Factors Affecting the User Acceptance of Electric Motorcycle in Indonesia Using Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

Made Nindya Kirana, Farizal and Rahmat Nurcahyo
Department of Industrial Engineering, Faculty of Engineering
Universitas Indonesia
Depok, Jawa Barat, Indonesia
made.nindya@ui.ac.id, farizal@eng.ui.ac.id, rahmat.eng@ui.ac.id

Abstract

The high number of vehicle usage in Indonesia, especially motorcycles, has resulted in high gasoline consumption which is not balanced with current domestic fuel production. This condition also has an impact on the high number of carbon dioxide emissions. Indonesia's government has been pushing for electric vehicle usage to reduce pollution and energy consumption by formulating policies and regulations. However, the low public interest in switching to electric vehicles has resulted in the number of users still far below the target. This study aims to analyze factors that affect the acceptance of electric motorcycles in Indonesia. The unified theory of acceptance and use of technology 2 (UTAUT2) was used in this study to construct user's acceptance factors. It considered performance expectancy, effort expectancy, hedonic motivation, price value, habit, and social influence, combined with environmental concern, infrastructure readiness, and government policies as facilitating condition. This research uses partial least square structural equation modeling (PLS-SEM) to analyze the relationship among various constructs and moderating variables using data collected by questionnaire to current conventional motorcycle users in Indonesia. The results indicate that attitude toward use, social influence, and facilitating conditions positively affect the user acceptance of electric motorcycle. Attitude toward use is influenced by performance expectancy, effort expectancy, hedonic motivation, and price value. Facilitating conditions is influenced by environmental concern, infrastructure readiness, and government policies. The results of this research can be a source of information for electric motorcycles manufacturers and policymakers to improve transportation quality, services, and regulations.

Keywords
Electric vehicle, user acceptance factor, UTAUT2, environmental concern, structural equation modeling.

1. Introduction
The consumption pattern of fuel in Indonesia over the past five years has consistently been higher than the country's crude oil production capacity. Over the past five years, fuel consumption in Indonesia has been significantly higher than crude oil production. The gap between crude oil production and demand has resulted in the government having to import fuel. In 2017, the import of fuel reached over 220 trillion rupiah and according to the National Energy General Plan, it is projected to continue to increase to more than 550 trillion rupiah in 2025 (PLN, 2021). The significant dependence of society on fossil fuels is likely to lead to an energy crisis (Subekti et al. 2014).

Indonesia's population has grown by 1.25%, with a corresponding increase in the number of vehicles by 6.13% per year (Gunawan et al. 2022). This condition has also contributed to the high consumption of fossil fuels. Increase in the number of motor vehicles is also due to the fact that nowadays, modern society heavily relies on mobility for both humans and goods (Maghfiroh et al. 2021). In 2020, motorcycles were the most commonly used vehicles, with 84.49% of the total number of vehicles in Indonesia (BPS, 2021). The high number of vehicle users, especially motorcycles, has contributed to the emission of CO_2 gas in Indonesia. According to the World Air Quality Report released by IQAir, in 2021 Indonesia ranked 17th as the most polluted country in the world and was the most polluted country in Southeast Asia (IQAir, 2021). Transportation sector contributes 28% to Indonesia's air pollution, which is the second-highest after the electricity sector (Climate Transparency, 2021). The transportation sector is responsible for emitting various types of gases, including carbon dioxide (CO_2), nitrous oxide (N_2O), nitrogen dioxide (NO_2), argon (AR), carbon monoxide (CO), and sulfur dioxide (SO_2) (Mathew and Paraprasad, 2020).

To address the issue of high fuel consumption in Indonesia and emissions from the transportation sector, Indonesia government established a target for accelerating the electric battery-based motor vehicle program (Kemenperin, 2022). The government also aim to stop the sale of gasoline-powered motor vehicles in an effort to achieve zero carbon emissions by 2060. However, the number of electric vehicles in Indonesia, especially electric motorcycles is still far below the usage target set by the government for 2025 and 2050. By the end of 2021, the use of electric motorcycles in Indonesia was only 12,464 units, and as of September 2022, it had reached 21,668 units, or only 1.02% of the target set for 2025 (CNN, 2022).

In order to support the acceleration of the electric battery-based motor vehicle program, the government has also developed several policies. Some of these policies include providing incentives by setting 0% import duty tariffs for electric vehicle imports, increasing the number of battery charging stations, credit incentives for electric vehicle ownership, and subsidies for electric vehicle purchases. However, despite the government issuing policies related to accelerating the electric vehicle program, the low interest of the public in switching to electric vehicles has caused the number of users to still be far below the target that must be achieved in 2025. Based on a survey conducted by Charta Politika (2022), 61% of 1,220 respondents said they are not interested in switching to electric vehicles despite the fuel price increment in September 2022. Considering the low public interest and the policies that have been implemented by the government, it is important to understand from the perspective of potential users what factors influence their acceptance of electric motorcycles.

1.1 Objectives

This research aims to analyze factors that affect the user acceptance of electric motorcycles in Indonesia. It is known that the use of electric motorcycles is still very low despite the government's efforts to accelerate the electric vehicle program. Therefore, the problem formulations determined in this study are:

1. What are the factors that influence public acceptance of the use of electric motorcycles?
2. How do age, gender, and income moderate the acceptance factors for the use of electric motorcycles?

