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Investigating Key Factors Influencing Purchase Intention of Electric Motorcycle in Indonesia

YUNIARISTANTO[a], MARTHA WIDHI DELA UTAMI[b], WAHYUDI SUTOPO[c] AND MUHAMMAD HISJAM[a]

a. Department of Industrial Engineering, Universitas Sebelas Maret, Surakarta, Indonesia
b. Anugerah Pharmindo Lestari Inc., 135 Senen Raya St., Jakarta, Indonesia
c. University Centre of Excellence for Electrical Energy Storage Technology, Universitas Sebelas Maret, Surakarta, Indonesia

ABSTRACT: Indonesia is the top three global motorcycle market, contributing to the high CO_2 emissions. Electric motorcycles (EMs) are an effective way to reduce CO_2 emissions. This study examines the purchase intentions of EMs that focus on micro-levels, cost, technological and macro-level factors. Partial Least Square - Structural Equation Model (PLS-SEM) is used to explore the significant factors and the relationship among these factors in constructing the purchase intention model. The questionnaire survey collected from 1,223 respondents shows that almost 82% of respondents revealed their intention to buy EMs. This result indicates that the future of the EM market is very promising. This research also finds that macro-level, technology and cost factors are significant factors in the purchase intention of EMs. Consumers are still reluctant to buy EMs due to the barriers in the charging station infrastructure, tax and incentive policies, EM prices, battery costs, charging time, and battery life resulting in consumers choosing a "wait and see" decision in adopting EMs. Meanwhile, respondent characteristics such as age, education, and income level do not significantly affect the EM purchase intention. Respondents who have extensive social networks and are concerned about the environment are more willing to adopt EMs.

KEYWORDS: Purchase intention; questionnaire survey; electric motorcycle; PLS-SEM; Indonesia

1. INTRODUCTION

Transportation sectors comprise many fossil fuel vehicles, thus contributing to high levels of CO_2 in the air. Indonesia is a developing country with a large population and increased usage of motorcycles as it has more motorcycles than cars. Indonesia is the top three global motorcycle market after China and India (Eccarius & Lu, 2020b). Besides, the number of motorcycles in Indonesia was 112,771,136 units in 2019 (Statistics Indonesia, n.d.), and the number of motorcycle sales was 3,660,616 units in 2020 (AISI, 2020). This fact also contributes to increasing carbon emissions. Migration in the transportation sector from fossil fuels to alternative fuels can reduce carbon emissions. The solution of this migration is to implement electric vehicles such as plug-in hybrid electric vehicles, hybrid electric vehicles, and battery electric vehicles (Samosir et al., 2018). Migration from conventional vehicles (CVs) to electric vehicles (EVs) will reduce the harmful effects of air pollution and improve air quality (Chen et al., 2013).

Research in this field has become more relevant since Indonesia has recently stepped up its citizens to promote EV use. The Indonesian government recently revealed a roadmap for electric vehicles, producing more than three million electric vehicles (EVs) units, consisting of 600 thousand electric cars and 2.45 million electric motorcycles by 2030. The government also issued Presidential Regulation No. 55 of 2019 about the Acceleration of the Battery EV Program for Road Transportation (Indonesian Government, 2019). These efforts were a step to overcome two problems. The problems are about the scarcity of fuel oil reserves and high air pollution. Regarding air pollution, Indonesia has committed to reducing 29% of carbon dioxide emissions by 2030 due to the Paris Climate Change Conference held in 2015 (Goldenberg, 2015). The Ministry of Energy and Mineral Resources has determined a target in 2040 that Internal Combustion Engine Vehicles (ICEV) sales will be prohibited. The public will be asked to use EVs (Gaikindo).

Consumer adoption of alternative fuel vehicles was more a subject of research than alternative fuel motorcycles. In particular, there are few studies on consumer adoption of EMs, which are more environmentally friendly than conventional two-wheelers motorcycles (Eccarius & Lu, 2020b). Eccarius and Lu (2020b) conducted a literature review on the adoption model of alternative fuel motorcycles. They explained alternative fuel motorcycle studies with five theoretical frameworks: planned behavior, normative, symbols, lifestyle, self-identity, diffusion of innovation, and consumer emotions. Eccarius and Lu (2020a) investigated what factors affect university students' usage intention of electric scooter sharing services by applying the Theory of Planned Behaviour. Utami et al. (2020) investigated the factors that influenced the adoption intentions of electric motorcycles and determined the function opportunities for the adoption of electric motorcycles in Indonesia. Liu and Lai (2020) contributed to the theory of environmental technology acceptance by considering an environmental policy. Huang et al. (2018) found a dynamic adjustment mechanism for subsidy policies for EVs in Taiwan's EM case study so that the government can allocate its limited budget. Guerra (2019) evaluated the potential replacement for gasoline motorcycles with EMs by applying the choice experiment in Solo, Indonesia. Wu et al. (2015) analyzed the antecedents of buying intention and the correlation between purchase intention, image, risk, value, and perceived usefulness in the EM market. Jones et al. (2013) used a stated preference survey of households in Hanoi, Vietnam, to explore the adoption of electric two-wheelers while focusing on the effects of economic incentives and technological improvements.

When reviewing the previous literature, it should be noted that some studies attempted to understand subjective consumer factors such as psychology and behavior on purchase intentions of EMs (Eccarius & Lu, 2020a; Wu et al., 2015).

