Research Article

Adoption Intention Model of Electric Vehicle in Indonesia

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ABSTRACT

Indonesia's government was targeting the adoption of 2.1 million units of two-wheeled electric vehicles and 2,200 units of four-wheeled electric vehicles in 2025 through the Republic of Indonesia's Presidential Regulation No. 22 in 2017 about the National Energy General Plan. In 2019, the Government of Indonesia issued Presidential Regulation No. 55 in 2019 concerning the Acceleration of the Battery Electric Vehicle Program for Road Transportation. In 2018, the adoption of two-wheeled electric vehicles only reached 0.14% of the government's target for 2025. Therefore, the adoption of Electric Motorcycle (EM) technology must also consider many factors to be successful. This research develops a non-behavioral electric vehicle adoption intention model. The factors include sociodemographic, financial, technological, and macro-level. The online survey involved 1,223 respondents. Logistic regression is used to obtain the function and probability value of intention to adopt EM in Indonesia. Frequency of sharing on social media, level of environmental awareness, purchase prices, maintenance costs, maximum speed, battery charging time, availability of charging station infrastructure at work, availability of home power based - charging infrastructure, purchase incentive policies, and charging cost discount incentive policies are significantly influencing the intention to adopt electric vehicles. It also shows that the opportunity for Indonesians to adopt electric motorcycles reaches 82.90%. The realization of the adoption of electric motorcycles in Indonesia requires infrastructure readiness and costs that can be accepted by consumers. Lastly, the results of this research provide some suggestions for the government and businesses to accelerate electric motorcycle adoption in Indonesia.

INTRODUCTION

The economic sector in Indonesia (transportation, electricity generation, and households) mostly use fossil fuels. Some of the negative effects of the high dependency on fossil fuels are the increased allocation for fuel subsidies, energy sustainability problems, and high levels of CO_2 emissions. Transportation is a major sector that contributes to high levels of CO_2 in the air due to the many uses of fossil fuel vehicles. This research focuses on motorcycles because Indonesia, as a developing country, has more motorcycles than cars. The number of motorcycles in Indonesia reached 120,101,047 units in 2018 [1] and motorcycle sales reached 6,487,460 units in 2019 [2]. Shifting the transportation sector to alternative energy sources can reduce high CO_2 levels. The realistic solution for this problem is to implement green logistics through penetration of electric vehicles in Indonesia such as hybrid electric vehicles, plug-in hybrid electric vehicles, and battery electric vehicles [3]. Electric vehicle technology innovation and battery technology innovation can provide transportation solutions that are environmentally friendly, energy efficient, and lower operational and maintenance costs [4].

Electric vehicles are many discussed by countries in the world. In the global electric vehicle business, there was a significant sales growth for two-wheeled electric motorcycles which reached 58% or around 1.2 million units from 2016 to 2017. This sales growth indicates a good response from countries in the world about the development of electric motorcycle technology that someday, electric motorcycles expected to replace fossil-fueled vehicles. The research object is Electric Motorcycle (EM) that consists of New Design of Electric Motorcycle (NDEM) and Converted Electric Motorcycle (CEM). The first type, the New Design of Electric Motorcycle (NDEM), is a vehicle designed by the company that uses electric technology for its operations. Some countries in the world such as Australia, Germany, England, France, Japan, Taiwan, South Korea, and China already used electric motorcycles as a substitute product for fossil-fueled motorcycle vehicles [5]. One brand of electric motorcycles is Zero Motorcycle which manufactures sport electric motorcycles [6]. PT. Gesits Technologies Indo has also produced two-wheeled electric motorcycles under the brand Gesits. The second type is a CEM. Converted electric motorcycle is an oil-fueled motorcycle where the motor and engine parts replaced with Lithium Ferro Phosphate (LFP) battery kits as an energy source. Although many

countries produce electric motorcycle, no one has created the vehicle by using conversion techniques. Conversion can be done on a two-wheeled motorcycle that is no longer used by its users. Universitas Sebelas Maret is a pioneer in manufacturing CEM and technically prove that Lithium-Ion batteries can replace fossil fuel energy sources on conventional motorcycles. CEM uses LFP technology, this battery does not explode when a short circuit occurs. Besides that, the LFP battery has a long usage life of up to 3000 usage cycles and longer than current commercial EM batteries (such as Lithium-Ion Battery and LiPo Battery). CEM can travel 55 km/charge and have maximum speed up to 70 km/hour [7]. Jodinesa, et al. [8] examined the market share of convertible electric motorcycles in Surakarta, Indonesia and resulted that the people of Surakarta responded positively to the CEM. From the explanation above, it can be seen that the opportunity for electric motorcycles is huge. Several studies on standards related to electric vehicles and batteries have been developed, such as the Lithium Ion battery standard by Sutopo et al. [9], the battery management system standard by Rahmawatie et al. [10], and electric vehicle charging standards by Sutopo et al. [11].

