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Adoption Intention for EV: Implementing Theory of Planned Behavior

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ABSTRACT

The development of sustainable energy in Electric Vehicles (EV), is highly dependent on customer perceptions of adoption intentions (EV). The purpose of this study is to identify the motivations that influence the adoption intention of EVs either directly or indirectly by using knowledge, subjective norms, environmental concerns, and attitudes. To test the 4 hypotheses, the data were collected using a quantitative survey design, and 200 respondents in Jabodetabek were selected using the purposive sampling method, and processed using the Structural Equation Modeling (SEM) method to examine the direct and indirect effects, as well as multi-group SEM to test the effect of adoption intention. The results of processing the data show that there are 4 accepted hypotheses, which show that there is a direct effect of the Knowledge, Subjective norms, environmental concerns and attitudes on EV adoption intention. This finding will assist policy makers in adopting effective variables to set the overall communication strategy as well as in EV segmentation to build potential adoption intentions of electric cars in a structured manner.

KEYWORDS - Electric Vehicle, Theory of Planned Behavior, Adoption Intention, Knowledge, Attitude, Environmental Concern, Subjective norms

1. INTRODUCTION

Green behavior to protect humanity and our planet has become a global issue over the last three decades. The problem of global ecological imbalance is greatly affected by pollution and scarcity of resources (Chaturvedi et al., 2021). Furthermore, it is estimated that by 2030, the transportation sector will contribute 50% of total global greenhouse gas (GHG) emissions (Huang et al., 2019). As one of the largest economies in Southeast Asia and a major contributor to carbon emissions, Indonesia has been at the center of global efforts to reduce emissions. The 2021 Climate Transparency report notes that fuel combustion is the biggest cause of total CO2 emissions in the country, which come from the power sector (35%), industry (27%), and transportation (27%) (The Jakartapost, 2023). Therefore, our transportation system must be made more environmentally friendly through a comprehensive transformation. The Indonesian Automotive Industry needs energy efficient and cleaner vehicles to create an environmentally friendly scenario and enhance the country's ability to turn around environmental problems

Land transportation is the highest emitter, amounting to 88% of the total emissions of the transportation sector. The use of electric vehicles is considered environmentally friendly because they do not release CO2 emissions into the atmosphere (Andrian and Marpaung, 2019). The electric car is a zero-emission vehicle which is an alternative to reduce air pollution. One of the things that underlies the growing use of electric cars is the limited availability of fossil fuels that are dwindling and the tendency to continue to rise in prices for these fossil-based fuels. Along with the growth of high public awareness of the environment, especially related to air pollution resulting from vehicle emissions, it is necessary to pay more attention to what factors can influence the adoption intention of electric cars.

Subjective norms (Subjective Norms) are one's perceptions or views of other people's beliefs that influence whether or not to perform the behavior under consideration (Handika & Sudaryanti, 2017). If individuals feel that subjective norms require a person to have a certain attitude toward something, they may be more inclined to adopt that attitude. For example, if environmental subjective norms require people to believe that exercise is an important part of a healthy life, then the individual may be more inclined to have a positive attitude toward exercise and more likely to do so regularly.

Environmental Concern is a concern related to limits to growth, pollution, established economies, and resource conservation. Previous research was conducted by (Resty, 2023) environmental concerns affect attitude. Currently, electric cars are considered as one of the solutions to reduce greenhouse gas emissions that have an impact on the environment and human health. Therefore, individuals who have a high level of environmental concern tend to have a positive attitude towards electric cars.

According to Notoatmodjo in (Hamid, 2019) knowledge is the result of knowing from humans who simply answer the question "What". Knowledge is the result of knowing, and this occurs after people sense a certain object. Sensing, smelling, tasting, and touching. Knowledge or cognitive is a very important domain in shaping one's actions (over behavior). People's knowledge about electric cars can affect their attitude towards this technology. The more information obtained about the advantages and performance of electric cars, the more likely individuals will have a positive attitude towards electric cars and plan to adopt them in the future. Therefore, effective education and promotion of electric cars can help increase people's knowledge and subsequently achieve the intention to adopt the technology.