2. Literature Review

2.1 User Acceptance Model

Acceptance is defined as a positive decision to use an innovation and is the negation of the term rejection (Taherdoost, 2018). User acceptance is crucial in further developing a new innovation or technology (Taherdoost, 2018). Several models and theories have been developed to explain the adoption of new technology use and determine factors that can influence user acceptance, such as the Theory of Reasoned Actions (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), Diffusion of Innovation Theory (DOI), and Unified Theory of Acceptance and Use of Technology (UTAUT). Acceptance models and theories have been widely applied in various fields to understand and predict user behavior. A study by Khrisnan and Koshy (2021) expand TAM with other factors such as perceived benefit, perceived barriers, technological consciousness, and social influence in determining factor affecting purchase intention of electric vehicle in India. TAM also used in study conducted by Yankun (2020) to predict factors that influence consumers' willingness to use pure electric vehicles in China. Shakeel (2022) used TPB to analyze the main elements that influence the decision of citizens in Pakistan to buy electric cars.

However in the research conducted by Taherdoost (2018), it was found that several theories have weaknesses in interpreting the factors that influence the acceptance of the use of a technology. In Technology Acceptance Model (TAM), the acceptance factors considered are the perceived usefulness and perceived ease of use. Other external variables need to be added to provide a more accurate prediction of system usage. In the Theory of Planned Behavior (TPB), factors that influence individual behavior are attitudes, subjective norms, and perceived control. This makes TPB considered as a theory that is more suitable for explaining the level of voluntariness of individuals in choosing whether or not to use a technology. Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al (2003) identifies four main factors that influence technology acceptance, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. UTAUT is also a development of TRA, TAM, and TPB theories, making it more useful for research due to the limitations of other models that may affect research results.

2.2 UTAUT2

Unified Theory of Acceptance and Use of Technology (UTAUT) is a model proposed by Venkatesh et al. (2003). UTAUT integrates previous technology acceptance models such as Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Theory of Reasoned Actions (TRA), Combined TAM and TPB (C-TAM-TPB),

Innovation Diffusion Theory (IDT), Social Cognitive Theory (SCT), Motivational Model (MM), and Model of PC Utilization (MPCU). The UTAUT model aims to explain user behavior towards the use of information technology. Empirical testing of UTAUT has shown positive results, indicating that UTAUT outperforms the previous eight models. In the UTAUT model, there are four factors that play a significant role in determining user acceptance: performance expectancy, effort expectancy, social influence, and facilitating conditions. UTAUT2 is a development of UTAUT focused on technology acceptance and usage in consumer contexts (Venkatesh et al., 2012). UTAUT2 includes three additional constructs: hedonic motivation, price value, and habit. The aim of the UTAUT2 model is to identify three important constructs in technology acceptance and use research for general and consumer contexts by introducing several new relationships.

UTAUT and UTAUT2 has been commonly used in various fields to understand and predict user behavior in accepting technology. Study conducted by Nordhoff et al. (2020) used UTAUT2 to to explain public acceptance of conditionally automated cars in Europe. The study found that the factor of hedonic motivation had the greatest influence on an individual's behavioral intention towards conditionally automated cars, indicating that individuals who find these cars enjoyable are more inclined to have the intention to use them. Gunawan et al. (2022) integrated UTAUT2 and perceived risk to determine customer intentions to use electric vehicles. Study by Korkmaz et al. (2022) integrated and expanded UTAUT2 with other factors such as trust, safety, and perceived risk to investigate the factors affecting the acceptance and use of autonomous public transport systems potential users. The study indicates that performance expectancy, social influence, habit, and trust and safety constructs are concluded to have significant positive effects on behavioral intention.

2.3 Structural Equation Modeling

Structural equation modeling (SEM) is a model that allows researchers to explain complex relationships among several independent and dependent variables simultaneously (Hair et al. 2021). In the process of estimating the relationships, SEM takes into consideration any measurement errors that may be present in the observed variables. There are two main approaches to estimating the relationships in a structural equation modeling, namely Covariance-Based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM). CB-SEM is primarily used to confirm (or reject) theories and their underlying hypotheses. In contrast, PLS focuses on explaining the variance in the model's dependent variables (Hair et al. 2021). SEM is widely used in research because SEM is able to test complex research models simultaneously, and able to analyze variables that cannot be directly measured or unobserved variables and take into account measurement errors.

This research uses PLS-SEM to explain relationship between acceptance factors and electric motorcycle acceptance. PLS-SEM is suitable for a relatively complex structural model which containing multiple constructs and numerous indicators. PLS-SEM analysis also does not require specific data distribution. PLS-SEM consists of three stages, namely the outer model or measurement model, inner model or structural model, and weight relation (Hair et al. 2021).

Outer model refers to evaluating the reliability of measures which is done at two levels, namely, the indicator level (indicator reliability) and the construct level (internal consistency reliability) (Hair et al. 2021). The validity assessment focuses on the convergent validity of each measure, measured through the average variance extracted (AVE). In validity assessment, the recommended value for outer loading is > 0.708, while outer loadings that are very small (< 0.40) should be eliminated. Reliability testing is conducted by calculating the values of composite reliability and Cronbach's Alpha. The larger the values of composite reliability and Cronbach's Alpha, the more reliable the variables are considered to be. An acceptable value for exploratory research is >0.7. (Hair et al. 2021).

Inner model or structural model describes the relationship between independent latent variables (exogenous) and dependent latent variables (endogenous). PLS-SEM is designed for recursive models or models that have a one-way cause and effect relationship and no reversing direction or bidirectional influence, thus the relationship between latent variables is referred to as a causal chain system. Inner model evaluation is conducted by evaluating the coefficient of determination or R-squared (R^2) where a higher R^2 value indicates a better fit (Hair et al, 2021). If the R^2 value is > 0.75, the relationship is categorized as substantial, >0.50 categorized as moderate, and >0.25 categorized as weak (Hair et al, 2021).