The slow rate of electric vehicles adoption in Indonesia has prompted the government to release several policies for the development of the automotive industry and planned to target the adoption of 2.1 million units of electric motorcycles and 2,200 units of electric cars in 2025. Besides, the government was also targeting Indonesia to be able to produce 2,200 electric or hybrid cars which are stated in the Republic of Indonesia's Presidential Regulation No. 22 of 2017 concerning the National Energy General Plan. This regulation has been applied by various countries such as France, England, Norway, and India. The Ministry of Energy and Mineral Resources has been set a target that starting in 2040, sales of Internal Combustion Engine Vehicles (ICEV) are prohibited and the public is asked to use electric-based vehicles [12]. In 2019 the Government of Indonesia issued Presidential Regulation No. 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program for Road Transportation. This effort is a step to overcome two problems, namely the depletion of fuel oil reserves and air pollution. Regarding air pollution, Indonesia has committed to reducing 29% of carbon dioxide emissions by 2030 as a result of the Paris Climate Change Conference held in 2015. In 2018, the penetration of two-wheeled electric vehicles only reached 0.14% of the government's target is 2025, while for four-wheeled electricity reached more than 45%. In December 2017, there were at least more than 1,300 public electric charging stations available nationwide in 24 cities, wherein 71% (924 refilling stations) located in DKI Jakarta [13].

Many countries have researched about electric vehicle adoption, but in Indonesia, national scale research have not been done before. There have been many kinds of research in some countries that have conducted studies on the adoption of new technologies by using several methods such as multiple linear regression to know electric vehicle usage intention in Malaysia [14], Structural Equation Modelling (SEM) to know adoption of battery electric vehicles' barriers in Tianjin, China [15], exploratory factor analysis & multivariate regression model to know barriers amongst electric vehicle drivers in the United Kingdom [16], and

logistic regression to know the factors influencing the uptake of electric vehicles in Beijing, China [17].

The purposes of this research are to develop an adoption model for electric motorcycles in Indonesia, to find the factors that influence the intentions of adopting electric motorcycles in Indonesia, and to determine the function opportunities for the adoption of electric motorcycles in Indonesia. Modelling the factors is important to find out which factors that influence the intention to adopt electric motorcycles in Indonesia. These influential factors can be used as a reference to formulate appropriate policies to accelerate the adoption of electric motorcycles. These significant factors are a picture of the ideal conditions desired by potential electric motorcycle users in Indonesia. Some ministries in Indonesia related to the formulation of policies regarding electric vehicles are the Ministry of Industry which deals with vehicle tax rules based on its emissions that deal directly with electric vehicle manufacturers, the Ministry of Transportation which runs the feasibility test of electric vehicles that will pave on the highway such as battery tests and so forth, as well as The Ministry of Energy and Mineral Resources which is reponsible to formulate the Electric Vehicle Charging Station tariffs to the infrastructure of electric vehicle charging businesses. Electric vehicle innovation also encourages the birth of new business entities in the supply chain including technopreneurs and start-ups from developers, suppliers, manufacturers, and distributors of electric vehicle products / services and their derivatives to the market [24]. Electric motorcycle entrepreneurs can also develop technology and marketing by considering these significant factors in order to support the realization of electric motorcycles instead of conventional motorcycles in Indonesia.

Ordinal logistic regression used to obtain the function and probability value of intention to adopt electric motorcycles in Indonesia using SPSS 25 software. Logistic regression or logit regression is an approach to make predictive models. Logistic regression in statistics used to predict the probability of an event occurring by matching the data in the logit curve logistic function. This method is a general linear model for binomial regression [18]. Logistic regression has been used to predict the acceptance of internet and mobile banking adoption [19], predict the acceptance of photo voltaic technology adoption in the Netherlands [20], predict the acceptance of telemonitoring system technology for health [21], and to find out the technical obstacles that affect the decision to adopt cloud services [22]. Utami et al. [23] who previously conducted research on consumer perceptions of electric vehicles in Surakarta, found that purchase prices, models, vehicle performance, and infrastructure readiness were the biggest barriers for people adopting electric vehicles.

METHOD

The data collected in this research are primary data obtained through online surveys to find out opportunities and factors that influence the intention to adopt electric motorcycles in Indonesia.

Questionnaire and Survey

The online survey was distributed to 1,223 respondents in eight provinces in Indonesia to explore the factors influencing the intention to adopt electric motorcycles in Indonesia. These chosen

provinces had more than 80% of motorcycle sales in Indonesia [2]: West Java, East Java, Jakarta, Central Java, North Sumatra, West Sumatra, Yogyakarta, South Sulawesi, South Sumatra, and Bali. The factors explored are shown in Table 1. General knowledge about electric motorcycles was provided at the beginning of the questionnaire by using video to avoid misunderstandings.

The questionnaire was divided into five sections: screening section, sociodemographic section, financial section, technological section, and macro-level section. The questionnaire was presented in a Likert scale of 1 to 5, where 1 for strongly disagree, 2 for disagree, 3 for doubt, 4 for agree, and 5 for strongly agree. Determination of the minimum sample size refers to [25], stated that observational studies with large population sizes involving logistic regression requires minimum sample size of 500 to obtain statistics representing parameters. Cluster sampling

or area sampling with proportions is used in this research because the population of motorcycle users in Indonesia is very large. Besides, purposive sampling is used to determine samples based on certain criteria [26]. Online surveys are carried out through Facebook Ads. Eligible respondents are people aged ≥ 17 years old, having a SIM C, being one of the decision-makers to replace or buy a motorcycle, and domiciled in one of the provinces in Table 1.

Theoretical Framework

She et al. [15] and Habich-Sobiegalla et al. [28] used frameworks for a systematic categorization of factors that drive or obstruct the adoption of electric vehicle by consumers. We adapted these frameworks by modifying it based on our analysis of electric motorcycle literature on the consumer adoption of electric motorcycles. We have visualized it in Table 1.