Some studies focused on objective factors such as socioeconomic (Guerra, 2019; Utami et al., 2020), subsidy policy (Huang et al., 2018; Jones et al., 2013), and environmental policy (Liu & Lai, 2020). Researches that considered more complete factors mainly was conducted on electric cars or vehicles. She et al. (2017) examined the intention to adopt EVs that focus on financial, vehicle performance, and infrastructure barriers. In Sang and Bekhet (2015), the study explored the key predictors affecting the usage acceptance of EVs in Malaysia. Habich-Sobiegalla et al. (2018) conducted cross-national surveys in Brazil, Russia, and China which studied citizens' purchase intentions of EVs, considering individual micro-level (i.e., sociodemographic and social network), product-level and technological factors, and macro-level factors. Lee et al. (2021) investigated the factors affecting behavioral intentions to buy EVs in Pakistan, including perceived ease of use, environmental concerns, social influence, effort expectancy, and perceived facilitating conditions. Tarei et al. (2021) focused on technological, infrastructural, financial, behavioral, and external barriers for the Indian EV context. They also proposed prioritizing EV barriers that provide a framework for decision-makers.

Many studies on the adoption intention of EVs used statistical methods such as multiple linear regression (Sang & Bekhet, 2015), structural equation model (Higueras-Castillo et al., 2019; Lee et al., 2021; She et al., 2017), exploratory factor analysis, multivariate regression modeling (Berkeley et al., 2018), and logistic regression (Zhuge & Shao, 2019). Higueras-Castillo et al. (2019) used the SEM to evaluate the consumer behavior on electromobility. SEM was used to identify the determinants of adoption intention and examine the relationship amongst these factors on EVs (Higueras-Castillo et al., 2019; She et al., 2017) and EMs (Eccarius & Lu, 2020a; Wang, 2007; Wu et al., 2015). SEM is widely used in these studies because it can test and estimate the relationship between one or more exogenous variables and endogenous variables with many indicators simultaneously (Hair et al., 2016).

This study aims to develop an adoption model for EMs, find the factors that influence the usage intention of EMs in Indonesia, and the correlation between the factors. Thus, the contribution of our study can be described as follows. First, this study identifies the significant determinants of adoption intention of EMs in Indonesia, and the survey was conducted on a national scale. Indonesian people have a unique behavior where motorcycles for mobility are higher than cars. Second, this study is still relevant to the current market conditions in Indonesia, where EM adoption is still at an early stage, with a large number of potential buyers still considering whether to buy EM or not. Third, this study adapts Habich-Sobiegalla et al. (2018) by considering micro-level (i.e., sociodemographic and social network), cost, technology, and macro-level factors. We consider cost and technology factors separately to determine more complete indicators and various government incentives at macro-level factors. We also examine the direct and indirect effects of these factors on the purchase intention of EMs. Fourth, this study also provides suggestions to the government and companies. These suggestions can be used for consideration in building strategies for developing and accelerating EMs, both in terms of EM technology and market in Indonesia. This study uses the SEM approach to determine the structural model and the significance of the direct and indirect correlation of factors that influence the adoption intention of EMs in Indonesia.

2. METHOD

2.1 Conceptual Framework and Research Hypotheses

We categorized the potential factors of purchase intentions for electric motorcycles (EMs) into the following factors: micro-level, cost, technology, and macro-level factors. However, inter-linkages between these factors and indicators are also discussed in the following section. This study assumes that micro-level, cost, technology, and macro-level are the objective factors that influence the purchase intentions of EMs from a consumer perspective. This study does not discuss subjective factors that can affect the adoption intention of EMs, such as consumer psychology and behavior. The conceptual framework of the research is shown in Fig. 1. This study hypothesizes that purchase intention is influenced by micro-level, cost, technology, and macro-level factors either directly or indirectly. We assume that micro-level, cost, technology, and macro-level factors affect EM purchase intention directly. In addition, we also assume that micro-level, cost, and technology factors influence EM purchase intention indirectly. Based on the conceptual framework discussed above, the hypotheses of this research can be summarized in table 1.

Code	Hypotheses
H1	Micro-level has a significant positive effect on EM purchase intention.
H2	The cost has a significant positive effect on the EM purchase intention.
H3	Technological has a significant positive effect on EM purchase intention.
H4	Macro-level has a significant positive effect on EM purchase intention.
H5	Micro-level has a significant indirect positive effect on EM purchase intention through cost factors.
H6	The cost has a significant indirect positive effect on EM purchase intention through technological factors.
H7	Technological has a significant indirect positive effect on EM purchase intention through macro-level factors.
H8	The cost has a significant indirect positive effect on EM purchase intention through macro-level factors.

Table 1. Hypotheses and the expected outcome

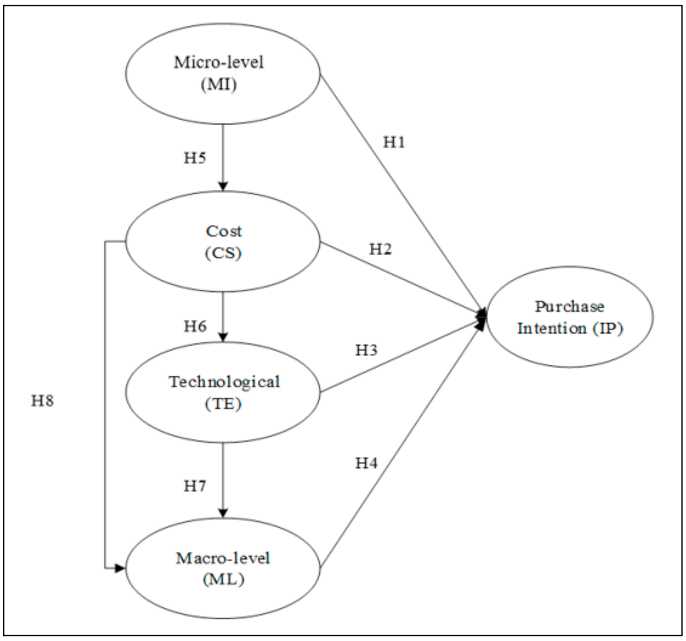

Fig. 1. Conceptual framework

2.1.1 Micro-level

The micro-level variable was built from sociodemographic and social network factors (Habich-Sobiegalla et al., 2018).

