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Identification of Critical Factors in Product Change in The Automotive Industry

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A B S T R A C T

Electric vehicles are a future transportation option that has the advantages of reducing air pollution and being environmentally friendly. Battery-based electric vehicles are still relatively new in Indonesia and have not received public attention like conventional oil-fueled vehicles. Electric vehicles such as electric cars have been socialized, but there are still many assumptions that electric cars are still not roadworthy because they are still in the development process. Presidential regulation number 55 of 2019 is expected to be the legal basis for boosting the development of electric vehicles in Indonesia. This study address to explore and identify the main impact factors of product change on the automotive industry in Indonesia. To identify this case, the model was built based on the Theory of Planned Behavior (TPB) which was expanded in the context of the adoption of electric vehicles. This study aims to identify what factors can affect product changes in the automotive industry. This model is formed by main constructs: individual behavior, subjective norms, and perceived behavior control, as well as three other factors identified from the literature review and interviews. Based on this research, it was found that three factors can have an impact on product changes in the automotive industry. These three factors are subjective norms, perceived risk, and logistical incentives. Apart from these three factors, other supporting factors are also expected to be able to develop the electric vehicle ecosystem in Indonesia.

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1. INTRODUCTION

Electric vehicle technology in Indonesia is starting to show significant market development. Started by a Korean company that dared to make a difference by selling electric cars that had long cruising capabilities on just a one-time charge. The Ministry of Transportation has issued 2278 certifications related to electric vehicles until the end of 2020 based on actual data from The Central Bureau of Statistics Indonesia. The population of conventional vehicles in Indonesia has reached 133.617.012 units. Based on these data, it shows that electric vehicles have less attention

compared with the growth of electric vehicle technology in Indonesia. Several countries such as Europe, China, United States have conducted several studies and implemented electric vehicles in society (Csamango, 2020). Electric vehicles are still relatively new in Indonesia and have not become a public concern widely like conventional oil-fueled vehicles. In 2012, electric vehicles, especially electric cars, have begun to be socialized, but there are still many assumptions that electric cars are still not roadworthy because they are still in the development process (Iskan, 2021). According to Presidential Regulation Number 55 of 2019 concerning in Acceleration of the Battery Electric Vehicle Program for road transportation, it is intended to be the foundation in terms of reducing Greenhouse Gas emissions and mastering industrial technology in Indonesia.

Electric vehicles are an evolution of conventional oil-fueled vehicles. The ecosystems affected by the emergence of electric vehicles are the vehicle assembly industry, dealers, suppliers, customers, and the government. According to Tarei et al., (2021b) several barriers can affect the process of adopting new products in this case electric vehicles including technology, infrastructure, finance, and consumer behavior. In addition, there are also other factors such as environmental impacts both in the use and processing of waste.

One of the obstacles to implementing electric vehicles is the price issue of the latest technology which is still not affordable to the public. Supporting infrastructure such as electric power at home and supporting components of electric vehicles still require incentives from the government. Some of these points are still being considered by the wider community, especially in Indonesia because there is still a lack of intention to be able to adopt the use of electric vehicles as an alternative or substitute for oil-fueled vehicles. Currently, there is few of research related to the identification of factors that influence product changes in the automotive industry, especially in Indonesia. Therefore, this research is expected to provide insight in identifying what factors influence changes in automotive products, especially in Indonesia. To be able to identify this, a literature review was carried out based on the research background and suitable methods to be used as input in this research.

This study is expected to describe intentions by identifying factors from each automotive ecosystem and articulating direct and indirect relationships between influencing factors in the context of adopting new products. The objective of this research is to get an overview of the critical factors that will have an impact on product changes in the automotive industry. The theory of planned behavior (TPB) is used to help identify a factor that can affect the intention. This can be proven through previous research which discussed the level of adoption of electric vehicles among vehicle users and non-vehicle users where the attitude factor is the dominant factor in influencing intentions (Haustein & Jensen, 2018). The other research also states that the TPB construct relationship has a positive influence on intentions toward commercial electric vehicles as an alternative in making business decisions (Shanmugavel & Balakrishnan, 2023). TPB is also widely used to identify how recycling impacts the development of electric vehicles where TPB is used as a tool to help determine which factors have a significant influence on the interest in electric vehicles (Lou et al., 2022). Therefore, The Theory of Planned Behavior (TPB) conceptual model is used as a basic method in this research and is expanded by identifying and prioritizing the main constructions that can affect the level of adoption of electric vehicles through structured interviews followed by qualitative analysis and modeling. Furthermore, structured equation modeling (SEM) is used as a tool to analyze the pattern of relationships between variables and indicators.