Table 1. Explanation and Reference of Factors and Attributes

Factor	Code	Artribute	Ref.
Sociodemographic	SD1	Marital status	[27], [28]
	SD2	Age	
	SD3	Gender	
	SD4	Last education	
	SD5	Occupation	
	SD6	Monthly consumption level	
	SD7	Monthly income level	
	SD8	Number of motorcycle ownership	
	SD9	Frequency of sharing on social media	
	SD10	Size of online social network	
	SD11	Environmental awareness	
Financial	FI1	Purchase price	[29]
	FI2	Battery cost	[30]
	FI3	Charging cost	[31]
	FI4	Maintenance costs	[32]
Technological	TE1	Mileage capability	[33]
	TE2	Power	[33]
	TE3	Charging time	[33]
	TE4	Safety	[34]
	TE5	Battery life	[35]
Macro-level	ML1	Charging station availability in public places	[36]
	ML2	Charging station availability at work	[15]
	ML3	Charging station availability at home	[37]
	ML4	Service places availability	[38]
	ML5	Purchase incentive policy	[15]
	ML6	Annual tax discount policy	[15]
	ML7	Charging cost discount policy	[15]
Adoption intention	IP	Intention to use	[15]

Sociodemographic Factor

Sociodemographic factor is personal factors that influence an individual's behavior in decision making. Eccarius et al. [28] stated on their adoption model that age, gender, marital status, education, income, occupation, and vehicle ownlership are important factors impacting the electric vehicle adoption. Habich-Soebigalla et al highlight social network factors such as number of motorcycle ownership, frequency of sharing on social media, and size of online social network be the influencing factors for electric vehicle adoption [28]. Eccarius et al. [27] and Habich-

Sobiegalla et al. [28] also considered environmental awareness belongs to socialdemographic factors.

Financial Factor

Purchase price is the original price of an electric motorcycle without any purchase subsidies. Sierzchula et al. [29] said that the high purchase price of electric vehicle caused by the highest battery capacity. Battery cost is the cost of replacing the battery when the old battery life has run out. Krause et al. researched that battery cost is belongs to financial barrier for someone to adopt an electric vehicle [30]. Charging cost is the cost of electricity to

power an electric motorcycle compared to the cost of gasoline [31]. Maintenance costs is routine maintenance costs for electric motorcycles, not repairs because of accident that impacting electric vehicle adoption [32].

Technological Factor

Mileage capability is the furthest distance after the electric motorcycle battery is fully charged. Zhang et al. [33] said that vehicle performance refers to consumers evaluation on electric vehicle including mileage capacity, power, charging time, safety, and battery life. Power is the maximum speed of an electric motorcycle. Charging time is overall time to fully charge an electric motorcycle. Safety feeling when riding an electric motorcycle related to sound (dB) is the factors that highlight by Sovacool et al. [34] to be factors that impacting consumer perception on electric vehicle. Graham-Rowe et al. [35] said that battery life is considered to be degraded.

Macro-level Factor

Infrastructure of charging station availability is something that can not be avoid for electric motorcycle adopter. Charging availability in public places is considered important to support electric vehicle adoption [36]. Charging availability at work [15] and charging availability at home [37] also needed by consumers to fulfill the battery of their vehicle. Krupa et al. [38] said that the availability of service places for routine maintenance and damage is impacting adoption of electric vehicle. She et al. [15] suggested some public incentives which is very wanted by consumers in Tianjin such as providing subsidies for purchasing electric motorcycles, annual tax discount for electric motorcycles, and charging cost discount policy when consumers need to charge electric motorcycle in public places [15].

Ordinal Logistic Regression

Ordinal logistic regression is one of the statistical methods that describe the relationship among a dependent variable with one or more independent variables, where the dependent variable is more than 2 categories and the measurement scale is level or ordinal [39]. Equation 1 is a model for ordinal logistic regression and Equation 2 shows the function g(x) as logit equation.

$$P(x) = \frac{e^{g(x)}}{1 + e^{g(x)}} \tag{1}$$

$$g(x) = \beta_{0j} + \sum_{k=1}^{m} \beta_k X_{ik} \tag{2}$$

RESULTS AND DISCUSSION

The questionnaire was distributed online on March - April, 2020, through paid Facebook Ads by setting filter area: West Java, East Java, Jakarta, Central Java, North Sumatra, West Sumatra, Yogyakarta, South Sulawesi, South Sumatra, and Bali which reached 21,628 users. Total incoming responses were 1,443 responses, but only 1,223 responses were eligible for data processing. Table 2 shows the demographics of respondents.

Descriptive Statistics

Table 3 shows descriptive statistics for quantitative variables. Charging cost discount, annual tax discount, and purchase price subsidies have higher average among other factors. This illustrates that most respondents consider that there is a policy the government-given intensive was able to encourage them to adopt electric motorcycles.

On financial factors, purchase price and battery cost have lower average among other factors. This illustrates that the purchase price of an electric motorcycle and battery cost are not suitable with the budget of most respondents. Most respondents considered the price of electric motorcycle was too expensive when compared to the price of a conventional motorcycle. The replacement cost of battery every three years which reaches IDR 5,000,000 is also too expensive fot most respondents so that the purchase price and battery cost are a barrier for Indonesian to adopt electric motorcycles.

Battery life, power, charging time have low average scores in descriptive statistics but the average scores for these three factors is more than 4. Charging time which took three hours was too long for most respondents. The maximum speed of an electric motorcycle is 70 km/h and a 3-year battery life is not met the needs of the respondents. This illustrates that most respondents consider performance electric motorcycles are not met their standards. Altough respondents have not fully trusted the performance of electric motorcycles, EM can meet their daily mobility needs.