The sociodemographic is the personal factor that influences an individual's behavior in decision making. Indicators on sociodemographic factors in this study include age (Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015), last education level (Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015), monthly income level (Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015), and environmental awareness (Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015). Higueras-Castillo et al. (2019) also considered that environmental awareness belongs to sociodemographic factors. Table 2 shows an explanation and reference for the micro-level variable. In Habich-Sobiegalla et al. (2018), it was highlighted that social network factors such as experience with EV, frequency of sharing on social media, and size of the online social network were the influencing factors for EV adoption. We only consider the size of the online social network indicator in this study. Experience with EV is not considered because there are very few EM owners in Indonesia, around 7,526 units in August 2021 (Natalia, n.d.). We also do not consider the frequency of sharing on social media because this indicator is a subjective measure, so it can cause a bias in the response. We also refer to Habich-Sobiegalla et al. (2018), who combine the indicator of the size of the online social network and sociodemographic factors into one variable, namely micro-level.

2.1.2 Cost

The cost related to EV adoption includes high purchase price, poor understanding of fuel cost, high battery cost, and maintenance costs (She et al., 2017). The purchase price is the original price of an EV without any purchase subsidies. Sierzchula (2014) said that the high battery capacity caused the high purchase price of EVs, while Kim et al. (2018) noted that high purchase price is one barrier to EV adoption. Battery cost is battery replacement when the old battery life has run out. In (Kim et al., 2018; Krause et al., 2013), battery cost becomes a financial barrier for adopting an EV. Charging cost is the cost of electricity to power an EM compared to gasoline. Electric vehicles have the advantage because of their lower fuel cost (Browne et al., 2012; Sang & Bekhet, 2015). Maintenance costs are routine maintenance costs for EVs, not including repairs due to the accident that affects EV adoption. Uncertainty about maintenance, service, and facilities for repairs are important factors that obstruct EV adoption (Egbue & Long, 2012; Sovacool & Hirsh, 2009). Table 3 shows an explanation and reference for the cost variable.

2.1.3 Technological

Mileage capability was the furthest distance traveled after the EM battery is fully charged (Guerra, 2019; She et al., 2017). Power is the maximum speed of an EV (Egbue & Long, 2012). In (Egbue & Long, 2012; Guerra, 2019), they found that top speed and charging time are barriers to the widespread adoption of EVs. Charging time is the overall time to charge an EV fully. Safety feeling when riding an EV related to sound (dB) was the factor that affects consumer perception of EVs (Sang & Bekhet, 2015; She et al., 2017). In (Graham-Rowe et al., 2012; Habich-Sobiegalla et al., 2018), battery life is considered degraded. Table 4 shows an explanation and reference for the technological variable.

2.1.4 Macro-level

Macro-level factors are mostly related to infrastructure and incentive requirements. In particular, macro-level factor includes infrastructure for charging stations, government

Indicator	Code	Scale	Sources
age	MI1	ordinal	(Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015)
last education level	MI2		(Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015)
monthly income level	MI3		(Habich-Sobiegalla et al., 2018; Sang & Bekhet, 2015)
size of online social network	MI4		(Habich-Sobiegalla et al., 2018)
environmental awareness	MI5		(Habich-Sobiegalla et al., 2018; Higueras-Castillo et al., 2019)

Table 2. Explanation and sources of micro-level variable

Indicator	Code	Description	Scale	Sources
purchase price	CS1	the electric motorcycle's original price without any purchase subsidies	five-point likert scale	(Kim et al., 2018; Sierzchula, 2014)
battery cost	CS2	the battery replacement cost when the old battery life has run out		(Kim et al., 2018; Krause et al., 2013)
charging cost	CS3	the charging electricity cost of EMs compared to the cost of gasoline		(Browne et al., 2012; Sang & Bekhet, 2015)
maintenance costs	CS4	routine maintenance cost for EMs, not repairs because of accident		(Egbue & Long, 2012; Sovacool & Hirsh, 2009)

Table 3. Explanation and sources of cost variable

Indicator	Code	Description	Scale	Sources
mileage capability	TE1	the furthest distance after the EM battery is fully charged	five-point likert scale	(Guerra, 2019; She et al., 2017)
power	TE2	the maximum speed of an EM		(Egbue & Long, 2012)
charging time	TE3	overall time to fully charge an EM		(Egbue & Long, 2012; Guerra, 2019)
safety	TE4	safety feeling when riding an EM related to sound (dB)		(Sang & Bekhet, 2015; She et al., 2017)
battery life	TE5	battery life (considered being degraded)		(Graham-Rowe et al., 2012; Habich-Sobiegalla et al., 2018)

Table 4. Explanation and sources of technological variable

budget incentives, and environmental pollution needed to be taken into account for the compilation explaining purchase intentions of EVs (Habich-Sobiegalla et al., 2018). Charging station infrastructure availability cannot be avoided for EM adopters. It is important to consider charging availability in public places to support EV adoption (Krupa et al., 2014; She et al., 2017). Charging availability at work and charging availability at home were also needed by consumers to charge their vehicle's battery (Jensen et al., 2013; She et al., 2017). The uncertainty of procuring a personal charging station can be a barrier to the adoption of EVs (Caperello & Kurani, 2012; She et al., 2017). (Krupa et al., 2014) said that the availability of service places for routine maintenance and damage affects the adoption of EVs. Some research suggested some public incentives that consumers wanted, such as providing subsidies for purchasing EMs and annual tax discounts for EMs (Kim et al., 2018; She et al., 2017), charging cost discount policy when consumers need to charge EMs in public places (She et al., 2017). Table 5 shows an explanation and reference for the macro-level factor.