2. LITERATURE REVIEW

2.1. Electric Vehicles in Indonesia

Electric vehicles are a technology that has long been introduced by an engineer in Hungary, Jedlik Anyos in 1828. Further developments were started by Thomas Parker (1884) in England, Ryker and William Morrison (1891) in United States, and Camille Jenatzy (1899) in Belgium. Many studies on electric vehicles prove that they have lower economic value than oil-fueled vehicles and allow them to directly

reduce exhaust emissions (Moriarty and Wang, 2017). Several countries in the world have started to mass produce electric vehicles and introduce them to the public. Half of the world's electric vehicle sales in 2019 were controlled by China, followed by the European Union and the United States (International Energy Agency, 2020).

Presidential Regulation Number 55 of 2019 is used as the basis for regulating the acceleration of the battery-based electric motorized vehicle program for road transportation. The implementation structure is divided into four aspects. The first aspect is the acceleration of industrial development and the provision of incentives for the introduction of vehicle specifications, development roadmaps, procedures for calculating domestic content levels, import periods, and phasing out levels of main component manufacturing. The second aspect is the provision of electric charging infrastructure and setting up charging fees. The third aspect is the technical requirements of the vehicle and roadworthiness. The last aspects are environmental protection in the form of appreciation for the handling of battery waste.
The President of the Republic of Indonesia, Joko Widodo, also has plans to make Indonesia one of the centers of the world's electric car industry (Kompas, 2021). The government is trying to downstream the nickel industry which is the basic material for lithium batteries in electric vehicles. In addition, the government also made new regulations related to limiting the export of nickel with low grades below 1.7% which are not allowed to be exported. Currently, Indonesia already has its own electric car assembly plant, which was just inaugurated by the President of the Republic of Indonesia (Bisnis.com, 2022). The Indonesian government also supports the manufacture of lithium batteries, which are currently in the facility construction stage (Bisnis.com, 2022)

2.2. Conceptual Model Development

The conceptual model used in this study aims to explore what factors that have an impact on product changes in the automotive industry. The basic model used is the Theory of Planned Behavior (TPB). Intention is considered a motivational factor that can influence a person's behavior in making a lot of planned efforts towards a behavior (Ajzen, 1991). The intention is supported by several main factors consisting of (a) attitudes towards behavior such as one's beliefs about behavior and its consequences, (b) subjective norms such as expectations that are considered important from certain behaviors, and (c) perceived behavior control such as understanding of the ease or difficulty of certain behaviors (Ajzen, 1991).

Based on the conventional TPB form, it is then developed into a new conceptual framework by examining several previous studies related to TPB. The construction of a framework was developed to help define several questions that will be prepared in an expanded semi-structured interview with external factors to determine the level of adoption of electric vehicles in Indonesia. In the literature review, several constituent factors can influence the intention of adoption. Performance expectations, business expectations, and environmental impact are part of the underlying attitude variables that help determine which factors have value or are not valuable (Tarei et al., 2021a). Social influence and as a determinant the condition of the of the facility a determinants of how individuals or institutions can be affected by the existence of new technology so that it will consider behavior that influences intention (Wang et al., 2021). Perceived risk and support from the government are the constituent factors that underlie perceived behavioral control variables which describe the ease or difficulty of adopting new things (Bastida-Molina et al., 2020)

3. RESEARCH FRAMEWORK AND METHOD

3.1. Research Framework

Based on the TPB framework, the present study was developed, and the explanatory behavior was adjusted for electric vehicle adoption, with behavioral determinants identified from the previous research. Attitude is closely related to where a person will have an assessment by considering the costs and benefits of environmental behavior if they have a good level of literacy (Ajzen, 1991). Subjective norms will always refer to external social influences from individual behavioral factors (Ajzen, 1991). Perceived behavioral control will refer to perceived ease to reflect on past experiences, anticipated incentives, and

obstacles (Ajzen, 1991).