Willingness to adopt refers to the subjective probability that a person will buy an electric vehicle in the future and depends on his attitude towards it. Therefore, the proposed model considers environmental concern (EC), knowledge about electric vehicles (knowledge), and subjective norms (SN) as independent factors which are responsible for shaping their attitude towards electric vehicles (attitude) which in turn influences consumer willingness to adopt it (WA) in the future. Acceptance or rejection of electric vehicles is based on several factors such as attitudes, behavior, perceptions, social, and so on, which requires an eclectic perspective to understand the dynamics of behavior related to the adoption of electric vehicles.

2. LITERATURE REVIEW

Theory of Planned Behavior (TPB) can be considered as an extension of the theory of reasoned action (TRA) and argues that a person's behavior can be predicted with the help of behavioral intentions which again depend on three determinants, namely AT, SN, and PBC (Ajzen 1991). TPB was proposed by Ajzen to explain the process of customer behavior when making decisions (Ajzen, 2005), while TPB is a successor of TRA (Theory of Reasoned Action) which proposes that attitudes and subjective norms are driving factors. However, behavioral intentions do not depend entirely on attitudes and subjective norms because the level of ease or difficulty perceived by consumers regarding the behavior of buying an electric car is another factor. Therefore, to increase the power of TRA interpretation, (Ajzen, 2005) introduces a perceived behavioral control variable. In TPB, perceived behavioral control can directly affect behavioral intentions and indirectly affect behavior. Because of its strong explanation, TPB has been widely used to investigate environmentally friendly intentions and behaviors related to green buying behavior such as the purchase intention of electric vehicles with environmental benefits (Zhang et al., 2018), household energy saving intentions (Tan et al. , 2017; Z. Wang et al., 2011), purchase intentions of green products (Z. Wang et al., 2017; Yadav & Pathak, 2016), and environmental protection intentions and behavior (López-Mosquera et al., 2014) . In addition to environmental benefits, product factors also have an impact on purchase intentions.

Subjective norms and attitudes

Subjective norm is one of the main predictor variables of behavioral intention after attitude in the social cognitive theory literature. Scholars (eg Wang et al., 2021) note that it is related to external social pressures or obligations arising from others that affect an individual's decision to show or not to show certain behaviors (Claro and Esteves, 2021). Several studies have noted a direct and positive relationship between subjective norms and behavioral intentions, including intentions to buy or adopt green products or electric vehicles (Wang et al., 2021). In addition, scholars (Alzahrani et al., 2019; Jaiswal et al., 2022a) also observe that subjective norms from a social perspective have a greater influence on green consumption than other important factors related to eco-friendly and pocket-friendly products. This suggests that when consumers feel a high degree of certainty about the support of others in carrying out certain behaviors (Jaiswal et al., 2022a), using technology and adopting battery-powered electric vehicles, their intention to adopt those behaviors is more likely to increase in those social considerations. (Wang et al., 2021). Hence, the above observations confirm that social norms are one of the main elements of behavioral intention and this can have a positive effect on consumer adoption intentions for battery-powered electric vehicles in emerging mobility markets like India. Thus, the above arguments lead to the hypothesis:

H1: Subjective norms have a positive effect on attitudes.

Environmental Concern and attitude

Individual concern for environmental issues is fundamental in demonstrating green behavior (Kautish and Dash, 2017; Mostafa, 2007), and their understanding of readiness to address environmental issues is one of the main motivations in the emerging domain of green consumer psychology (Jaiswal et al., 2021b). Scholars (Lee, 2008; Wang et al., 2021) note that environmental concern is strongly related to one's emotions and sense of duty to protect the environment. This therefore reflects their inclination towards sustainable solutions such as buying green products and adopting cleaner technologies including hybrid and green vehicles (Chowdhury et al., 2016; Wang et al., 2021). This view is that a consumer does not only think about the environmental attributes of a sustainable product in their purchase preference for the offering (Sharma et al., 2022), but also cares about its positive impact on the ecosystem. Therefore, the discussion above leads to the next hypothesis.

H2: Environmental concerns have a positive effect on attitudes.

Knowledge and attitude

Knowledge is a significant cognitive element in predicting individual decision-making processes regarding certain behaviors, such as purchasing decisions for sustainable products (Kautish and Dash, 2017; Jaiswal et al., 2022b). Scholars have confirmed that an individual's level of knowledge about the general environment leads to better pro-environmental behavior due to a higher level of logical cognition before making such decisions (Berliner et al., 2019; Jaiswal et al., 2022a). In this context, research shows that consumer-specific knowledge about products has a positive effect on attitudes and behavioral intentions to use these products, both directly and indirectly, including energy-efficient products and zero emission vehicles (Mostafa, 2007; Policarpo and Aguiar, 2020).