3. Methods

This study's conceptual model is derived from UTAUT2 because this model is suitable to examine acceptance factor in customer-oriented study. In this study, UTAUT2 model is expanded by considering environmental concern, infrastructure readiness, and government policies which construct the facilitating conditions in use of electric

motorcycle. According to study by Digalwar and Rastogi (2022) and Mathew and Varaprasad (2020), infrastructure readiness such as domestic and public charging infrastructure is considered as factor that affects the adoption of electric vehicles. Environmental concern is also considered as factor that influence the electric vehicle acceptance (Mathew and Varaprasad, 2020). Xia et al (2022) consider monetary subsidy as factors that influence the adoption of electric vehicle. Study conducted by Shakeel (2022) also consider government policies such as monetary incentive as factor that influence the decision of citizens to buy electric vehicle. Therefore, conceptual model for this study is developed as seen in Figure 1.

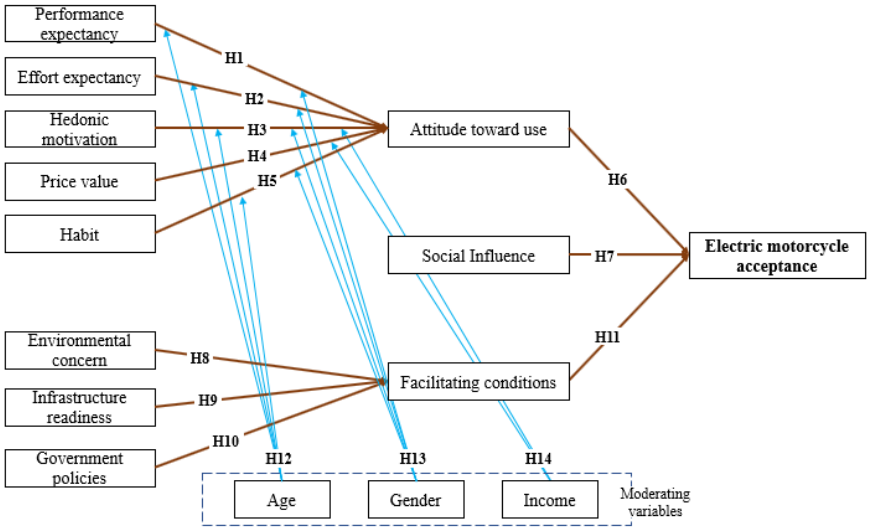

Figure 1. Conceptual model

Performance expectancy (PE) refers to an individual's perception of how a particular technology can be useful and improve their job performance (Venkatesh et al. 2003). In the context of this study, PE refers to the belief that electric motorcycle will be beneficial in daily life. Previous research has shown that PE has a positive effect on an individual's behavioral intention to use technology. Based on this, the following hypothesis is proposed:

Hypothesis 1 (H1): Performance Expectancy (PE) has a significant positive relationship towards attitudes toward the use of electric motorcycles in Indonesia.

Effort expectancy (EE) is defined as the extent of the ease of using a particular technology (Venkatesh et al. 2003). This concept is similar to the factor of 'perceived ease of use' in the Technology Acceptance Model (TAM) and the factor of 'complexity' in the Diffusion of Innovation (DOI) theory (Yuen et al. 2020). Many studies have provided empirical evidence that effort expectancy is related to the level of a consumer's expectation that using a technology should be effortless and not complicated. In the context of this study. Therefore, the following hypothesis is proposed:

Hypothesis 2 (H2): Effort Expectancy (EE) has a significant positive relationship towards attitudes toward the use of electric motorcycles in Indonesia.

Hedonic Motivation (HM) is defined as the pleasure or enjoyment that users derive from using a technology (Venkatesh et al. 2012). Individual who believe that using technology will lead to feelings of happiness are more likely to form emotional attachments and may disregard rational factors (Gunawan et al. 2022). Based on this, the following hypothesis is proposed:

Hypothesis 3 (H3): Hedonic Motivation (HM) has a significant positive relationship towards attitudes toward the use electric motorcycles in Indonesia.

Price Value (PV) is defined as the balance between the advantages that customers get from using a technology and the financial cost of utilizing such technology systems (Venkatesh et al. 2012). Zeithaml (1988) stated in Venkatesh,

et al (2012) that price or monetary cost is linked to the quality of a product or service in order to determine the value that consumers believe in the product or service. Based on this, the following hypothesis is proposed:

Hypothesis 4 (H4): Price Value (PV) has a significant positive relationship towards attitudes toward the use electric motorcycles in Indonesia.

Habit can be defined as a previously repeated behavior that is naturally performed as a result of an individual's past experiences, which is learned about various factors and becomes a preference because it is considered useful. (Venkatesh et al. 2012). However, study by Ajzen (2002) resulted that the performance of future habits cannot be directly controlled by previous behavior alone, as habits are formed through an evaluation process. In this study, the concept of habit is related to habits in the past which is habit of using conventional motorcycle that impact future decision in using electric motorcycles. Individuals who are regularly use conventional motorcycles may be reluctant to switch to electric motorcycles. Therefore, negative hypothesis is proposed:

Hypothesis 5 (H5): Habit (HA) has a significant negative relationship towards attitudes toward the use electric motorcycles in Indonesia.