The construction of the framework built as shown in Figure 1 will help define the questions to be prepared for conducting semi-structured interviews. Based on TPB framework, the explanatory behavioral model for electric vehicle adoptions is by developing from existing research by incorporating factors that govern intentions and behavior identified in semi-structured interviews with relevant experts. The factors identified from previous studies will also be asked during the interview to determine the accuracy of the factors based on actual conditions. Semi-structured interviews were conducted with six representatives from automotive companies who already have an electric vehicle product that has been marketed in Indonesia.

Representatives from each company are selected based on their expertise and knowledge of the products and the technology developed in their production systems. In the interview, a pre-screening process was carried out to avoid information bias related to knowledge regarding the factors that have an impact on the disruption of electric vehicles in the automotive industry. Table 1. shows an overview of company representatives and electric vehicle products that have started to be marketed in Indonesia.

The questions asked consisted of the current development of conventional vehicles, the condition of the automotive industry in Indonesia, views on the future of the local automotive industry, perceptions of electric vehicles, and future ecosystem developments. In addition, questions about the company's product technology were also asked to find out how far the company's image or business has evolved in facing the era of electric vehicles. The interview results were processed and analyzed qualitatively by collecting and transcribing the interview results verbally and reading the narrative repeatedly (Braun and Clarke, 2006).

Table 1. Company representative profile

No.	Company Representative	EV Technology
1	R1	e-Power
2	R2	PHEV, HEV
3	R3	BEV
4	R4	
5	R5	
6	R6	HEV, BEV

The next step is to examine, compare, conceptualize, and categorize the data (Corbin and Strauss, 1990). The keywords that are relevant and repeated by each representative are grouped for easy identification (Boyatzis, 1998). The keywords such as fee schemes and incentives can be grouped as economic incentives or business expectation factors. Technology, maintenance, and service life can be grouped as performance expectation factors. Reducing exhaust emissions, and processing of waste can be categorized as environmental impact factors. Culture, social activities, and corporate image are categorized as social factors. Availability of space, ecosystem supporting facilities fall into the category of facility conditions.

The shortcomings and opportunities for the small automotive industry to disappear in the future can be categorized as risk perception factors. All basic and binding rules related to electric vehicles can be categorized as a form of government support for the development of electric vehicles. The new framework was developed based on a literature review and the results of semi-structured interviews which were built based on the TPB framework which was expanded with seven interrelated factors to be able to identify factors resulting from product changes in the automotive industry.

3.2. Method

To evaluate the initiatives that determine behavior in adopting electric vehicles on a larger scale, an open survey was conducted of the community, especially those living in the JABODETABEK area. After collecting data through a questionnaire, the next step is to process the data obtained using statistical analysis first. Data processing is used to interpret the descriptive data obtained from the questionnaire. The respondent population is

based on the domicile location of vehicle users, To measure the important factors that control individual behavior, based on the TPB factors obtained from the identification of semi-structured interviews and the three conventional TPB constructs, Partial Least Squares Structural Equation Modelling (PLS-SEM) was adopted to be used as a method in measuring each factor.

The research hypothesis is proven based on the conclusion from previous studies. There are several factors are identified from the previous study related to the adoption of electric vehicles. The factors consist of attitude, subjective norms, perceived behavior control, performance expectations, business expectations, environmental impact, social influence, facility condition, risk perception, and government support. All these factors will have a relationship with each other and have an impact on the intentions that drive subsequent behavior.
The conceptual model used will be simpler, where there are only seven factors which are the core variables in this study which are especially in the JABODETABEK area. shown in Fig. 2.