Moreover, studies examining the effect of constructed knowledge as consumer-specific understanding of zero or low emission vehicles (referred to in this study as perceived knowledge about BEVs) are still sparse in the literature (Jaiswal et al., 2022c), which is one of the barriers main influence on the adoption (Berliner et al., 2019). In summary, when consumers have a good understanding of the performance of BEVs, consider them economical, and are aware of the ecological benefits associated with their use, etc., they are expected to show an inclination to adopt eco-friendly or low-emission cars (Policarpo and Aguiar, 2020; Simsekoglu and Nayum, 2019) as a result of an increase in the level of positive attitude formation by consumers. The above observations lead to the following hypothesis:

H3: Perceived knowledge about BEV has a positive effect on attitude.

Attitude and adoption intention

Consumer attitudes have been frequently used in many studies to predict consumer ecological conscious behavior and the use of environmentally friendly products. Schlegelmilch et al. (1996) concluded that environmentally friendly attitudes play an important role in shaping the acceptance of environmentally friendly products. Another study by Roberts (1996) confirmed the relevance of attitude variables in explaining consumer behavior that cares about the environment. In another study conducted by Kassarjian (1971), it was found that consumer attitudes toward air pollution were the most important variable in determining their behavior towards biofuel consumption (Mostafa, 2007). In a study in Germany, it was found that consumers' positive attitude towards an environmentally conscious lifestyle encouraged them to adopt environmentally friendly products in an environmentally conscious way (Mostafa, 2007). Interestingly, a favorable attitude towards a product is strongly associated with the propensity to adopt that product. Hini et al. (1995) in their study of adoption decisions also reported a significant relationship between a person's attitude towards a product and his willingness to adopt the product.

Therefore, the hypothesis proposed is as follows:

H4: Attitudes towards electric vehicles significantly influence consumers' willingness to adopt electric vehicles.