Attitude towards use (AU) refers to an individual's assessment of a behavior, without any negative consequences. This indicates that the more positively an individual evaluates a product or service, the more motivated they are to take actions that lead to the adoption of the product or service (Yuen et al. 2020). Positive emotions such as liking, comfort, and happiness associated with a product or service can drive adoption behavior (Venkatesh et al. 2003). Therefore, the following hypothesis is proposed:

Hypothesis 6 (H6): Attitude towards use (AU) has a significant positive relationship towards electric motorcycles acceptance in Indonesia.

Social Influence (SI) is a concept relates to the degree which an individual perceives that significant individuals or particular reference groups believe that a behavior should be performed or avoided (Venkatesh et al. 2003). Individuals are more likely to adopt a behavior if they believe that important reference groups, such as friends and colleagues, think they should engage in that behavior. Based on this, the following hypothesis is proposed:

Hypothesis 7 (H7): Social Influence (SI) has a significant positive relationship towards electric motorcycles acceptance in Indonesia.

Environmental concern is defined as the level of interest, care, and responsibility individuals feel towards the environment and its protection. It involves the awareness of environmental issues and the willingness to take action to reduce negative impacts on the environment. Study conducted by Chu et al (2019) found that environmental concern was the most important reason for purchasing an EV in China. People who are concerned with technological advancement and environmental conditions are more willing to adopt electric vehicle (Mathew and Varaprasad, 2020). Therefore, the following hypothesis is proposed:

Hypothesis 8 (H8): Environmental concern (EC) has a significant positive relationship towards facilitating conditions in using electric motorcycles in Indonesia.

Infrastructure readiness (IR) refers to readiness and availability of infrastructure needed to use a technology. This variable construct facilitating conditions. Study conducted by Digalwar and Rastogi (2022) found that infrastructure readiness such as public charging infrastructure and maintenance infrastructure construct the facilitating conditions. Therefore, the following hypothesis is proposed:

Hypothesis 9 (H9): Infrastructure readiness (IR) has a significant positive relationship towards facilitating conditions in using electric motorcycles in Indonesia.

Government policies is defined as policy, regulation, and laws issued by the government in regulating the use of a technology. Different types of policy measures can be issued to make electric motorcycle more appealing (Shakeel, 2022). Study conducted by Xia et al (2022) found that policies such as monetary subsidy is an important factor that construct the conditions in adopting electric vehicles. Therefore, the following hypothesis is proposed:

Hypothesis 10 (H10): Government policies (GP) has a significant positive relationship towards facilitating conditions in using electric motorcycles in Indonesia.

Facilitating conditions refers to an individual's perception of the extent to which an organization and technical infrastructure is available to support the use of a specific technology. Previous research has shown that facilitating conditions have a significant impact on usage behavior. In fact, customers may be more motivated to continue using an innovation if they receive a certain level of technological support, knowledge, and resources (Yuen et al. 2020). Therefore, the following hypothesis is proposed:

Hypothesis 11 (H11): Facilitating condition (FC) has a significant positive relationship towards electric motorcycles acceptance in Indonesia.

The moderating variables in this study are age, gender, and income. When age is considered as a moderating variable, it means that it has the potential to affect the relationship between other variables. Younger people may have a higher performance expectancy and therefore a stronger inclination to use technology (Venkatesh et al, 2003). Older people may find technology more difficult to use and may need more support in order to overcome barriers to use (Venkatesh et al, 2003). Younger people may be more inclined to use technology for hedonic reasons, while older people may prioritize other factors such as practicality or ease of use (Venkatesh et al, 2012). Older people may be more set in their ways and therefore less likely to adopt new technology (Venkatesh et al, 2012). Therefore, the following hypothesis is proposed:

Hypothesis 12 (H12): Age moderates the relationship between performance expectancy, effort expectancy, hedonic motivation, and habit towards the attitude toward use

Gender moderates the relationship between performance expectancy, effort expectancy, hedonic motivation, and habit by influencing how these factors impact an individual's attitude toward use. Males tend to have higher levels of performance expectancy and effort expectancy compared to females, which may lead to different attitudes toward using technology (Venkatesh et al, 2003). Gender differences in hedonic motivation may also impact attitudes toward use, as males may be more motivated by pleasure and enjoyment, while females may be more motivated by social influence and personal relevance (Venkatesh et al, 2012). Habit formation also may differ by gender, as males may be more likely to form habits around technology use compared to females (Venkatesh et al, 2012). Therefore, the following hypothesis is proposed:

Hypothesis 13 (H13): Gender moderates the relationship between performance expectancy, effort expectancy, hedonic motivation, and habit towards the attitude toward use

Income moderates the relationship between hedonic motivation and price value towards the attitude toward use. People with higher incomes may be more willing to pay a premium for a product or service that they find enjoyable or pleasurable (Neto, 2022). Therefore, the following hypothesis is proposed:

Hypothesis 14 (H14): Income moderates the relationship between performance expectancy, effort expectancy, hedonic motivation, and habit towards the attitude toward use

4. Data Collection

4.1 Sample and Sampling Technique

The sample size for this study was determined by multiplying the number of questions by five as a minimum requirement (Hair et al, 2017) and resulted 250 respondents as minimum requirement (50 question × 5). The study uses purposive sampling method and required participants to be at least 17 years old and currently have conventional motorcycle. A total of 267 data were collected from cities in Indonesia namely Jakarta, Bogor, Depok, Tangerang, Bekasi, Karawang, and Bandung.