After the conceptual model was developed based on previous studies, the automotive expert was invited to be able to express their views regarding the adoption behavior of electric vehicles in Indonesia. In addition, the experts are invited to examine several questions that will be asked as questionnaire questions. The survey was carried out using a questionnaire to the public through social media and face-to-face interviews. The questionnaire was divided into two parts, the first part explored more on the characteristics of the respondents such as gender, occupation, domicile, vehicle owned, and the things that underlie the choice of electric vehicles. The second part contains detailed questions related to product change factors in the automotive industry. To measure the respondent's perspective on the issues discussed in the questionnaire, a Likert scale is used where a scale of 5 means having a positive view, a scale of 3 has a neutral view and a scale of 1 has a negative view.

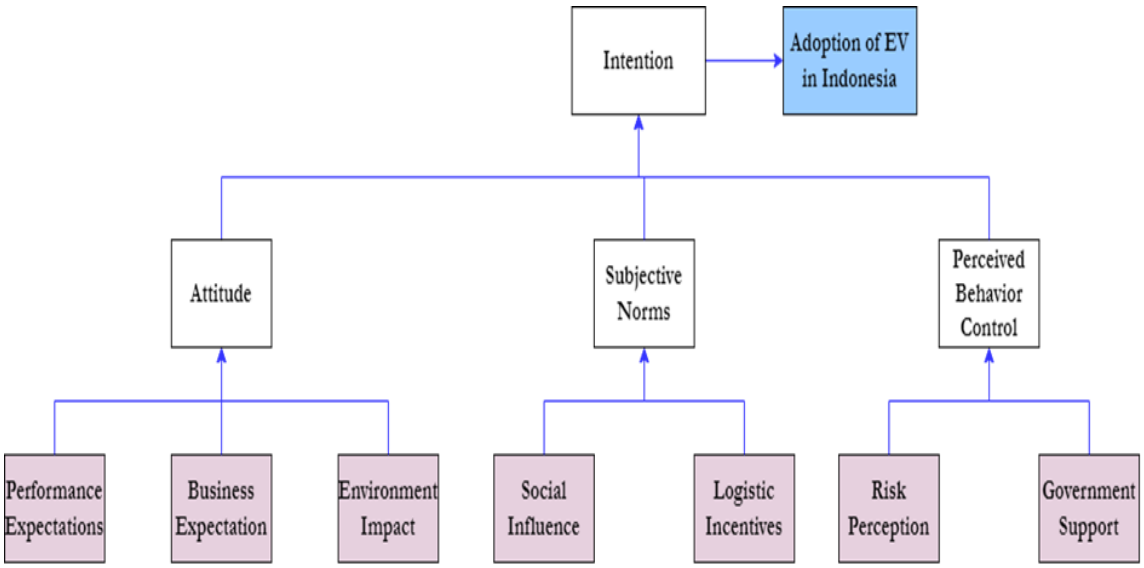

Fig. 1. Extended TPB framework
Source: Data is processed from various sources

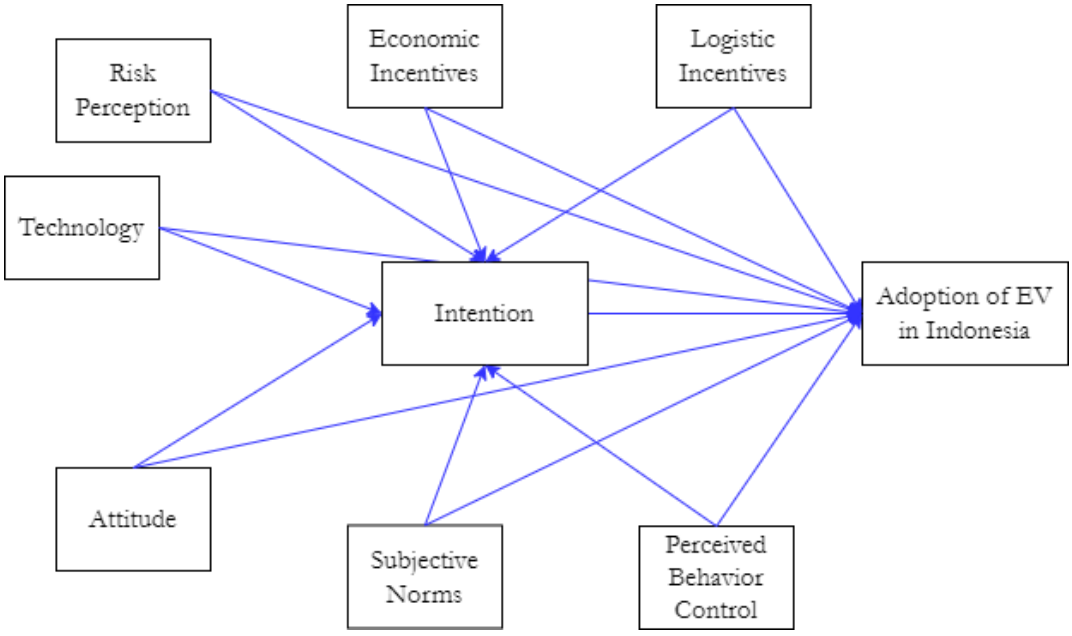

Fig. 2. The conceptual model used in the research

4. RESULT AND DISCUSSION

4.1. Questionnaire Results

To see the impact and influence of product changes in the automotive industry, from conventional vehicles to electric vehicles, a survey was conducted using a questionnaire with the public via social media and face-to-face. The questionnaire was divided into two parts, namely the first part explored more on the characteristics of the respondents such as gender, occupation, domicile, vehicle owned, and the things that underlie the choice of electric vehicles.

The second part contains detailed questions related to product change factors in the automotive industry. To be able to measure the respondent's perspective on the issues discussed in the questionnaire, a Likert scale is used where a scale of 5 means having a strong view, a scale of 3 has a neutral view and a scale of 1 has a negative view. The total number of respondents who were collected in the study was as many as 40.