More respondents gave more score to the charging availability in their homes and offices than in public places. However, a barrier that often found is that home electricity power is still below 1300 VA, making respondents strongly expect the government to be able 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 office.

Table 4 shows the responses of respondents to the adoption of electric motorcycles. It shows that 45,626% of respondents have a strong willingness to use an electric motorcycle. This result shows a bright future for the electric motorcycle market share. Table 4 also shows that almost 55% of respondents do not have a strong willingness to use an electric motorcycle. The interesting results from these descriptive statistics imply that although the enthusiasm for using electric motorcycles still requires stimulation, public acceptance of electric motorcycles is good. Another reason that might occur is that respondents have the attitude to wait and see the adoption of an electric motorcycle or whether someone else uses an electric motorcycle or not.

Ordinal Logistic Regression

Data are process and analyze to determine the adoption intention of electric motorcycles in Indonesia using ordinal logistic regression. The dependent variable in this research is the willingness to use an electric motorcycle (1: strongly unwilling, 2: unwilling, 3: doubt, 4: willing, 5: strongly willing). Ordinal logistic regression was chosen as the method in this research because the dependent variable uses the ordinal scale. Data were

processed using SPSS 25 software with a confidence level of 95%. Multicollinearity tests have been carried out to calculate Variance Inflation Factors (VIF) with an average VIF of 1.15-3.693, which means there is no multicollinearity in the model.

The hypothesis used in ordinal logistic regression is shown in Table 5. Table 6 shows the partial test results to be the basis for rejecting or accepting the hypothesis for ordinal logistic regression.

Table 2. Demographics of Respondents

Demographic	Item	Freq	%	Demographic	Item	Freq	%
Domicile	West Java	345	28.2%	Occupation	Student	175	14.3%
	East Java	162	13.2%		Civil servants	88	7.2%
	Jakarta	192	15.7%		Private employees	415	33.9%
	Central Java	242	19.8%		Entrepreneur	380	31.1%
	North Sumatera	74	6.1%		Others	165	13.5%
	Yogyakarta	61	5.0%				
	South Sulawesi	36	2.9%	Age	17-30	655	53.6%
	Bali	34	2.8%		31-45	486	39.7%
	West Sumatera	26	2.1%		46-60	79	6.5%
	South Sumatera	51	4.2%		>60	3	0.2%
Marital status	Single	370	30.3%	Last Educational	SMP/SMA/SMK	701	57.3%
	Married	844	69.0%	Level	Diploma	127	10.4%
	Others	9	0.7%		Bachelor	316	25.8%
Gender	Male	630	51.5%		Master	68	5.6%
	Female	593	48.5%		Doctoral	11	0.9%
Monthly	0	154	12.6%	Monthly	< IDR 2,000,000	432	35.3%
income level	< IDR 2,000,000	226	18.5%	consumption	IDR2,000,000-5,999,999	640	52.3%
	IDR 2,000,000-5,999,999	550	45%	level	IDR6,000,000-9,999,999	121	9.9%
	IDR 6,000,000-9,999,999	199	16.3%		≥ IDR 10,000,000	30	2.5%
	IDR10,000,000-19,999,999	71	5.8%				
	≥ IDR 20,000,000	23	1,9%				

Table 3. Descriptive Statistics for Financial, Technology, and Macro-level

Variable	Average	Rank	Variable	Average	Rank
ML7 (charging cost disc.)	4.4563	1	ML3 (CS at home)	4.1554	9
ML6 (annual tax disc.)	4.4301	2	ML2 (CS at workplaces)	4.1055	10
ML5 (purchase incentive)	4.4146	3	ML1 (CS in public places)	4.0965	11
TE4 (safety)	4.3181	4	TE5 (battery life)	4.0924	12
FI3 (charging cost)	4.2518	5	TE2 (power)	4.0597	13
TE1 (mileage capability)	4.2396	6	TE3 (charging time)	4.0303	14
ML4 (service place)	4.2142	7	FI1 (purchase cost)	3.8814	15
FI4 (maintenance cost)	4.1980	8	FI2 (battery cost)	3.5045	16

Table 4. Descriptive Statistics for Adoption Intention

	1:strongly unwilling	2:unwilling	3:doubt	4:willing	5:strongly willing
Willingness to use electric motorcycle	0.327%	2.044%	15.863%	36.141%	45.626%

The results of logistic regression analysis for variables SD1 through SD11 which are belongs to sociodemographic factors show the results that only the frequency of sharing on social media (SD9) and the level of environmental concern (SD11) have a significant effect on the intention of electric motorcycles in Indonesia. The significant values for the qualitative variable of marital status are 0.622 for single and 0.801 for married. Those values do not support Hypothesis 1. Marital status does not significantly influence the intention of adopting an electric motorcycle because the significant value is more than 0.05. The significant value for age is 0.147 so that age does not significantly influence the intention to adopt an electric motorcycle. The value of estimate for the age of -0.168 does not support Hypothesis 2. The negative sign means that the higher the age, the lower the intention to adopt an electric motorcycle.