2.2 Questionnaire and Survey

The questionnaire survey was conducted in April 2020 involving ten provinces: West Java, East Java, Jakarta, Central Java, North Sumatra, West Sumatra, Yogyakarta, South Sulawesi, South Sumatra, and Bali. These provinces have over 80% of motorcycle sales in Indonesia. The questionnaire comprised three sections, including:

- Section A is about an introduction, including the screening questions and the video about the electric motorcycles (EMs) in Indonesia to avoid misunderstandings. This video can be accessed at https://youtu.be/z6TdObCaD7k. The screening questions require respondents to be over 17 years old, have a motorcycle driving license, be decision-makers to replace or buy a motorcycle, and be domiciled in one of the ten provinces observed.
- Section B is about micro-level information, including age, monthly income, educational background, and domicile.
- Section C is a five-point Likert scale that is used to explore the respondent's perception of EM purchase intention. This part includes cost, technological, and macro-level factors as well as purchase intention. A questionnaire was presented on a Likert scale of 1 to 5, where 1: strongly disagree, 2: disagree, 3: doubt, 4: agree, and 5: strongly agree.

Cluster sampling with proportions is used in this research because the population of motorcycle users in Indonesia is substantial. The clusters were defined by the geographical region of the home location. Purposive sampling was used to determine samples based on specific criteria (Etikan, 2016). The criteria used in the purposive sampling are people who have a motorcycle driving license and are over 17 years old, as mentioned in screening questions.

2.3 Least Squares - Structural Equation Model

The structural equation model (SEM) enables researchers to combine non-observable variables measured indirectly by indicator items (Hair et al., 2016). SEM is divided into covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). CB-SEM is mainly employed to confirm theories by measuring how well the proposed theoretical framework can estimate the covariance matrices for a sample data set. PLS-SEM is usually used in exploratory research to develop a theoretical model by defining the variance of the dependent variable when testing the model (Hair et al., 2019). In this study, we applied PLS-SEM for the following reasons (Hair et al., 2019):

- This study is related to evaluating the conceptual framework from a predictive perspective;
- The structural model of this study is complex and includes many constructs, indicators, and/or model relationships;
- The path model of this study includes several formatively measured constructs;
- PLS-SEM can also be used well for large sample sizes and even increase precision (i.e., consistency);
- PLS-SEM can be applied when the distributional assumptions do not exist;
- This study requires a score of construct variables for further analysis.

3. RESULTS

The questionnaire was distributed online in April 2020 and received 1,443 responses, but only 1,223 were eligible for data processing. It is around 220 respondents not eligible because of dual input and did not pass the screening questions. Table 6 shows the demographics of respondents.

3.1 Descriptive Statistics

Table 7 shows descriptive statistics for quantitative variables on technological, cost, and macro-level factors. ML7 (charging cost discount) has the highest average, ML6 (annual tax discount) ranks second, and ML5 (purchase price subsidies) ranks third. This result illustrates that most respondents consider that there has to be a policy such as the government-given intensive to encourage them to adopt electric motorcycles (EMs).

CS1 (purchase price) and CS2 (battery cost) have the lowest rank on cost factors. This result illustrates that the purchase price of an EM and battery cost is under the budget

Indicator	Code	Description	Scale	Sources
availability of charging station infrastructure in public places	ML1	charging availability in public places	five-point likert scale	(Krupa et al., 2014; She et al., 2017)
availability of charging station infrastructure at work	ML2	charging availability at work		(Jensen et al., 2013; She et al., 2017)
availability of charging station infrastructure at home	ML3	charging availability at home		(Caperello & Kurani, 2012; She et al., 2017)
service places availability	ML4	the availability of service places for routine maintenance and damage		(Krupa et al., 2014)
purchase incentive policy	ML5	providing subsidies for purchasing EMs		(Kim et al., 2018; She et al., 2017)
annual tax discount policy	ML6	annual tax discount for EMs		(Kim et al., 2018; She et al., 2017)
charging cost discount policy	ML7	charging cost discounts on public places		(She et al., 2017)

Table 5. Explanation and sources of macro-level variable

Demographic	Item	Number	%	Demographic	Item	Number	%
Domicile	West Java	345	28.2%	Last educational level	high school	701	57.3%
	East Java	162	13.2%		diploma	127	10.4%
	Jakarta	192	15.7%		bachelor	316	25.8%
	Central Java	242	19.8%		master	68	5.6%
	North Sumatra	74	6.1%		doctoral	11	0.9%
	Yogyakarta	61	5.0%	Monthly income	0	154	12.6%
	South Sulawesi	36	2.9%		< 2,000,000 IDR	226	18.5%
	Bali	34	2.8%		2,000,000-5,999,999 IDR	550	45%
	West Sumatra	26	2.1%		6,000,000-9,999,999 IDR	199	16.3%
	South Sumatra	51	4.2%		10,000,000-19,999,999 IDR	71	5.8%
Age	17-30	655	53.6%		≥ 20,000,000 IDR	23	1,9%
	31-45	486	39.7%				
	46-60	79	6.5%				
	>60	3	0.2%				

Table 6. Demographics of respondents

Indicator	Mean	Min	Max	Indicator	Mean	Min	Max
ML7 (charging cost disc.)	4.4563	1	5	ML3 (Chg. Sta. at home)	4.1554	1	5
ML6 (annual tax disc.)	4.4301	1	5	ML2 (Chg. Sta. at workplaces)	4.1055	1	5
ML5 (purchase incentive)	4.4146	1	5	ML1 (Chg. Sta. in public places)	4.0965	1	5
TE4 (safety)	4.3181	1	5	TE5 (battery life)	4.0924	1	5
CS3 (charging cost)	4.2518	1	5	TE2 (power)	4.0597	1	5
TE1 (mileage capability)	4.2396	1	5	TE3 (charging time)	4.0303	1	5
ML4 (service place)	4.2142	1	5	CS1 (purchase cost)	3.8814	1	5
CS4 (maintenance cost)	4.1980	1	5	CS2 (battery cost)	3.5045	1	5

Table 7. Descriptive statistics for cost, technology, and macro-level

	1:strongly unwilling	2:unwilling	3:doubt	4:willing	5:strongly willing
Willingness to buy EM	0.327%	2.044%	15.863%	36.141%	45.626%
Willingness to recommend EMs to others	0.409%	1.472%	13.164%	34.260%	50.695%

Table 8. Descriptive statistics for adoption intention

of most respondents. The price of an EM which ranges from IDR 18,000,000 - 25,000,000 compared to the price of a conventional motorcycle which ranges from IDR 17,000,000 - 22,000,000, is not under the budget of most respondents. The replacement cost of the battery every three years, which reaches IDR 5,000,000, is also not under the budget of most respondents. Therefore the purchase price and battery cost are barriers for Indonesian people to adopt EMs.