Based on the results of the questionnaires collected, the demographic characteristics of the respondents were obtained, consisting of 67% male respondents and 33% female respondents. In the age category, 59% is dominated by the age group 26 - 34 years which represents the average productive age that carries out a lot of mobility activities using vehicles. The domicile of most respondents came from Jakarta with a percentage of 42% of the total target respondents who live in the JABODETABEK area. Furthermore, from the job criteria, 42% of the respondents had employment status as private employees, 34% were BUMN employees, and the remaining 24% had employment status as students and SMEs. All respondent's data is shown in Fig. 3. The type of vehicle owned by the respondents in this study shows that 90% of the respondents have conventional vehicles and 10% have electric vehicles. This condition is in line with the development of electric vehicles where people are currently still trying to explore the advantages offered by electric vehicles. In addition, electric vehicle owners also still have conventional cars and there are still doubts from the public about electric vehicle technology.

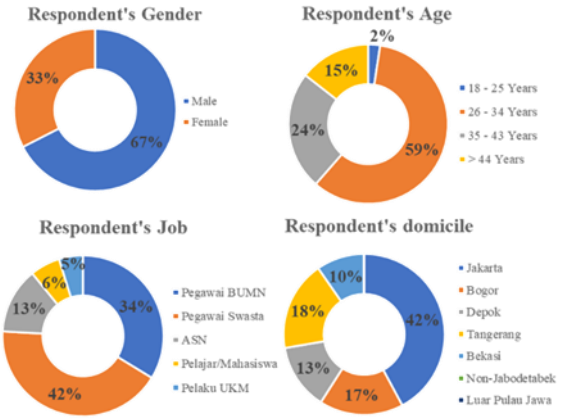

Fig. 3. Respondent profile

The model that has been built is then tested using the PLS method. Model testing consists of structural models, outer model testing, inner model testing and hypothesis testing. Fig. 4, shows a model built with the help of PLS-SEM software where there are 9 latent variables that are interconnected to form an intention or thought for electric vehicles in Indonesia. Model calculations were carried out using the PLS-SEM method and the parameters of the path weighting scheme and the maximum number of iterations used were 200 (Hair et al., 2014). Based on the calculation results, the results of indicator reliability, composite reliability and AVE can be shown in Table 2.