The significant value for the qualitative variable, gender, (0.385) does not support Hypothesis 3. Gender does not significantly influence the intention to adopt an electric motorcycle. The significant value for the last level of education (0.603) does not support Hypothesis 4. So, the last education does not significantly influence the intention to adopt an electric motorcycle. The value of estimate for the last education level of 0.036 means a positive sign means the higher the level of education the higher the intention to adopt an electric motorcycle. The significant value for the qualitative variable of the occupation was 0.487 for students, 0.999 for civil servants, 0.600 for private employees, and 0.480 for entrepreneurs not supporting Hypothesis 5. Occupation does not significantly influence the intention to adopt an electric motorcycle.

Tabel 5. Hypothesis

	Hypothesis
Socio-Demo-graphic	H_1: marital status has a positive significant effect on the intention of adopting an electric motorcycle.
	H_2: age has a positive significant effect on the intention of adopting an electric motorcycle.
	H_3: gender has a positive significant effect on the intention of adopting an electric motorcycle.
	H_4: last education level has a positive significant effect on the intention of adopting an electric motorcycle.
	H_5: occupation has a positive significant effect on the intention of adopting an electric motorcycle.
	H_6: monthly consumption level has a positive significant effect on the intention of adopting an electric motorcycle.
	H_7: monthly income level has a positive significant effect on the intention of adopting an electric motorcycle.
	H_8: number of motorcycle ownership has a positive significant effect on the intention of adopting an electric motorcycle.
	H_9: frequency of sharing on social media has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{10}: size of online social network has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{11}: environmental awareness has a positive significant effect on the intention of adopting an electric motorcycle.
Financial	H_{12}: purchase price has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{13}: battery cost has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{14}: charging cost has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{15}: maintenance costs has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{16}: mileage capability has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{17}: power has a positive significant effect on the intention of adopting an electric motorcycle.
Techno-logical	H_{18}: charging time has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{19}: safety has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{20}: battery life has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{21}: availability of charging station infrastructure in public places has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{22}: availability of charging station infrastructure at work has a positive significant effect on the intention of adopting an electric motorcycle.
Macro-level	H_{23}: availability of charging station infrastructure at home has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{24}: service places availability has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{25}: purchase incentive policy has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{26}: annual tax discount policy has a positive significant effect on the intention of adopting an electric motorcycle.
	H_{27}: charging cost discount policy has a positive significant effect on the intention of adopting an electric motorcycle.

Table 6. Logistic Regression Partial Test Results

Var	Value	Sig	Var	Value	Sig
SD1:single	0.349	0.622	TE1	0.146	0.069
SD1:married	0.173	0.801	TE2	0.167	0.726
SD1:others	0		TE3	0.240	0.161
SD2	-0.168	0.147	TE4	-0,005	0.013*
SD3:male	0.117	0.385	TE5	0,068	0.765
SD3:female	0		ML1	-0.127	0.022*
SD5:students	-0.195	0.487	ML2	0.309	0.000*
SD5:civ. serv	0,0000	0.999	ML3	0.253	0.355
SD5:priv. emp	-0.110	0.6	ML4	0.134	0.109
SD5:entrepr	0.147	0.48	ML5	0.301	0.017*
SD5:others	0		ML6	-0.059	0.107
SD6	0.227	0.069	ML7	0.521	0.052
SD7	0.032	0.726	TE1	0.146	0.004*
SD8	0.180	0.161	TE2	0.167	0.962
SD9	0.111	0.013*	TE3	0.240	0.424
SD10	0.016	0.765	TE4	-0.005	0.254
SD11	0.226	0.022*	TE5	0.068	0.007*
FI1	0.348	0.000*	ML1	-0.127	0.009*
FI2	-0.069	0.355	ML2	0.309	0.181
FI3	0.136	0.109	ML3	0.253	0.017*
FI4	0.193	0.017*	ML4	0.134	0.672

* Significant at 95% confidence level

The significant value for the monthly consumption level (0.069) does not support Hypothesis 6, the monthly consumption level does not significantly influence the intention to adopt an electric motorcycle. The estimates value for the monthly consumption level of 0.227, a positive sign means the higher the level of monthly expenses the higher the intention to adopt an electric motorcycle. The significant value for the monthly income level (0.726) does not support Hypothesis 7, the monthly income level does not significantly influence the intention to adopt an electric motorcycle. The value of estimate for the monthly income level is 0.032, positive sign means that the higher the level of monthly income the higher the intention to adopt an electric motorcycle.

The significant value for the number of motorcycle ownership (0.161) does not support Hypothesis 8, the number of motorcycle ownership does not significantly influence the intention to adopt an electric motorcycle. The value of estimate for the level of motorcycle ownership is 0.180, positive sign means the more number of motorcycles owned, the higher the intention to adopt an electric motorcycle.

The significant value for the frequency of sharing on social media (0.013) supports Hypothesis 9, the frequency of sharing on social media has a significant effect on the intention of adopting an electric motorcycle because the significant value is less than 0.05.

The value of estimate for sharing frequency on social media is 0.111, positive sign means that the higher the frequency of sharing someone on social media, the higher the chance of adoption of an electric motorcycle. Significant value for size of online social network (0.765) does not support Hypothesis 10, the size of the reach of the social network does not significantly influence the intention of adopting a motorcycle. The value of estimate for the number of people reached in the social network is 0.016, positive sign means the higher the size of social media networks the higher the intention to adopt an electric motorcycle. The significant value for the level of environmental awareness (0.022) supports Hypothesis 11, the level of environmental concern has a significant effect on the intention to adopt an electric motorcycle. The value of estimate for the level of environmental awareness is 0.226, positive sign means that the higher the level of environmental concern a person has, the higher the intention to adopt an electric motorcycle.