4.2 Questionnaire Design

The questionnaire is divided into three sections, with the first section providing a brief overview of the research's purpose, second section is to gather their demographic data, and third section consists of questions that measure the acceptance to use the technology, shown in Table 1. A Likert scale of 1–5 was used in this study, where a score of 1 and 5 denotes the opinion of “strongly disagree” and “strongly agree.”

Table 1. Questionnaire constructs and measurements

Construct	Item	Measurement
Performance expectancy	PE-1	Electric motorcycles will be useful in supporting everyday life.
	PE-2	An electric motorcycle can help me do my activities more productively.
	PE-3	Using an electric motorcycle will be more environmentally friendly than a gasoline motorcycle.
	PE-4	Electric motorcycles will be useful and provide benefits for their users.
Effort expectancy	EE-1	How an electric motorcycle works is easy to learn
	EE-2	Electric motorcycles provide easy transportation for their users
	EE-3	I understand and can use an electric motorcycle
	EE-4	I feel comfortable traveling on an electric motorcycle
Social Influence	SI-1	Electric motorcycles have a positive image in society
	SI-2	People around me thought I should use an electric motorcycle
	SI-3	People whose opinions I have always weighed advised me to go for an electric motorcycle
	SI-4	In general, the authorities will support the use of electric motorcycles
	SI-5	If a lot of electric motorcycles are used around me, maybe I will use them
Hedonic motivation	HM-1	Using an electric motorcycle makes me feel proud
	HM-2	Using an electric motorcycle increases my social status
	HM-3	If an electric motorcycle makes me feel good, I'll buy it even if it's expensive
	HM-4	Traveling on an electric motorcycle feels comfortable and enjoyable
Price Value	PV-1	The price offered by electric motorcycles fits the benefits that will be felt
	PV-2	I can reduce daily expenses by using an electric motorcycle
	PV-3	The price of an electric motorcycle is quite affordable
	PV-4	I am willing to find information about the best prices and promos offered by electric motorcycles
Habit	HA-1	Using a gasoline motorcycle has become my daily habit
	HA-2	I'm having a hard time switching from a petrol motorcycle to an electric one
	HA-3	I feel using a gasoline motorcycle is a natural thing
	HA-4	My habit of using a petrol motorcycle keeps me from switching to an electric motorcycle
Infrastructure Readiness	IR-1	The existence of charging facilities for the public made me interested in using an electric motorcycle
	IR-2	I have the facilities needed to use an electric motorcycle
	IR-3	The existence of a charging facility in workplace made me interested in using an electric motorcycle
	IR-4	The existence of maintenance facility made me want to use an electric motorcycle
Government Policies	GP-1	There is an incentive to make me want to use an electric motorcycle
	GP-2	The government actively provides electric motorcycle charging facilities
	GP-3	The existence of a tax subsidy made me want to use an electric motorcycle
	GP-4	Promotions and sales facilities for electric motorcycles are easy to find
Environmental Concern	EC-1	I am concerned about the air pollution caused by conventional vehicles.
	EC-2	I feel the need to contribute to reducing energy consumption
	EC-3	I am willing to pay more to buy environmentally friendly products.
	EC-4	Using an electric motorcycle can contribute to environmental preservation
Facilitating Condition	FC-1	The technology used makes me feel confident using an electric motorcycle
	FC-2	I have sufficient knowledge about electric motorcycles
	FC-3	If given the facilities and knowledge about electric motorcycles, I will be interested in using them
	FC-4	I am willing to find information about the supporting facilities required for electric motorcycle
Attitude toward Use	AU-1	I think using an electric motorcycle is a good idea
	AU-2	In my opinion, the use of electric motorcycles is a positive thing
	AU-3	I am interested in the possibilities offered by new technologies
	AU-4	The use of an electric motorcycle supports my daily activities
Public Acceptance	PA-1	I intend to use electric motorcycles in everyday life
	PA-2	I will buy and recommend an electric motorcycle to those closest to me
	PA-3	I imagine in the future will use electric motorcycles
	PA-4	I look forward to the introduction of various brands of electric motorcycles in the market.
	PA-5	I will choose an electric motorcycle for my next vehicle

4.3 Demographic Data

Table 2 shows the demographic characteristics of 267 respondents.

Table 2. Respondents' demographic data

Characteristics	Category	Frequency	Proportion (%)
Gender	Male	160	59.93%
	Female	107	40.07%
Age (year)	17-25	82	30.71%

	26-34	116	43.45%
	35-43	51	19.10%
	44-52	13	4.87%
	More than 52	5	1.87%
Domicile	Jakarta	156	58.43%
	Bogor	17	6.37%
	Depok	17	6.37%
	Tangerang	20	7.49%
	Bekasi	26	9.74%
	Bandung	21	7.87%
	Karawang	10	3.75%
Educational Background	≤ Senior high school	57	21.35%
	Diploma	7	2.62%
	Bachelor's Degree	184	68.91%
	Master's Degree	19	7.12%
	Doctoral Degree	0	0.00%
Monthly Income	< 5 million IDR	61	22.85%
	5-15 million IDR	140	52.43%
	16-25 million IDR	42	15.73%
	26-35 million IDR	18	6.74%
	> 35 million IDR	6	2.25%
Experience in using conventional motorcycle	Less than 1 year	2	0.75%
	1-5 year	41	15.36%
	6-10 year	67	25.09%
	10-15 year	75	28.09%
	More than 15 year	82	30.71%

5. Results and Discussion

5.1 Measurement Model Analysis

The structural equation modeling (SEM) analysis requires the measurement model to meet the minimum theoretical standards. The study's validation instrument was tested using a loading factor (λ) assessment that ranged from 0.4 to 0.7 (Hair et al. 2021), while still ensuring that the question instrument was adequate. The reliability of the study data was determined by analyzing the suitability of the CR (composite reliability) and Cronbach's Alpha standards. The larger the value of composite reliability and Cronbach's Alpha, the more reliable the variable is considered. Acceptable value (for exploratory research) is > 0.7 (Hair et al., 2021). Table 3 shows the measurement model analysis results.