4.2. Measurement Model Test Results

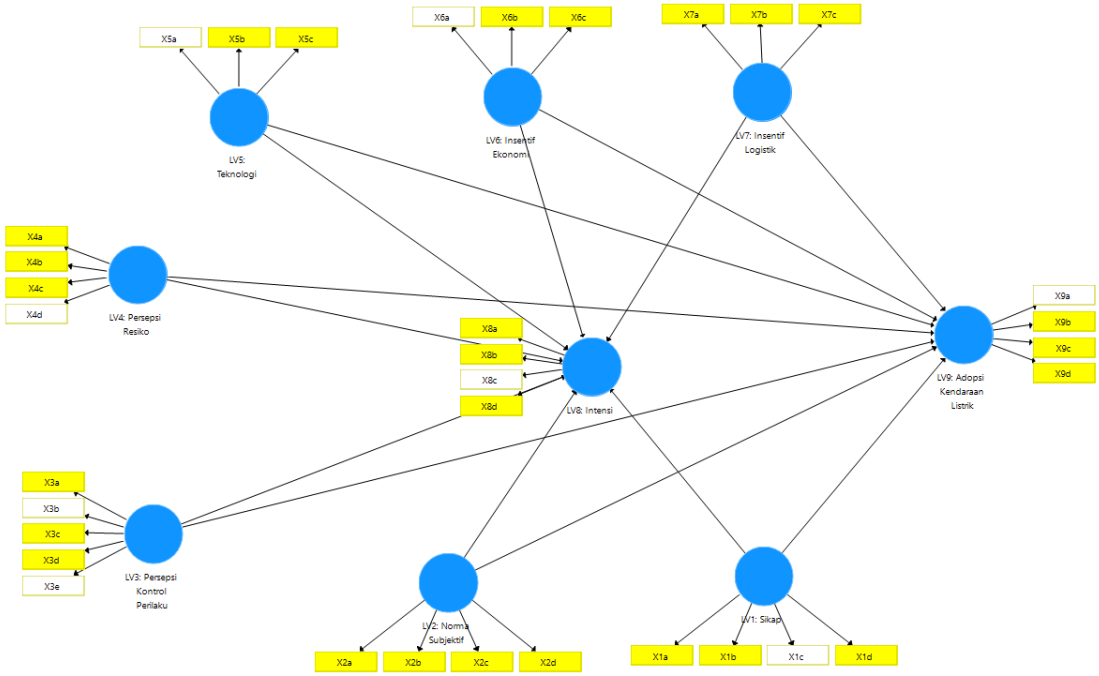

Fig. 4. Structural Model built using smartPLS

Based on the results of the tests that have been carried out, it was found that there are indicators that have a low level of reliability because the calculated values do not meet the predetermined requirements. Indicators that do not meet the reliability requirements will then be removed and retested with the same parameters. Convergent validity is then seen from the results of the AVE value where there are three valid variables. The results of discriminant validity can be seen in Table 3 where the results show satisfactory results indicated by the square root value of AVE (bold number) which is greater than the correlation value of the variable with other variables.

Table 2. Model Reliability & Validity Calculation

Latent Variable	Indicator	Indicator Reliability	Composite Reliability	AVE
		>0.50	**>0.6**	**>0.50**
LV1: Attitude	X1a	0.721	0.658	0.332
	X1b	0.566		
	X1c	0.423		
	X1d	0.557		
LV2: Subjective Norm	X2a	0.654	0.806	0.513
	X2b	0.775		
	X2c	0.801		
	X2d	0.618		

Latent Variable	Indicator	Indicator Reliability	Composite Reliability	AVE
		>0.50	>0.6	>0.50
LV3: Perceived Behavior Control	X3a	0.550	0.698	0.335
	X3b	0.408		
	X3c	0.628		
	X3d	0.824		
	X3e	0.361		
LV4: Risk Perception	X4a	0.808	0.803	0.530
	X4b	0.767		
	X4c	0.889		
	X4d	0.300		
LV5: Technology	X5a	-0.071	0.559	0.411
	X5b	0.799		
	X5c	0.768		
LV6: Economic Incentive	X6a	0.450	0.690	0.439
	X6b	0.821		
	X6c	0.665		
LV7: Logistic Incentive	X7a	0.576	0.807	0.589
	X7b	0.822		
	X7c	0.873		
LV8: Intention	X8a	0.631	0.686	0.366
	X8b	0.615		
	X8c	0.360		
	X8d	0.746		
LV9: EV Adoption	X9a	0.234	0.605	0.302
	X9b	0.763		
	X9c	0.544		
	X9d	0.524		