The results of logistic regression analysis for the variables FI1 to FI4 which are belongs to financial factors show the results that the purchase price (FI1) and maintenance costs (FI4) have a significant effect on the intention of electric motorcycles in Indonesia. The significant value for the purchase price (0.00) supports Hypothesis 12, the purchase price has a significant effect on the intention of adopting an electric motorcycle. The value of estimate for the purchase price is 0.348, positive sign means that the more appropriate the purchase price of an electric motorcycle for someone, the higher the intention to adopt an electric motorcycle. The significant value for the battery cost (0.355) does not support Hypothesis 13, battery cost does not significantly influence the intention to adopt an electric motorcycle. The significant value for charging costs (0.109) does not support Hypothesis 14, charging cost has no significant effect on the intention to adopt an electric motorcycle. The value of estimate for the charging cost is 0.136, positive sign means that the more appropriate the cost of charging an electric motorcycle for someone, the higher the intention to adopt an electric motorcycle. The significant value for maintenance costs (0.017) does not support Hypothesis 15, maintenance costs have a significant effect on the intention to adopt an electric motorcycle. The value of estimate for maintenance costs is 0.193, positive sign means that the more appropriate the cost of electric motorcycle maintenance for someone, the higher the intention to adopt an electric motorcycle.

The results of the logistic regression analysis for variables TE1 through TE5 which are belongs to technological factors show the results that battery charging time (TE3) has a significant effect on the adoption intention of electric motorcycles in Indonesia. The significant value for mileage capability (0.107) does not support Hypothesis 16, mileage capability has no significant effect on the intention to adopt an electric motorcycle. The value of estimate for a maximum mileage is 0.146, positive sign means that the more appropriate the maximum mileage of an electric motorcycle for someone, the higher the intention to adopt an electric motorcycle.

The significant value for the independent variable power or maximum speed (0.052) does not support Hypothesis 17, maximum speed does not significantly influence the intention to adopt an electric motorcycle. The value of esimate for power or maximum speed is 0.167, positive sign means that the more appropriate the maximum speed of an electric motorcycle for a person, the higher the intention to adopt an electric motorcycle. The significant value for charging time (0.004) supports Hypothesis 18, charging time has a significant effect on the intention to adopt an electric motorcycle. The estimated value for charging time is 0.240, positive sign means that the more appropriate the maximum speed of an electric motorcycle for someone, the higher the intention to adopt an electric motorcycle.

The significant value for safety (0.962) does not support Hypothesis 19, safety does not significantly influence the intention to adopt an electric motorcycle. The value of estimate for safety is -0.005, negative sign means that the more secure someone feels using an electric motorcycle, the lower the intention to adopt an electric motorcycle. The significant value for battery life (0.424) does not support Hypothesis 20, the battery life has no significant effect on the intention to adopt an electric motorcycle. The value of estimate for battery life is 0.068, positive sign means that the more appropriate the life span of an electric motorcycle battery, the higher the intention to adopt an electric motorcycle.

The results of logistic regression analysis for variables ML1 to ML7 which are belongs to macro-level factors show the results that only charging availability in the workplace (ML2), charging availability in the residence (ML3), and charging cost discount policy (ML7) that have significant effect on the adoption intention of electric motorcycles in Indonesia. The significant value for the charging availability in public places (0.254) does not support Hypothesis 21, charging availability in public places does not significantly influence the intention to adopt electric motorcycle. The significant value for the charging availability at workplace (0.007) supports Hypothesis 22, charging availability at workplace has a significant effect on the intention of adopting an electric motorcycle. The significant value for the charging availability at a home (0.009) supports Hypothesis 22, availability of charging at home has a significant effect on the intention of adopting a motorcycle. The significant value for the availability of service places (0.181) does not support Hypothesis 24, the availability of service places has no significant effect on the intention of adopting an electric motorcycle. The significant value for the purchase incentive policy (0.017) supports Hypothesis 25, purchase incentive policy has a significant effect on the intention of adopting an electric motorcycle. The significant value for the annual tax discount policy (0.672) does not support Hypothesis 26, annual tax discount incentive policy has no significant effect on the intention of adopting an electric motorcycle. The significant value for the charging cost discount policy (0.00) supports Hypothesis 27, the charging cost discount incentive policy has a significant effect on the intention of adopting an electric motorcycle. According to the result from macro-level factor, electric motorcycle adoption can be realized if charging station in the workplace, charging station in the residence, and charging cost discount policy are ready to acces by consumers.

Overall, the frequency of sharing on social media, the level of environmental awareness, purchase prices, maintenance costs, the maximum speed of electric motorcycles, battery charging time, availability of charging station infrastructure at work, availability of home power based - charging infrastructure,

purchase incentive policies, and charging cost discount incentive policies are significantly influencing the intention to adopt electric vehicles.