Technological factors including TE5 (battery life), TE2 (power), TE3 (charging time) also rank last in descriptive statistics, but the average for these three variables is over 4. This result illustrates that most respondents consider that EM performance is not following their standards though respondents have not fully trusted the performance of EMs might meet their mobility needs. It shows that the charging time which took 3 hours, was too long for most respondents.

Table 8 shows the responses of respondents to the adoption of EMs. It is around 45.626% of respondents have a strong willingness to buy an EM. This result shows a bright future for the EM market share. Table 6 also shows that almost 85% of respondents will recommend EMs to others even though nearly 55% of respondents do not strongly want to buy an EM. Almost 15% of respondents are unwilling to recommend an EM to others. The interesting results from these descriptive statistics imply that although the enthusiasm for purchasing EMs still requires stimulation, public acceptance of EMs is good. Another reason that might occur is that respondents have the attitude to wait and see the adoption of an EM and whether or not someone else buys an EM.

The maximum speed of an EM is 70 km/h with 3-year battery life. Although it is not following the respondent's needs, these three variables are low-ranked. More respondents gave more scores to the charging availability in their homes and offices than in public places. However, a barrier that is often found is that most home electricity power is still below 1300 VA, making respondents strongly expect the government to help provide charging facilities at home. The availability of charging in the office is more preferred than in public places because the mobility of respondents every day involves homes and offices.

3.2 Measurement model

We first tested the reliability and validity of the construct variables, which are instrumented using indicator items. Indicators MI1 to MI3 are eliminated because the outer loading values are insufficient to be a valid model on the first iteration (see Table 9). If outer loading is <0.40, delete the reflective indicator but consider its effect on content

Construct	Item	Outer loading	AVE	CR
Micro-level	MI1	-0.04*	0.586	0.734
	MI2	0.072*		
	MI3	0.407*		
	MI4	0.640		
	MI5	0.873		
Cost	CS1	0.806	0.613	0.864
	CS2	0.790		
	CS3	0.760		
	CS4	0.775		
Technological	TE1	0.783	0.612	0.888
	TE2	0.782		
	TE3	0.795		
	TE4	0.758		
	TE5	0.793		
Macro-level	ML1	0.808	0.667	0.933
	ML2	0.832		
	ML3	0.821		
	ML4	0.839		
	ML5	0.815		
	ML6	0.793		
	ML7	0.808		
Purchase Intention	IP1	0.927	0.863	0.926
	IP2	0.930		

Note: * first iteration

Table 9. Results of testing construct reliability

validity. If outer loading is ≥ 0.40 but <0.70, then analyze the impact of deletion indicator on internal consistency reliability (Hair et al., 2016). In micro-level variables, only the size of the online social network indicator (MI4) and the level of environmental awareness indicator (MI5) are retained because they have an outer loading value above 0.6 after the third iteration. The average variance extracted (AVE) and composite reliability (CR) is calculated to evaluate each construct variable, as shown in Table 9. Discriminant validity is the degree to which measures of different attributes are not related and can be assessed by the AVE. AVE represents the average percentage of variation explained by the indicator items and is employed to measure a construct. AVE values for micro-level, cost, technological, and macro-level factors and purchase intention were eligible because the values are above 0.5 and all construct variables' CR values are above 0.6. It means the model is good. Table 9 shows the results of testing the construct reliability of the model.

Table 10 shows a correlation matrix diagonally between pairs of constructs and the square roots of AVE (Fornell-Larcker Criterion). For example, Macro-level's AVE is 0.667 (from Table 9), and its square root is 0.817, where this value is higher than any correlation value in column 'ML' (0.664–0.262) and the ML's row (0.646–0.557). The convergent and discriminant validity can be calculated by testing all the constructs for their CR and AVE values. The results show that it meets the threshold value for each case (see Table 10).

	CS	IP	ML	MI	TE
CS	**0.783**				
IP	0.509	**0.929**			
ML	0.557	0.646	**0.817**		
MI	0.302	0.288	0.262	**0.765**	
TE	0.674	0.589	0.664	0.303	**0.782**

Note: square root of each construct's AVE is highlighted in bold

Table 10. Fornell-Lacker criterion

3.3 Structural Model

This study used SmartPLS 3 software to analyze the Structural Equation Model assigned to 5000 re-sampling numbers in the bootstrap procedure. Then the R-square value and coefficient for each link were estimated. The structure's fitness, which comprises a hypothetical relationship between the construct variables, was also tested to calculate the R-square value. Cohen (1988) stated that the R-square values of 0.02, 0.13, and 0.26 are thresholds that distinguish the model's small, medium and large explanatory power. The R-square value of the purchase intention model is 0.477, meaning that the model has great explanatory power.

Fig. 2 shows the path in the hypothetical model. Table 11 shows the t-statistic and p-value in the total analysis indirect effect. Thus the significance of the indirect effect between construct variables can be seen. Macro-level factor was confirmed as the most important factor driving EMs Purchase Intention (β = 0.427, p < 0.001). Technological factor direct impact on purchase intention (β = 0.211, p < 0.001) and Technological indirect impact through Macro-level factor (β = 0.226, p < 0.001) also affect the overall EMs purchase intention. These findings provide support to all of the hypotheses.