Based on the results of model testing, it was found that there are reliability indicators that are still below standard where these indicators can be said to be invalid. The reliability and validity tests that have been carried out give the result that three latent variables can meet the criteria seen from the AVE value. These three latent variables can be used as an initial basis for determining factors that have an influence on product changes in the automotive industry.

The first variable is subjective norm with AVE value 0.513. The subjective norm variable describes more the influence of social factors on behavior. In the context of this study, subjective norms can be seen from how much influence conventional vehicle brands currently have on the automotive industry in Indonesia. Currently, Toyota can be said to be a conventional vehicle manufacturer that has proven to be tough and is widely used by most Indonesians based on data collected by GAIKINDO at the beginning of the second semester of 2022.

For now, the Korean vehicle manufacturer has started an electric vehicle campaign in Indonesia. This was also done during an international event where Indonesia hosted the G20 event in Bali. Electric vehicles in Indonesia are still relatively new and not many vehicle manufacturers are willing to start marketing and promoting electric vehicles. There are still many vehicle users' perceptions of the level of ease in operating electric vehicles that will hinder the growth of electric vehicles.

The second variable is risk perception with AVE value 0.530. The risk perception variable has a significant influence on the intention of electric vehicles in Indonesia. The supporting facilities for this new ecosystem are not yet fully available for the continuity of electric vehicles. Some of the opinions from respondents regarding the risks that will be experienced by owners of electric vehicles are practical problems when driving long distances. Electric vehicle mobility is still considered limited and cannot be used as a traffic solution, especially in the JABODETABEK agglomeration area. In addition, the presence of electric vehicles can also trigger small businesses in the automotive industry to close their businesses because several components have been replaced and combined with a system that can only be controlled by pressing this function on the touch screen on electric vehicles.

The next variable is logistical incentives with AVE 0.589, where the incentives expected by users and other stakeholders are the availability of business processes from upstream to downstream. This will be closely related to the provision of after-sales services and the availability of several services that can support the ecosystem of electric vehicles. Logistical incentives can be used as a variable that must be considered because it will have a direct impact on the sustainability of electric vehicles in Indonesia. Ease of getting services will be able to encourage vehicle manufacturers and users to start transitioning to using vehicles that are more environmentally friendly. Logistical incentives according to respondents' views are not only seen from how a new product flows but

also more to the services offered. The JABODETABEK area is a limitation in this study because researchers want to see the level of logistical capabilities in that area.

Respondents stated that the JABODETABEK area was quite good in terms of service logistics for vehicle users. However, this is inversely proportional to conditions outside the JABODETABEK area where simple facilities such as charging stations are still very rare in several cities. So that this logistical incentive variable must be the main concern if the government has a long-term plan to form an electric vehicle ecosystem in all parts of Indonesia.

5. CONCLUSION

This study aims to find critical factors that influence product changes in the automotive industry, in this case electric vehicles. Several carbon-free movements and actions have been launched in various countries whose goal is to reduce emissions from conventional fossil fuel vehicles by introducing electric vehicle technology. Based on the results of this study, it was found that three factors mutually impacted intention and behavior in changing products in the automotive industry, namely subjective norms, perceived risk, and logistical incentives.

These three factors have their own considerations where each variable will form a new thought from the consumer side when buying an electric vehicle. One of the main considerations is how to carry out maintenance, recharge and the distance that can be covered in one charge. The results of the model test can be said to be good and able to provide output in the form of three variables that are expected to be considered in product changes in the automotive industry. However, these results can still be refined by re-testing to get more optimal results. The number of respondents currently used meets the minimum data required in the analysis using PLS-SEM. In addition, the number of iterations is still very possible to be increased to achieve the most optimal results.

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