Table 3. Measurement model analysis results

No	Variabel	Item	Loading Factor (λ)	Validity	Cronbach's Alpha	Composite Reliability	Reliability
1	Performance Expectancy	PE-1	0.870	Valid	0.801	0.873	Reliable
2		PE-2	0.814	Valid			
3		PE-3	0.587	Valid			
4		PE-4	0.885	Valid			
5	Effort Expectancy	EE-1	0.807	Valid	0.784	0.858	Reliable
6		EE-2	0.851	Valid			
7		EE-3	0.680	Valid			
8		EE-4	0.756	Valid			
9	Social Influence	SI-1	0.724	Valid	0.836	0.884	Reliable
10		SI-2	0.830	Valid			
11		SI-3	0.825	Valid			
12		SI-4	0.706	Valid			
13		SI-5	0.793	Valid			

Table 4. Measurement model analysis results (cont.)

No	Variabel	Item	Loading Factor (λ)	Validity	Cronbach's Alpha	Composite Reliability	Reliability
14	Hedonic Motivation	HM-1	0.854	Valid	0.805	0.871	Reliable

15		HM-2	0.886	Valid			
16		HM-3	0.594	Valid			
17		HM-4	0.816	Valid			
18	Price Value	PV-1	0.821	Valid	0.784	0.859	Reliable
19		PV-2	0.759	Valid			
20		PV-3	0.766	Valid			
21		PV-4	0.761	Valid			
22	Habit	H-1	0.830	Valid	1.000	1.000	Reliable
23		H-2	-0.292	Eliminated			
24		H-3	0.262	Eliminated			
25		H-4	-0.478	Eliminated			
26	Attitude toward Use	AU-1	0.882	Valid	0.854	0.903	Reliable
27		AU-2	0.887	Valid			
28		AU-3	0.829	Valid			
29		AU-4	0.739	Valid			
30	Infrastructure Readiness	IR-1	0.783	Valid	0.805	0.875	Reliable
31		IR-2	0.647	Valid			
32		IR-3	0.889	Valid			
33		IR-4	0.856	Valid			
34	Government Policies	GP-1	0.859	Valid	0.776	0.856	Reliable
35		GP-2	0.712	Valid			
36		GP-3	0.808	Valid			
37		GP-4	0.706	Valid			
38	Environmental Concern	EC-1	0.726	Valid	0.750	0.844	Reliable
39		EC-2	0.867	Valid			
40		EC-3	0.652	Valid			
41		EC-4	0.777	Valid			
42	Facilitating Condition	FC-1	0.857	Valid	0.784	0.862	Reliable
43		FC-2	0.643	Valid			
44		FC-3	0.745	Valid			
45		FC-4	0.865	Valid			
46	Public Acceptance	PA-1	0.874	Valid	0.900	0.926	Reliable
47		PA-2	0.821	Valid			
48		PA-3	0.837	Valid			
49		PA-4	0.846	Valid			
50		PA-5	0.849	Valid			

Factor loadings (λ) were examined to evaluate the validity of each item which construct a variable. From Table 4 there are three indicators that were found to be invalid: H-2, H-3, and H-4. Regarding the reliability of the measurement model, composite reliability and Cronbach's Alpha were tested and overall, all composite reliability and Cronbach's Alpha values were greater than the recommended values of 0.7.

5.2 Structural Model Analysis

The structural model aims to determine the relationships between latent variables based on the formulated hypotheses. In this study, the latent variables are attitude toward use, facilitating condition, and electric motorcycle acceptance. The testing was done by evaluating the coefficient of determination or R-squared (R^2). Table 5 shows the value of R-squared for each latent variables. It was found that the attitude toward use and facilitating condition variables were categorized as moderate, while the electric motorcycle acceptance variable was categorized as good or substantial.

Table 5. Structural model analysis result

Variable	R Square	R Square Adjusted
Attitude toward Use	0.649	0.624
Facilitating Condition	0.633	0.628
Electric Motorcylce Acceptance	0.740	0.734

5.3 Hypothesis Test and Analysis

Hypothesis testing is conducted by calculating the P value and comparing it with the error tolerance or alpha value. Alpha value used in this research is (α) = 5%. A hypothesis is accepted if the P value is less than 0.05. Figure 2 shows the final model of this research with P value for each variable.