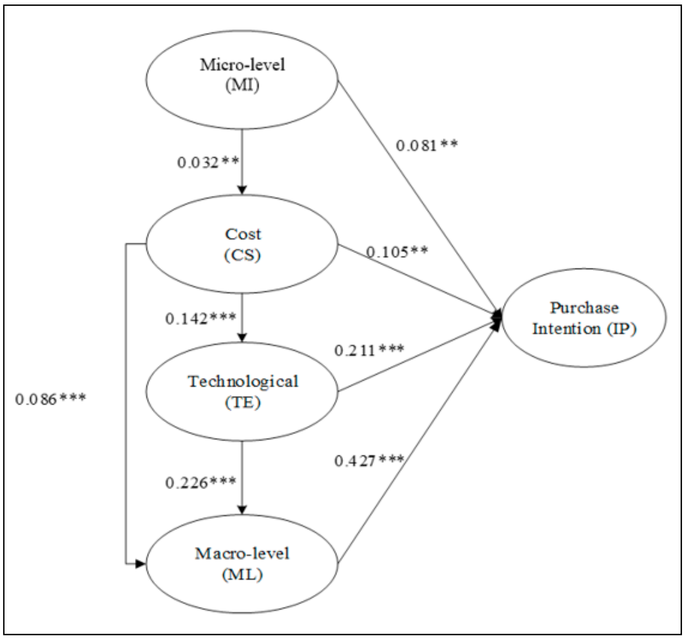

Fig. 2. Paths within the hypothesis model. Note: *** p < 0.001, ** p < 0.005.

Hypotheses	Hypotheses Path	Path Coefficient	p-Value	Results
H1	Micro-level → Purchase intention	0.081	0.003**	Supported
H2	Cost → Purchase intention	0.105	0.002**	Supported
H3	Technological → Purchase intention	0.211	0.000***	Supported
H4	Macro-level → Purchase intention	0.427	0.000***	Supported
H5	Micro-level → Cost → Purchase intention	0.032	0.003**	Supported
H6	Cost → Technological → Purchase intention	0.142	0.000***	Supported
H7	Technological → Macro-level → Purchase intention	0.226	0.000***	Supported
H8	Cost → Macro-level → Purchase intention	0.086	0.000***	Supported

Note: *** p < 0.001; **p < 0.005

Table 11. Results of tested hypothesis H1 – H8

4. DISCUSSIONS

H1. Micro-level has a significant positive effect on electric motorcycle (EM) purchase intention. The value of the path coefficients in Fig. 2 and the significance in Table 11 support Hypothesis 1, which states that micro-level factors significantly affect EM purchase intention (path coefficient = 0.081; p-value = 0.003). The indicators that construct micro-level variables are the only size of online social networks and environmental awareness. The outer loading value for the size of the online social network is 0.640, and environmental awareness is 0.873, indicating that a person's level of environmental awareness has a significant influence on EM purchase intention in Indonesia.

H2. The cost has a significant positive effect on the EM purchase intention. The value of the path coefficients in Figure 2 and the significance in Table 11 support Hypothesis 2, which states that the cost factor has a significant positive effect on EM purchase intention (path coefficient value = 0.105; p-value = 0.002). This positive value means that the respondent is price sensitive. The outer loading value of the CS1 indicator (purchase price: 0.806), CS2 (battery cost: 0.79), CS3 (charging cost: 0.76), and CS4 (maintenance cost: 0.775). They show that the purchase price of an EM has the highest value, which means the purchase price has a significant influence on EM purchase intention in Indonesia.

H3. Technological has a significant positive effect on EM purchase intention. Fig. 2 and the significance in Table 11 support Hypothesis 3, which states that technological factors significantly affect EM purchase intention (path coefficient = 0.211, p-value = 0.00). This positive value illustrates that respondents pay attention to technological factors to decide EM adoption. Outer loading value for TE1 (mileage capability: 0.783), TE2 (power: 0.782), TE3 (battery charging time: 0.795), TE4 (safety: 0.758), and TE5 (battery life: 0.793) showing all indicators are important components to build technology variables.

H4. Macro-level has a significant positive effect on EM purchase intention. The value of the path coefficients in Fig. 2 and the significance in Table 11 support Hypothesis 4, which states that the macro-level factor has a significant positive effect on EM purchase intention (path coefficient = 0.427, p-value = 0.00). This positive value illustrates that respondents consider macro-level factors as the most critical factor in adopting EMs. The outer loading value of ML1 (availability of charging station infrastructure in public places: 0.808), ML2 (availability of charging station infrastructure at work: 0.832), ML3 (availability of charging station infrastructure at home: 0.821), ML4 (availability of service places: 0.839), ML5 (purchase incentive policy: 0.815), ML6 (annual tax discount incentive policy: 0.793), and ML7 (charging charge discount incentive policy: 0.808) showing all indicators are important components to build macro-level variables.

H5. Micro-level has a significant indirect positive effect on EM purchase intention through cost.

The significance value for the micro-level (MI) indirect effect on the purchase intention of EMs (IP) through cost factors (CS) is 0.003, so that it supports Hypothesis 5. Respondents who have extensive social networks and environmental awareness are also concerned about the cost factor on the purchase intention of EMs. It can be attributed to cost effects which have a significant positive impact on the intention to adopt.

H6. The cost has a significant indirect positive effect on EM purchase intention through technological factors. The significance value for the indirect cost effect (CS) on the intention to adopt an EM (IP) through technological factors (TE) is 0 so that it supports Hypothesis 6. High battery costs and purchase prices are considered hindering the adoption of EMs from a consumer perspective. It can be attributed to technology's effect, which has a significant favorable influence on adoption intention.

H7. Technological has a significant indirect positive effect on EM purchase intention through macro-level factors. The significance value for the indirect impact of technology (TE) on the intention to adopt an EM (IP) through macro-level factor (ML) is 0 so that it supports Hypothesis 7. Providing the infrastructure that can meet consumer needs such as fast-charging stations (related to the time charging power) and the availability of a charging station (associated with the maximum mileage of vehicles) suffices to offset the specifications of the existing EM technology.