Equation Model and Probability Function

Equation 3 is a logit equation for the choice of the answer "strongly unwilling" to adopt an electric motorcycle.

$$g(Y \leq 1 \mid X_n) = \beta_{01} + \sum_{k=1}^{27} \beta_k X_{ik} \tag{3}$$

Equation 4 is a logit equation for the choice of the answer "unwilling" to adopt an electric motorcycle.

$$g(Y \leq 2 \mid X_n) = \beta_{02} + \sum_{k=1}^{27} \beta_k X_{ik} \tag{4}$$

Equation 5 is a logit equation for the choice of the answer "doubt" to adopt an electric motorcycle.

$$g(Y \leq 3 \mid X_n) = \beta_{03} + \sum_{k=1}^{27} \beta_k X_{ik} \tag{5}$$

Equation 6 is a logit equation for the answer option "willing" to adopt an electric motorcycle.

$$g(Y \leq 4 \mid X_n) = \beta_{04} + \sum_{k=1}^{27} \beta_k X_{ik} \tag{6}$$

Probability functions of adoption intention electric motorcycles shown in Equation 7 to Equation 11. Equation 7 is the probablility function for the choice of the answer "strongly unwilling" to adopt an electric motorcycle.

$$
\begin{aligned}
P_1(X_n) &= P(Y \leq 1 \mid X_n) \\
&= \frac{e^{g(Y \leq 1 \mid X_n)}}{1 + e^{g(Y \leq 1 \mid X_n)}}
\end{aligned} \tag{7}
$$

Equation 8 is the probablility function for the choice of the answer "unwilling" to adopt an electric motorcycle.

$$
\begin{aligned}
P_2(X_n) &= P(Y = 2 \mid X_n) \\
&= P(Y \leq 2 \mid X_n) - P(Y \leq 1 \mid X_n) \\
&= \frac{e^{g(Y \leq 2 \mid X_n)}}{1 + e^{g(Y \leq 2 \mid X_n)}} - \frac{e^{g(Y \leq 1 \mid X_n)}}{1 + e^{g(Y \leq 1 \mid X_n)}}
\end{aligned} \tag{8}
$$

Equation 9 is the probablility function for the choice of the answer "doubt" to adopt an electric motorcycle.

$$
\begin{aligned}
P_3(X_n) &= P(Y = 3 \mid X_n) \\
&= P(Y \leq 3 \mid X_n) - P(Y \leq 2 \mid X_n) \\
&= \frac{e^{g(Y \leq 3 \mid X_n)}}{1 + e^{g(Y \leq 3 \mid X_n)}} - \frac{e^{g(Y \leq 2 \mid X_n)}}{1 + e^{g(Y \leq 2 \mid X_n)}}
\end{aligned} \tag{9}
$$

Equation 10 is the probablility function for the choice of the answer "willing" to adopt an electric motorcycle.

$$
\begin{aligned}
P_4(X_n) &= P(Y = 4 \mid X_n) \\
&= P(Y \leq 4 \mid X_n) - P(Y \leq 3 \mid X_n) \\
&= \frac{e^{g(Y \leq 4 \mid X_n)}}{1 + e^{g(Y \leq 4 \mid X_n)}} - \frac{e^{g(Y \leq 3 \mid X_n)}}{1 + e^{g(Y \leq 3 \mid X_n)}}
\end{aligned} \tag{10}
$$

Equation 11 is the probablility function for the choice of the answer "strongly willing" to adopt an electric motorcycle.

$$
\begin{aligned}
P_5(X_n) &= P(Y = 5 \mid X_n) \\
&= 1 - P(Y \leq 4 \mid X_n) \\
&= 1 - \frac{e^{g(Y \leq 4 \mid X_n)}}{1 + e^{g(Y \leq 4 \mid X_n)}}
\end{aligned} \tag{11}
$$

Adoption Intention Probability

The ordinal logistic regression equation then applied to a sample of the respondents' answers. Table 8 shows the characteristics and answers of the sample. So the probability to answer each criterion on the dependent variable is calculated based on Equation 7 - 11. A sample of respondents who has the answers as shown in Table 7 have an probability of 0.0013 for strongly unwilling to use electric motorcycle, a probability of 0.0114 for unwilling to use electric motorcycle, a probability of 0.1788 for doubt to use electric motorcycle, a probability of 0.563 to willing to use an electric motorcycle, and a probability of 0.2455 to strongly willing to use an electric motorcycle. Probability of electric motorcycle adoption for 1,223 respondents were also calculated and the average value of the probability for answers to strongly unwilling to use electric motorcycle was 0.0031, unwilling to use electric motorcycle was 0.0198, doubt to use electric motorcycle was 0.1482, willing to use an electric motorcycle was 0.3410, and strongly willing to use an electric motorcycle was 0.4880. If the probability for willing and strongly willing are totalized, the probability for Indonesians to adopt electric motorcycles reaches 82.90%.

Recommendations for Business and Policy Makers

In the ordinal logistic regression analysis, the frequency of sharing on social media is a significant factor affecting the intention of adopting an electric motorcycle. The importance of social media as a platform for the public to obtain information about electric motorcycles will influence the willingness to adopt electric motorcycles. The government and entrepreneurs can try to utilize this resource, for example, entrepreneurs can do promotions through bonuses or appreciation to consumers who have bought electric motorcycles and share positive things related to electric motorcycles at their social media. This way might stimulate others to be a new user of an electric motorcycle. The government can socialize or introduce electric motorcycles to the public through social media to motivate public shifting from conventional motorcycle to electric motorcycle.

This research proves how significant the influence of macro-level factors on the adoption of electric motorcycles in Indonesia. In the ordinal logistic regression analysis, charging station infrastructure availability at the workplace, charging station infrastructure availability at home, the purchase incentive policy, and the charging cost discount significantly influence the intention of adopting an electric motorcycle.