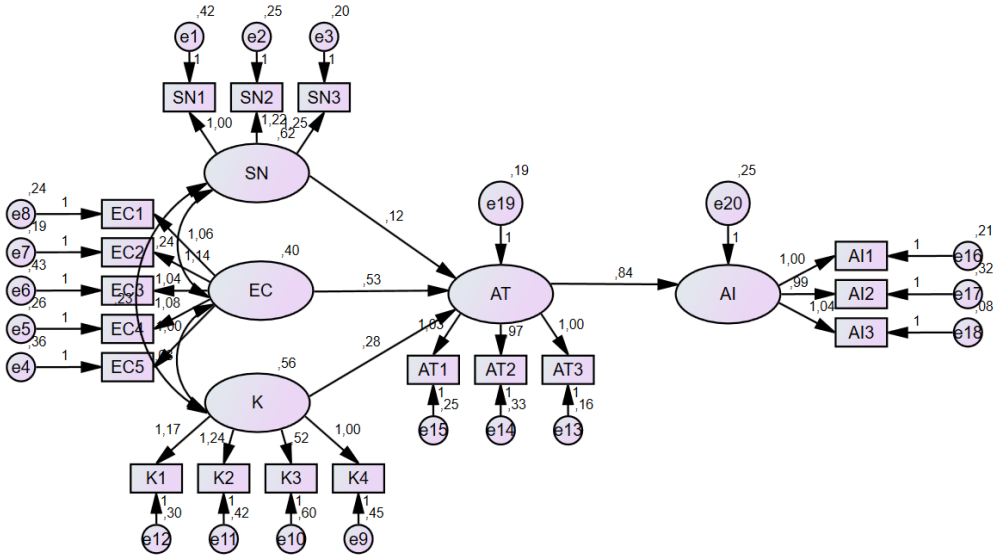

Figure 1. Research Framework

3. METHOD

This study uses the Structural Equation Modeling (SEM) technique to explore quantitative research. The data was obtained using a purposive sampling approach, with respondents who are interested and thinking about buying an electric car in Indonesia and are familiar with Fintech services. Data collection was carried out online in May - June 2023; 200 participants answered the questionnaire. The population of this study are people who have an interest in electric cars in Indonesia. The total number of respondents is determined by following several rules (Hair et al., 2019). The rule serves to avoid bias in the SEM estimation which suggests that a minimum sample size should be used. For example, (Widyaningtyas, 2010) argues that the minimum sample can be calculated if the population is unknown by adding indicators and latent variables and multiplying by 5. With 18 indicators plus five latent variables, the minimum sample size is 180 respondents. A total of 200 respondents exceeded the required minimum sample size because they used the SEM analysis method. Using the AMOS-SEM approach, we explore EV adoption intentions by extending the TPB model to include variables such as financial literacy, government support, and gender as moderating variables. This analysis includes a two-stage assessment; First, testing the measurement model by establishing the validity and reliability of each indicator; second, model fit is used to examine causal correlations between latent variables.

4. RESULT AND DISCUSSION

The instruments used to measure research variables were tested for validity and reliability. The sample size used affects the *factor loading value* which will be used as the limit for decision making in the validity test. The sample size used in this study was 200 respondents, so the limiting (Jr et al., 2019)*factor loading value was 0.40* . The results of the validity test in table 1 show that *the factor loading value* of each indicator is greater than 0.40 so that the indicators used in this study declared valid or appropriate in measuring the variables studied. The measurement instrument can be said to be reliable if it has a *Cronbach alpha value* greater than 0.6 (Sekaran & Bougie, 2016). The reliability test results in table 1 show that all instruments that measure all variables in the study have a *Cronbach alpha value* greater than 0.6 so that all instruments are declared reliable or there is internal consistency between indicators in measuring the same concept.

Table 1. Validity and Reliability Test Results

No	Statement	*Factor loading*	*Cronbach Alpha*	Information
	Knowledge			
1	Prospective consumers are familiar with battery electric vehicle (BEV) performance, such as charging time, acceleration, driving comfort, and mileage.	0.875	0.805	Valid and Reliable

2	Prospective consumers understand the costs of using electric vehicles	0.854		
3	Potential consumers know about the environmental advantages that battery electric vehicles (BEV) have compared to conventional vehicles.	0.585		
4	Prospective consumers know the ins and outs of electric vehicles above other average knowledge	0.836		
Subjective Norm				
1	Prospective consumers will feel they are a better person if they drive an electric vehicle	0.868	0.889	Valid and Reliable
2	If potential customers intend to change their cars now, consumers will feel they have a moral obligation to replace them with electric vehicles	0914		
3	Prospective consumers feel they have a moral obligation to use electric vehicles (EV).	0931		
Environmental Concerns				
1	Potential Consumers are very concerned about the current environmental pollution in Indonesia	0837	0.883	Valid and Reliable
2	Potential consumers are worried about the deteriorating air quality in Indonesia	0.876		
3	Potential consumers feel that vehicle exhaust emissions are one of the main sources of air pollution	0.774		
4	Prospective consumers feel they haven't done enough to save the environment from air pollution.	0.845		
5	Consumers argue that everyone has a responsibility to adopt a low-carbon mode of transportation.	0.799		
attitude				
1	Potential consumers believe that electric vehicles (EV) are good, useful and attractive	0.873	0.844	Valid and Reliable
2	Government support for the widespread use of electric vehicles (EV) is a wise move	0.868		
3	Consumer attitudes towards electric vehicles (EV) are positive	0.882		
Adoption Intention				
1	Prospective consumers are very willing to buy electric vehicles (EV).	0.900	0891	Valid and Reliable
2	Prospective consumers will seriously consider buying an electric vehicle (EV).	0.884		
3	Prospective Consumers will be excited at the prospect of purchasing an electric vehicle (EV).	0939		

Descriptive statistics aim to describe a variable. The mean value in descriptive statistics is commonly used for data that has an interval scale. The mean value shows the average value of the respondents' assessment of each variable statement studied (Sekaran & Bougie, 2016). Based on table 2, it can be seen that the *mean value* of the *Knowledge variable* is 3,342, which means that the average respondent feels an interest in electric vehicles and the standard deviation value is 0,806, which means that the respondents' responses regarding *Knowledge* are quite diverse. The *mean* value of the *Subjective Norms variable* is 3,276, which means that the average respondent is influenced by *the Subjective Norms* when the intention is to adopt an electric vehicle and the standard deviation value is 0,960, which means that the respondents' responses regarding *the Subjective Norms* are quite diverse. The *mean* value of the *Attitude variable* is 4,006, which means that the average respondent has a positive attitude towards electric vehicles and the standard deviation value is 0,719, which means that the respondents' responses regarding *Attitude* are quite diverse.

mean value of the *Adaptation Intention variable* is 3,733, which means that the average respondent has the intention to adopt an electric vehicle and a standard deviation value of 0.797, which means that respondents' responses regarding *Adoption Intention* are quite diverse.

