seems to be the most frequently expanded variable. Its expansion was included as attitudinal variables as shown by (Afroz et al., 2015a; Promphat & Deebhijarn, 2019; Wang et al., 2021) and was represented by other variables such as done by (Wang et al., 2017). Moreover, Wang et al. (2017) also represented the variable of SN and PBC with other variables to extend TPB.
- **Adding new variables into the TPB model:** This strategy is applied by (Huang & Ge, 2019; Promphat & Deebhijarn, 2019; Xu et al., 2019).
- **Looking at the determinants in the TPB from different dimensions or attributes:** Re-testing the new variables that were not significant in previous studies by testing from a different point of view (Wang et al., 2021).

The results showed that among the three core variables of TPB, only ATT is an important variable affecting purchase intention, while the SN and PBC variables are not significant and had a negative effect. Likewise Afroz et al. (2015a) stated that their result showed ATT as an important dimension for the formation of purchase intentions, although the other two main variables SN and PBC also greatly affect the purchase intentions. A number of studies have also failed to prove a significant positive impact of subjective norms on the consumer purchase intentions. In addition, ATT and PBC are the main factors that influence consumers' purchase intentions (Huang & Ge, 2019). Moreover, in many TPB studies, subjective norms tend to have no significant effect on intention (La Barbera & Ajzen, 2020). Meanwhile, it was reported that PBC has a moderating role in the influence of ATT and SN on intention (Ajzen, 2020; La Barbera & Ajzen, 2020). However, according to the authors, the direct effect of PBC on purchase intention still needs to be investigated further, considering that this study only supports one hypothesis, namely attitude (ATT).

This study also indicates that the variable of IPM is not significance but has a positive effect to PI. This means that the better the incentive policy measures (IPM), the purchase intention will increase, but the increase is not significant. Referring to previous studies with the primary data, extended variables (CI, EC, FB, EE, MM. WTP, IPM, and PV) in TPB gave varied results. Nevertheless, the measurement of the relationship between independent variables and PI seems to be influenced by several things. Huang and Ge (2019) shows that the variable relationship is influenced by the domestic conditions of each country. For example, the author explains that non-monetary incentive policies did not pass the test using SEM. They linked the results with the survey results and the situation in the city where the research was conducted. In addition, the variable relationship is also influenced by the characteristics of the country's society, as stated by Afroz et al. (2015). They said that Malaysians may feel not morally obligated to show purchase intentions towards EFs when they related the individual consequences to the environment and PI. Moreover, traditional Chinese culture adheres to the value of

image, which assumes behavior will make a good impression in their social circle (Xu et al., 2019).

In the aspect of the formula Cheung & Chan (2005) stated that the two-stage approach can use the path analysis model (β), CFA or correlation matrix (α). The use of the path analysis model may allegedly give poor results marked by the number of rejected hypotheses. This paper uses a path model considering that correlation data are rarely shown in the paper. This is due to the correlation value in research that aims to build a model does not provide information about the magnitude of the changes in the relationship between the variables. β values reflect the partial coefficients in influencing of all predictor variables in a multiple regression model. We term as an imposing of data β on the correlation matrix, so many blank cells are found. A previous study argued that correlation-based MASEM is a robust approach to exploring the theoretical assumptions of an alternative model, while beta values are used as a variation of the test between samples (Scherer & Teo, 2019). Nevertheless, instead of losing valuable data, Bamberg et al. (2017) decided to extract the standard regression coefficient (β) and treat them as the correlation coefficients (α). Their study consisted of 26 studies reported α values, and 13 studies reported β values. They found that the β values resulted in a lower combined correlation than the α values. However, they found the opposite pattern i.e. combined threat assessment - the estimated confidence effect size based on the α values were significantly smaller than estimation based on the β. This means that the pooled beta values are feasible/adequate to be used to determine the combined effect size, not imposing data, as the term used by this paper aforesaid. Nonetheless, Bamberg et al. (2017) suspected that due to the relatively low number of the study.

This paper also used relatively small studies (11 papers) compared to the other similar researches such as conducted by Scherer & Teo (2019) with 45 papers and Tehrani & Yamini (2020) with 72 papers. It is not surprising to assume that the more studies are collected and the larger the sample size, the more reliable the results (Landis & Landis, 2013). In addition, the assumption that due to the small amount of data will occur if the research results provide an insignificant relationship (Valentine et al., 2010) or there is an opposite pattern as experienced by Bamberg et al. (2017). However, in meta-analytical studies if the strength analysis tests, wide confidence interval examinations, and heterogeneity assessments have been performed, only a minimum of two samples is required (Valentine et al., 2010).

4.2 Theoretical contributions

This study has several implications. First, our research presents an integrated model using path analysis model to estimate the composite correlation matrix. Second, this paper applied A Two-Stage Approach for Meta-Analytic SEM to provide a new insight of the factors that influence EV purchase intention based on TPB. Third, by integrating the existing findings our study provides new insight into consumers' motivations and perceptions to purchase EVs. Fourth, this study reveals the development of hu- man behavior which is an extended of TPB based on the decision to buy an electric vehicle.

4.3 Limitations and future research directions

This study has a number of limitations that are natural in studies with the meta- analytic designs. First, this study uses secondary data instead of primary data, where all the papers involved are assumed to have the same quality and adequate data validity. Second, this study uses the path coefficient value (β), not the correlation value between constructs (α), to build the combined correlation value. Although, there are some studies that support the use of the β values to test an alternative model estimate the pooled correlation Matrix. Third, the researchers themselves who process the variables such as combining variables, this has the potential to be biased. It will minimize the bias if the research uses an expert opinion approach on the variable processing. Therefore, we call for future research to pay more attention in combining the variables.

5 CONCLUSION

We conclude that ATT is the most influential variable on customer purchase intention. ATT is also the variable that has experienced the most trials on the way to expanding TPB. It may be argued that compared to other core variables of the TPB, ATT are the key to certain behaviors including the intention to buy EVs. Therefore, it is important to develop policies taking into account ATT for the formation of customer purchase intentions. EVs are more expensive than other types of vehicles, but the formation of attitudes (ATT) can encourage consumers to buy EVs. These formations include increasing consumer confidence that the costs incurred for EVs will be commensurate with a comfortable environment, pollution-free environment, support for the government programs, appreciation from the colleagues and recognition of financial capabilities by the social environment. Furthermore, although the use of path coefficients or β values to construct a composite correlation matrix was supported by the previous researchers, the further explorations are still required.

6 DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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