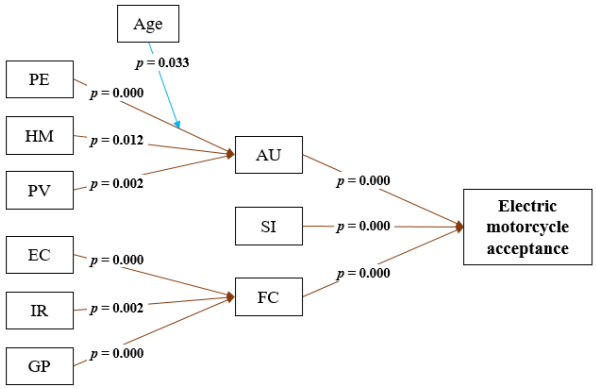

Figure 2. Final model

Attitude toward Use (AU) has a significant positive relationship towards electric motorcycles acceptance in Indonesia (p = 0.00). When an individual evaluates a product positively, they tend to be more motivated to take actions that lead to the adoption of the product. In constructing Attitude toward Use, Performance Expectancy (PE) has a significant positive relationship towards attitudes toward the use of electric motorcycles in Indonesia (p = 0.00). These findings are consistent with the research conducted by Gunawan et al (2022), Venkatesh et al (2003), Ho and Wu (2021). Individual perceived that electric motorcycles will be useful and provide benefits for their users. Hedonic Motivation (HM) has a significant positive relationship towards attitudes toward the use of electric motorcycles in Indonesia (p = 0.01). These results support the theory by Venkatesh et al (2012). People who perceive pleasure and comfort in using a technology tend to develop a positive attitude, which leads to increased likelihood of future use. Price value (PV) also has a significant positive relationship towards attitudes toward the use of electric motorcycles in Indonesia (p = 0.002). Individuals who believe that price of electric motorcycle reflects the quality offered are more likely to show interest in using it in the future.

Social Influence (SI) has a significant positive relationship towards electric motorcycles acceptance in Indonesia (p = 0.00). These findings are consistent with the research conducted by Gunawan et al (2022) and Venkatesh et al (2003). The influence of significant people, such as family members, friends, and colleagues can strongly impact an individual's behavior.

Facilitating Condition (FC) has a significant positive relationship towards electric motorcycles acceptance in Indonesia (p = 0.00). Independent variables that construct FC also have a significant impact, namely environmental concern (p = 0.00), infrastructure readiness (p = 0.002), and government policies (p = 0.00). These result are consistent with the previous researches, which stated that objective factors in the environment make individuals feel confident in using an innovation.

Effort Expectancy has not proven to have a positive relationship towards attitudes toward the use of electric motorcycles in Indonesia (p = 0.126). These result are not consistent with the research conducted by Gunawan et al (2022) and Venkatesh et al (2003), but support the research conducted by Korkmaz et al (2022) and Nordhoff et al (2020). Individuals do not consider the effort of using electric motorcycle as a deciding factor because the way of using it is not significantly different. Habit also has not proven to have a positive relationship towards attitudes toward the use of electric motorcycles in Indonesia (p = 0.508). These result are not consistent with the research conducted by Venkatesh et al (2012) but relevant with the research conducted by Gunawan et al (2022). Ajzen (2002) stated that past actions or behavior do not have direct control over future actions, which occurs due to the evaluation process of past behavior that is carried out.

From the moderating variables age, gender, and income, age has proven to moderate the relationship between performance expectancy and attitude toward use. Younger people may have a higher performance expectancy. Other moderating variables has not proven to moderate the relationship between variables.

6. Conclusion

The main aim of this study is to investigate the factors that influence the acceptance of electric motorcycles among users and to determine the relationships between these factors using the UTAUT2 model. The authors believe that the findings of the study could be valuable for for electric motorcycles manufacturers and policymakers to improve transportation quality, services, and regulations.

The results indicated that Attitude toward Use, Social Influence, and Facilitating Conditions significantly affect the electric motorcycles acceptance in Indonesia. Performance Expectancy (PE), Hedonic Motivation (HM), and Price value (PV) have significant positive relationship towards attitude toward the use of electric motorcycle. Environmental Concern (EC), Infrastructure Readiness (IR), and Government Policies (GP) have a significant positive relationship towards the facilitating condition in using electric motorcycle.

The results of this study show that the UTAUT2 framework-based model is a promising approach for analyzing customers' acceptance to use electric motorcycle in Indonesia. This study offers valuable insights into the future research directions that could increase customers' intention to use electric motorcycle. However, there are some limitations to be considered. The findings may only be applicable to Indonesia and cannot be generalized to other countries that have different political, environmental, and economic conditions. Additionally, the determinants examined in this study may not fully capture all the factors that could influence the acceptance of electric motorcycles. Future study could explore other potential determinants that may also have an impact on user acceptance.

References

Ajzen, I, Residual Effects of Past on Later Behavior: Habituation and Reasoned Action Perspectives. *Personality and Social Psychology Review*, 6(2), 107–122, 2002

Badan Pusat Statistik, Perkembangan Jumlah Kendaraan Bermotor Menurut Jenis, Available: https://www.bps.go.id/indicator/17/57/1/perkembangan-jumlah-kendaraan-bermotor-menurut-jenis.html

Charta Politika, Kondisi Sosial Politik dan Peta Elektoral Pasca Kenaikan Harga BBM, Available: https://www.chartapolitika.com/wp-content/uploads/2022/09/20220922_Rilis-Surnas-Sep-2022.pdf

Chu, W., Im, M., Song, M. R., & Park, J. Psychological and behavioral factors affecting electric vehicle adoption and satisfaction: A comparative study of early adopters in China and Korea, *Transportation Research Part D: Transport and Environment*, 76, 1–18, 2009

Climate Transparency, Laporan Climate Transparency Indonesia 2021: Membandingkan Aksi Iklim G20 Menuju Net Zero. Climate Transparency. Available: https://www.climate-transparency.org/wp-content/uploads/2021/11/Indonesia-Country-Profile-2021_Bahasa.pdf