Table 2. Descriptive Statistics Results

No	**Variable**	***Items***	***Means***	***std. Deviation***
1	*Knowledge*	4	3,342	0.806
2	*Subjective norms*	3	3,276	0.960
3	*environmental concerns*	5	4.107	0.713
4	*attitude*	3	4,006	0.719
5	*Adoption Intention*	3	3,733	0.797

The data analysis method used in this study is *Structural Equation Modeling* (SEM) which is run with the AMOS program. Before testing the hypothesis, *a goodness-of-fit model* will be carried out first to see the feasibility of the research model. Table 3 shows the results of the *goodness of fit test* where there are six measurements which state *goodness of fit* so that they can be declared feasible or pass the *goodness of fit test* (Hair et al., 2019).

Table 3. Results of *the Goodness of Fit Test*

Measurement	**Mark**	**GOF limit**	**Conclusion**
IFI	0.932	≥ 0.90	*Goodness of Fit*
TLI	0.918	≥ 0.90	*Goodness of Fit*
CFI	0.931	≥ 0.90	*Goodness of Fit*
RMSEA	0.077	≤ 0.1	*Goodness of Fit*
CMIN/DF	2,180	lower bound 1, Upper limit 5	*Goodness of Fit*
ECVI	1,835	Closer to Saturated value than Independent	*Goodness of Fit*
AIC	365,074		*Goodness of Fit*

Source: Data processing using AMOS

Table 4 shows the results of the direct hypothesis test proposed in the study. H1, H2, H3, and H4 are supported because the resulting *p-value* is < 0.05 with a positive *estimate* according to the proposed hypothesis. Table 5 shows the results of the mediation hypothesis test. H7 is supported because *Trust* has fulfilled the requirements to be a variable that mediates the effect of *Satisfaction* on *Continuance Intention* according to (Baron & Kenny, 1986).

Table 4. Direct Hypothesis Test Results

hypothesis	***P-Value***	***Estimates***	**Conclusion**
H1: Knowledge → *Attitudes*	0.000	0.282	H1 is supported
H2: Subjective norms → *Attitudes*	0.036	0.116	H2 is supported
H3: Environmental concerns → *Attitudes*	0.000	0.531	H3 is supported
H4: Attitudes → *Adoption Intention*	0.000	0.843	H4 is supported

Source: Data processing using AMOS

Hypothesis 1
Based on the results of hypothesis testing 1, it can be concluded that *Knowledge* has a positive effect on *Attitude*. This shows that the more potential consumers have knowledge regarding electric vehicles, the stronger the desire of potential consumers to adopt electric vehicles

Hypothesis 2
Based on the results of hypothesis testing 2, it can be concluded that *Subjective Norms* have a positive effect on *Attitude.* This shows that the more potential consumers have a high level of moral awareness, the higher their level of wanting to adopt electric vehicles.

Hypothesis 3
Based on the results of hypothesis testing 3, it can be concluded that *Environmental Concern* has a positive effect on *Attitude*. This shows that the higher the level of awareness of potential consumers about environmental conditions and care about air pollution conditions, the higher the level of their desire to adopt electric vehicles.

Hypothesis 4
Based on the results of hypothesis testing 4, it can be concluded that *attitude* has a positive effect on *adoption intention*. This shows that the more positive the attitude of prospective consumers makes the level of desire to adopt electric vehicles is also positive.

5. CONCLUSION

The magnitude of the desire of potential consumers to adopt electric vehicles shows that *electric vehicles* are acceptable among Indonesian people. Based on the results of the research and discussion previously described, it can be concluded that *Knowledge, Subjective Norms, Environmental Concern* and *Attitude* have a positive effect on *Adoption Intention.* This shows that the electric vehicle can be accepted as an alternative vehicle solution option in the midst of high levels of air pollution and high operational costs for the community in their activities compared to using oil-fueled vehicles. Further researchers can expand the research model by adding other independent variables that can influence *adoption intention*, such as *financial incentives or brand image.*

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