Table 7. Sample Respondent Answers

Variabel	Answer	Code	Value
Marital Status	Married	$X1_b$	2
Age	31-45	X2	2
Gender	Male	$X3_a$	1
Last Educational Level	Master	X4	4
Occupation	Private employees	$X5_c$	3
Monthly consumption level	Rp2.000.000-5.999.999	X6	2
Monthly income level	Rp. 6.000.000-9.999.999	X7	3
Number of motorcycle ownership	≥ 2	X8	3
Frequency of sharing on social media	Several times/month	X9	4
Size of online social network	100-500 people	X10	2
Environmental awareness	1	X11	1
Harga beli	3	X12	3
Battery cost	3	X13	3
Charging cost	3	X13	3
Maintenance costs	5	X14	5
Mileage capability	4	X15	4
Power	5	X16	5
Charging time	4	X17	4
Safety	5	X18	5
Battery life	4	X19	4
Charging station availability in public places	4	X20	4
Charging station availability at work	4	X21	4
Charging station availability at home	4	X22	4
Service places availability	2	X23	2
Purchase incentive policy	5	X24	5
Annual tax discount policy	5	X25	5
Charging cost discount policy	5	X26	5
Charging cost	5	X27	5
Maintenance costs	3	X13	3
Mileage capability	5	X14	5
Power	4	X15	4
Charging time	5	X16	5

Most respondents consider charging station infrastructure availability at home, workplaces and public places as significantly influence the adoption of electric motorcycles. The government can arrange the installation of charging station infrastructure in public places to support the adoption of electric motorcycles. The government can also work together with the business sector to realize this. In building macro-level indicators, this research proposes several incentive policy options. The most significant incentive policies according to the survey are purchase incentive policies and charging cost discount incentive policies which can be considered by the government to support the adoption of electric motorcycles in Indonesia.

On financial factors, the purchase price has a significant effect on the intention to purchase an electric motorcycle. This is the reason why the incentive for the purchase subsidy is also significantly impacting the adoption intention. The cheaper maintenance cost of electric motorcycles than conventional motorcycles significantly influences the adoption intention of electric motorcycles. Therefore the availability of services that meet consumer needs will further encourage the intention of adopting electric motorcycles because most users do not know the components in electric motorcycles so they need skilled technicians if there are some damages.

The performance of electric motorcycles has met the needs of consumers to meet their daily mobility. The maximum speed of an electric motorcycle and charging time are able to meet the standards desired by consumers. However, better motorcycle performance such as increased safety, battery life, and further mileage will certainly increase the intention of adopting an electric motorcycle. In addition to increasing technology investment, the government and businesses must also improve the safety and reliability evaluation system for electric motorcycles to increase public trust.

For businesses, promoting quality and performance is one of the most effective ways to increase consumer enthusiasm for electric motorcycles. Consumers who are younger and have a higher level of education can be targeted as early adopters to become influences because they already have a more optimistic attitude and have a broad network. Market segmentation can be achieved by launching specific models for targeted consumers. In addition, respondents with higher environmental awareness were more likely to want to adopt motorcycles.

CONCLUSIONS

The shifting from conventional motorcycles to electric motorcycles can be the best solution to overcome the problem of high CO_2 levels in Indonesia. The Indonesian government also realized and has stepped in by setting various policies regarding electric vehicles in Indonesia. But in reality, the adoption of electric vehicles in Indonesia is still at a very early stage even far from the targets set by the government. The environment does not support the adoption of electric motorcycles such as no more detailed regulations and the lack of supporting infrastructure causing the low adoption of electric vehicles in Indonesia.

This research surveyed 1,223 respondents from 10 provinces which had a total of 80% of the total motorcycle sales distribution in Indonesia to explore significant factors affecting the intentions of adopting electric motorcycles in Indonesia and find out the probability functions. Although the majority of respondent enthusiast about electric motorcycles and want to own an electric motorcycle in the future, their interest in adopting an electric motorcycle nowadays is relatively low. Respondents do not want to use electric motorcycles at this time due to various reasons such as lack of infrastructure and policies. Many respondents have the attitude of waiting and looking towards the adoption of electric motorcycles, with financial factors, technological factors, and macro-levels that must be following the demands of consumers.

This research proves how significant the frequency of sharing on social media, the level of environmental awareness, purchase prices, maintenance costs, the maximum speed of electric motorcycles, battery charging time, availability of charging station infrastructure at work, availability of charging infrastructure home, purchase incentive policies, and charging cost discount incentive policies are in supporting the adoption of electric motorcycles in Indonesia. Government needs to support the provision of charging station infrastructure and incentive policy making to accelerate the adoption of electric motorcycles in Indonesia. Technological factors such as mileage and battery life need to be considered by producers to be improved to support the adoption of electric motorcycles. Financial factors such as purchase prices and battery costs need to be of concern to businesses and the government. The maximal use of social networking should be taken to introduce an electric motorcycle to the community. Communities at a young age can promote as early adopters because they have a wide social media network.

The realization of the adoption of electric motorcycles in Indonesia requires infrastructure readiness and costs that can be accepted by consumers. This has been able to be implemented by the government through strong government commitments in several countries that have succeeded in substituting conventional vehicles. Further research will focus on finding appropriate policies to accelerate the adoption of electric motorcycles in Indonesia.

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NOMENCLATURE

j	dependent variable categories (j = 1, 2, 3, 4, 5)
k	independent variable categories (k = 1, 2, 3, …, m)
i	qualitative independent variable categories
n	order of respondents
β_{0j}	intercept each answer of dependent variable
X_k	quantitative independent variable
X_{ik}	quanlitative independent variable
Y	dependent variable
$P_j(X_n)$	the opportunity for each category of independent variable for each respondent

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