CNN Indonesia. Berapa Populasi Kendaraan Listrik di Indonesia Saat Ini?, Available: https://www.cnnindonesia.com/otomotif/20221013160146-603-860170/berapa-populasi-kendaraan-listrik-di-indonesia-saat-ini

Digalwar, A. K., & Rastogi, A., Assessments of social factors responsible for adoption of electric vehicles in India: a case study, *International Journal of Energy Sector Management*, 2002

Gunawan, I., Redi, A. A. N. P., Santosa, A. A., Maghfiroh, M. F. N., Pandyaswargo, A. H., & Kurniawan, A. C, Determinants of Customer Intentions to Use Electric Vehicle in Indonesia: An Integrated Model Analysis, *Sustainability*, 14(4), 1972, 2022

Hair, J. F, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Sage, 2017

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S, *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*, Springer International Publishing, 2021

Ho, C.-W., & Wu, C.-C, Exploring Intention toward Using an Electric Scooter: Integrating the Technology Readiness and Acceptance into Norm Activation Model (TRA-NAM). *Energies*, 14(21), 6895, 2021

IQAir. 2021 World Air Quality Report: Region and City PM2.5 Ranking. IQAir. Available: https://www.iqair.com/world-most-polluted-cities/world-air-quality-report-2021-en.pdf

Kemenperin. Kemenperin Dukung Akselerasi Ekosistem Kendaraan Listrik. Kementerian Perindustrian Republik Indonesia, Available: https://www.kemenperin.go.id/artikel/23140/Kemenperin-Dukung-Akselerasi-Ekosistem-Kendaraan-Listrik

Korkmaz, H., Akif Fidanoglu, Salih Ozcelik, & Abdullah Okumus, User Acceptance of Autonomous Public Transport Systems (APTS): Extended UTAUT2 Model, *Digital Commons @ University of South Florida*, 2021

Krishnan, V. V., & Koshy, B. I, Evaluating the factors influencing purchase intention of electric vehicles in households owning conventional vehicles. *Case Studies on Transport Policy*, 9(3), 2021

Maghfiroh, M. F. N., Pandyaswargo, A. H., & Onoda, H., Current Readiness Status of Electric Vehicles in Indonesia: Multistakeholder Perceptions, *Sustainability*, 13(23), 13177, 2021

Mathew, N., & Varaprasad, G. Technology advancement: Factors influencing the adoption of Electric Vehicles in India, *IEEE Xplore*, 2020

Nordhoff, S., Louw, T., Innamaa, S., Lehtonen, E., Beuster, A., Torrao, G., Bjorvatn, A., Kessel, T., Malin, F., Happee, R., & Merat, N, Using the UTAUT2 model to explain public acceptance of conditionally automated (L3) cars: A questionnaire study among 9,118 car drivers from eight European countries, *Transportation Research Part F: Traffic Psychology and Behaviour*, 74, 280–297, 2020

PLN, Rencana Usaha Penyediaan Tenaga Listrik 2021-2030, Available: https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf

Shakeel, U., Electric vehicle development in Pakistan: Predicting consumer purchase intention, *Cleaner and Responsible Consumption*, 5, 100065, 2022

Subekti, R. A., Sudibyo, H., Susanti, V., Saputra, H. M., & Hartanto, A., *Peluang dan Tantangan Pengembangan Mobil Listrik Nasional*, LIPI Press, 2022

Taherdoost, H.,A review of technology acceptance and adoption models and theories, *Procedia Manufacturing*, 22, 960–967, 2018

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D., User acceptance of information technology: Toward a unified view, *MIS Quarterly: Management Information Systems*, 27(3), 425–478, 2003

Venkatesh, V., Walton, S. M., & Thong, J. Y. L., Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly: Management Information Systems*, 36(1), 157–178, 2012

Xia, Z., Wu, D., & Zhang, L., Economic, Functional, and Social Factors Influencing Electric Vehicles' Adoption: An Empirical Study Based on the Diffusion of Innovation Theory. *Sustainability*, 14(10), 6283, 2022

Yankun, S., An Empirical Study on the Influencing Factors of Consumers' Willingness to Use Pure Electric Vehicle Based on TAM Model, *IEEE Xplore*, 2020

Yuen, K. F., Huyen, D. T. K., Wang, X., & Qi, G., Factors Influencing the Adoption of Shared Autonomous Vehicles. *International Journal of Environmental Research and Public Health*, 17(13), 4868, 2020

Biographies

Made Nindya Kirana is a Master's Degree student in Industrial Engineering Department, Faculty of Engineering Univeritas Indonesia. She holds a Bachelor of Engineering in Industrial Engineering from Universitas Atma Jaya Yogyakarta. Her research interests are operations management, and supply chain management, and sustainability.

Farizal is a senior lecturer at the Industrial Engineering Department, Faculty of Engineering Universitas Indonesia. He earned Bachelor of Engineering degree from Universitas Indonesia, Master's degree from Oklahoma State University and Doctoral degree in from University of Toledo. His research interests are reliability design optimization, renewable energy, supply chain management and techno-economy.

Rahmat Nurcahyo is a Professor in Industrial Engineering Department, Faculty of Engineering Universitas Indonesia. He earned Bachelor of Engineering degree in Mechanical Engineering from Universitas Indonesia, a Master of Engineering Science degree in Industrial Management from University of New South Wales, Australia, and a Doctoral degree in Strategic Management from Universitas Indonesia. His research interest are total quality management, production system, lean system, and maintenance management.