H8. The cost has a significant positive effect indirectly on EM purchase intention through macro-level factors. The significance value for the indirect cost influence (CS) on the intention to adopt an EM (IP) through a macro-level factor (ML) is 0 so that it supports Hypothesis 0. Purchase subsidies indicate macro-level variables and become a policy that influences the macro-level variable. It can be attributed to cost effects which have a significant positive impact on the intention to adopt.

4.1 Direct effect analysis

The size of an online social network indicator on micro-level variables shows the importance of social media as a means for the public to obtain information about EMs, which also influenced the people's purchase intention of EMs. The government and entrepreneurs can utilize resources derived from social relations in Indonesia. For example, entrepreneurs may do promotions by giving bonuses or appreciation to consumers who have bought EMs and share positive things related to EM online on social media. This method might make a new EM user. Then, the government may socialize or introduce EMs to the public through social media. These results are consistent with Habich-Sobiegalla et al. (2018), which stated that citizens of Brazil, Russia, and China who have extensive social networks also have a high purchase intention of electric vehicles (EVs). Environmental awareness also has a significant effect on EM purchase intentions. This result is suitable with Sang & Bekhet (2015) and Zhuge & Shao (2019), which explained that environmental concern or awareness significantly influences the purchase intention of EVs. Age and education background indicators do not considerably affect the purchase intention of EMs, and these results are consistent with the Brazilian and Russian citizens but differ from the Chinese citizens have a weak effect (Habich-Sobiegalla et al., 2018). This research proves how significant the influence of macro-level variables is in supporting the purchase of EMs in Indonesia.

The cost includes battery costs, charging fees, and maintenance costs indicators affecting consumer intentions to buy EMs. These results are consistent with the results of other studies, which stated that battery costs (Kim et al., 2018; Krause et al., 2013) and charging costs (Browne et al., 2012; Sang & Bekhet, 2015) affect the purchase intention of EVs. Consumers are sensitive to the purchase price of EMs and the purchase price of EVs (Kim et al., 2018; Sierzchula, 2014). On the cost variable, the purchase price significantly affects the intention to purchase an EM; this is linked with the incentive for the purchase subsidy, which is also significant. The EM maintenance costs that are cheaper than conventional motorcycles are also high towards the purchase intention of EMs. Therefore, the availability of services places that meet consumer needs will further encourage the purchase intention of EMs.

Technology factors including mileage capability, power, battery charging time, safety, and battery life indicators are concerns for respondents. The EVs study also showed that consumers have concerns about mileage capability (Guerra, 2019; She et al., 2017), power (Egbue & Long, 2012), battery charging time (Egbue & Long, 2012; Guerra, 2019), safety (Sang & Bekhet, 2015; She et al., 2017), and battery life (Graham-Rowe et al., 2012; Habich-Sobiegalla et al., 2018). This result is very reasonable considering that consumers will compare the technological capabilities between EMs and gasoline motorcycles. The performance of EMs has met the needs of consumers to fulfill their daily mobility. The maximum speed of the EMs and the battery charging time can meet the standards desired by the community. However, better motorcycle performance, such as increased safety, battery life, and the ability of EM mileage, will increase the intention of adopting an EM. Besides increasing technology investment, the government and producers must also improve safety and reliability evaluation systems for EMs to increase public trust. For manufacturers, promoting quality and performance is one of the most effective ways to increase consumer enthusiasm for EMs. Besides, respondents with higher environmental awareness are more likely and willing to use EMs.

In the PLS-SEM analysis, it was found that the macro-level had the most significant influence to purchase intention among other variables. Research results for EVs also showed that consumers have concerns about the availability of charging station infrastructure (Caperello & Kurani, 2012; Jensen et al., 2013; She et al., 2017), availability of service places (Krupa et al., 2014), and incentive policy (Kim et al., 2018; She et al., 2017). These results indicate that the macro-level factor is a barrier to consumers' intention to buy EMs. Most respondents consider the availability of charging infrastructure and service places as a very influencing factor in the adoption of EMs. The government shall provide charging infrastructure in public places to support the adoption of EMs. The government can also work together with the private sector to realize this. In compiling macro-level indicators, this study proposes several incentive policy options. The most significant incentive policies are purchasing incentive policies and charging cost discount incentive policies which the government can consider to support the adoption of EMs in Indonesia.

4.2 Indirect effect analysis

The results show that the micro-level factor has a significant direct positive effect on Indonesian consumers' EM purchase intention and has a significant indirect effect on EM purchase intention through the cost factor. This micro-level factor is limited to social network size and environmental awareness indicators, which have a strong influence on the cost factor that mediates its effect on EM purchase intention. If EM can be widely promoted through social media networks and consumers have higher environmental awareness, it will affect the determination of the selling price of EM and its batteries so that it can increase the purchase intention of EM.

The cost factor has a significant direct effect on EM purchase intention and strongly influences the technological and macro-level factors that mediate its effect on EM purchase intention. It can be attributed to technological and macro-level factors that significantly influence purchase intention. If manufacturers can provide EM and batteries at affordable prices, it will encourage the development of EM technology which has a better travel range, power, battery life, charging time, and safety so that people intend to buy EM. In addition, it also could encourage providing more battery charging stations and incentives or subsidies so that people are willing to buy EM.

Meanwhile, technological factors have a significant direct positive effect on EM purchase intentions and have a significant indirect effect on EM purchase intentions through macro-level factors. The development of EM technology to have a more extended travel range and shorter charging time will encourage the development of more charging stations and incentives for charging fees (e.g. bulk electricity tariffs for charging stations), thereby increasing public interest in buying EM.

4.3 Recommendations for policy makers and businesses

According to the results, the availability of charging stations at work and home significantly influences the intention of adopting an EM. Besides, the charging cost discount incentive policy ranks first with the most significant policy effect on the intention to adopt an EM. Providing the provision and standard of charging station infrastructure by the Ministry of Energy and Mineral Resources and the charging tariff provisions and the charging station procurement business scheme can be a good policy to encourage the adoption of EMs. The government can also take the public-private partnership model to construct charging station infrastructure (Samosir et al., 2018; She et al., 2017).

Based on the study results, the purchase price significantly affects the intention to adopt an EM. The purchase subsidy policy ranks as the most significant policy affecting the adoption intention. Providing fiscal incentives such as exemption from import duties given for the type of CKD (Completely Knocked Down) until 2022 and for the kind of IKD (Incompletely Knocked Down) until 2025 and providing incentives for purchasing an EM can encourage the private party to produce EMs and reduce the high price of EMs (Eccarius & Lu, 2020b; She et al., 2017).

Another policy recommendation supports the entry of many EM manufacturers and allows many EMs to be sold in the local market. Technical provisions for EMs include registration of vehicle identification numbers and types, technical requirements and roadworthiness, identification, classification, and registration of EMs. This policy was implemented in Taiwan and is considered the most successful after failing with the purchase subsidy policy. It is also applied in China and ranks among the most simultaneous policies (She et al., 2017). This action is supported by technological factors that significantly influence adopting EMs (Caperello & Kurani, 2012; Jensen et al., 2013; She et al., 2017).

The government, manufacturers, research and development institutions, and citizens must participate in all stages to successfully implement EMs in Indonesia. Active collaboration between key stakeholders is needed to support adopting EMs in Indonesia. The government can issue some policies to accelerate the adoption of EMs in Indonesia, such as reducing sales of conventional motorcycles, giving fiscal, taxes, and purchases incentives, and providing charging stations infrastructure. The government can also issue the technical procedures regarding business schemes for charging station installation and registration of vehicle numbers, type tests, and roadworthiness tests for EMs.

The EM market in Indonesia has just entered the introduction stage so that all supporting sectors in accelerating EM adoption can be developed to increase the EM's market share. The private company can help to provide the charging station infrastructure to accelerate EM adoption. This support will have a very significant effect on the purchase intention of EMs in Indonesia. Manufacturers and business people also need to campaign for EMs regarding security and conformance guarantees, the advantages of EMs, infrastructure readiness, and how to use the infrastructure.

5. CONCLUSIONS

The substitution with electric motorcycles (EMs) can be the best solution to overcome the problem of high CO_2 levels in Indonesia. The government has tried to realize the adoption of electric vehicles (EVs) by establishing various policies in Indonesia in 2017 and 2019. Nevertheless, since 2018, the reality of EV adoption for Indonesia is still far from the government's target. More detailed technical policies from the government are needed, and the lack of supporting infrastructure has led to the low adoption of EVs in Indonesia.

This research conducted a survey involving 1,223 respondents. Respondents came from 10 provinces which have over 80% of the total motorcycle sales distribution in Indonesia. This research explores significant factors that influence the purchase intention of EMs in Indonesia. Although most respondents have a positive response about EMs, their interest in adopting EM is relatively low. Respondents do not want to buy EM shortly due to various reasons such as lack of infrastructure and policies, and many respondents have the attitude of wait and see towards the adoption of EMs.

The adoption model for EMs is developed to determine the effect of micro-level, cost, technology, and macro-level factors on EM purchase intention. This model directly relates these four factors to EM purchase intention to determine their effect on EM purchase intention. Meanwhile, micro-level, cost, and technology factors are indirectly related to EM purchase intention to determine their effect on EM purchase intention. The results show that micro-level, cost, and technology factors have a significant direct or indirect influence on EM purchase intention. Meanwhile, the macro-level factor only directly affects EM purchase intention.

This study proves how significant the influence of macro-level factors is on the intention to use EMs in Indonesia. Government support is essential (procurement of charging infrastructure and incentive policy) to accelerate the adoption of EMs in Indonesia. Technological factors such as mileage capability and battery life need to be considered by producers to be improved to support the adoption of EMs. Cost factors such as purchase prices and battery costs also need to concern producers and the government. Infrastructure readiness and costs that prospective users can receive are required to realize the mass use of EMs in Indonesia.

This research still has several limitations that provide opportunities for future research. Since this study is based on the preferences of EM respondents while EM adopters are still relatively rare in Indonesia, the gap between consumer purchase intentions and actual behavior may exist. In addition, this study only focuses on objective factors and does not consider subjective factors such as attitude, subjective norms, behavior, motivation, and others. Studies to explore the influence of emotional factors on purchase intentions can be interesting. Finally, also essential to examine preferences with a broader scale survey for all Indonesian provinces.

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APPENDIX

Constructs	Items
Micro-level	How many people can you reach through your social media? I am a person who cares about the environment
Cost	The purchase price of an electric motorcycle is in accordance with my budget The battery replacement cost is in accordance with my budget to maintain a motorcycle Because charging cost is cheaper than gasoline price, so I want to buy an electric motorcycle The maintenance cost of an electric motorcycle is relatively cheaper than a conventional motorcycle
Technological	The maximum mileage of an electric motorcycle can meet my daily activities The maximum speed of an electric motorcycle can still meet my expectations The charging time of an electric motorcycle is still acceptable I feel safe when riding an electric motorcycle though the sounds is low The battery life is about 3 years is still in accordance with my expectations
Macro-level	Availability of a charging station at a public place can make me want to buy an electric motorcycle Availability of a charging station at a work place can make me intend to buy an electric motorcycle Availability of a charging station in my residential area can make me intend to buy an electric motorcycle The availability of easy-to-find service centers can make me want to have an electric motorcycle Subsidies on the price of electric motorcycles make me intend to buy an electric motorcycle The electric motorcycle tax discount makes me want to buy an electric motorcycle The discount on power charging fees makes me want to have an electric motorcycle
Purchase Intention	I want to buy an electric motorcycle I want to recommend an electric motorcycle to others

Table A1. Questionnaire items

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