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Adoption of Electric Vehicle: Perception of Young Generations (Case Study: Medan City)

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Abstract*— The adoption of electric vehicles as the main transportation is increasing. The infrastructure is rapidly developing, especially to support the big city life. Medan City is one of the biggest cities in Indonesia. This study aims to identify the factors affecting citizens of Medan to adopt electric vehicles as the main transportation mode. Using Technology Acceptance Model, some variables: perceived ease of use, perceived of usefulness, perceived of risk, environmental concern, knowledge of electric vehicle, financial incentive policy, attitude towards using, and intention of use. The young generations in Medan City tend to adopt the electric vehicle as their transportation mode. The environmental concern dan knowledge of the electric vehicle are the main perceptions affecting the attitude toward using the electric vehicle. And the attitude towards using positively related to intention of use (adoption).

***Index Terms*— Electric Vehicle, Transportation, Young Generation**

I. INTRODUCTION

Global warming is a significant issue today. Global warming is characterized by an increase in the average temperature in the atmospheric layer due to increasing carbon gas emissions. The rise in carbon gas emissions, in general, is caused by the burning of fossil fuels. Burning fossil fuels occurs due to two primary sources: coal-fired power plants and internal combustion engine vehicle (ICEV).

A four-wheel ICEV's fuel consumption per 100 km is about 7.8 liters, and it travels about 16 thousand km annually, resulting in emissions of about 3 tons of carbon dioxide. [1] In addition to carbon dioxide emissions, vehicle combustion emits carbon monoxide and other hydrocarbons.

From 2015 to 2020, motor vehicle growth reached 29.3 percent. The number of motor vehicles in five years can potentially increase exhaust emissions. North Sumatra is the province with the most significant number of motor vehicles outside Java, with around 6.7 million units of motor vehicles [2]. Medan City, the capital of North Sumatra and one of the largest cities in Indonesia became the city with the highest number of vehicles in the province.

One of the efforts to reduce the increase in carbon gas emissions is using environmentally friendly vehicles. One of the environmentally friendly vehicles is an electric-powered vehicle. Electric vehicles do not use combustion motors, so they do not emit gas emissions [3].

In general, electric vehicles could reach 200 km to 350 km with a full battery [4]. Research from Moeletsi [7] states that 58% of respondents are willing to buy electric vehicles even though they have limited mileage. In 2021, the best-selling electric car is the Hyundai Kona EV brand [5] and, the electric motor that became the reference was the United T1800 brand with a mileage of 65 km [6].

According to research by He et. al [8], high prices for electric vehicles have a negative effect on consumer purchases. In South Africa, research shows that 54% of respondents do not want to buy electric vehicles that cost more than USD 40,000 or IDR 593,568,000.00 [5].

According to Vassileva & Campillo [9], J. H. Lee et. al. [10], and Huang & Ge [11], people who have the potential to become users or buyers of electric vehicles are people with a high economic level. Based on the government policy, for Medan City the minimum wage in 2022 is IDR 3,370,645.08. It would be very challenging to suggest the adoption of the electric vehicle.

The government's efforts in increasing the adoption of electric vehicles are realized by providing electric charging infrastructure. Until now, there have been around 7000 units of public electric charging stations built by the state electricity company (PLN). The provision of infrastructure is still dominated in Java but has begun to be developed also in the city of Medan.

This study aims to identify the factors that influence the adoption of electric vehicle use in the city of Medan. The results of the study show that the younger generation became actors who would use electric vehicles as the main vehicle. Variables of knowledge, perception of use, environmental concern, finance incentive policies, behaviors, and intention of use are factors that influence the adoption of electric vehicles. Environmental concerns and knowledge of electric vehicles are becoming dominant factors in the adoption of electric vehicles.

II. METHOD

In conducting this study, preliminary observations were made regarding the use of electric transportation in Indonesia. A literature study was conducted to get an overview of the

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development of the use of electric vehicles. The research location was carried out in Medan City (Figure 1), the capital city of North Sumatra Province, and Indonesia's largest city outside Java Island.

To obtain opinions about the use of electric vehicles in the city of Medan, a questionnaire was distributed, which was prepared by involving independent variables and dependent variables based on several studies that had been conducted. Variable testing was carried out before the questionnaire was randomly distributed to respondents who were active in a business district or bustling hub in Medan City.

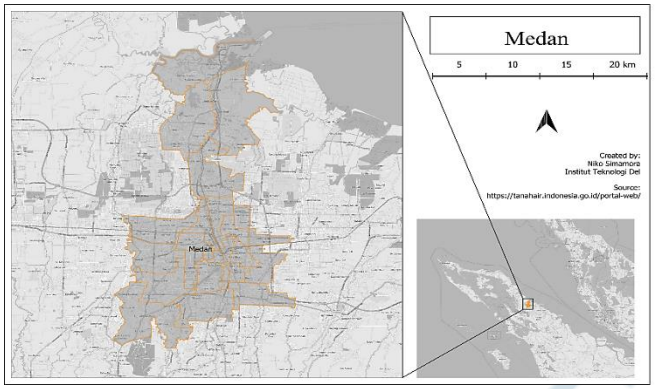

Figure 1 Research Location in Medan City

The data obtained in this study came from primary data in the form of questionnaires distributed to respondents and secondary data in the form of data obtained from literature studies, reports, news, and other data relevant to this study.

The research framework used in this study is an analysis of the variables that influence the adoption/attitude to use electric vehicles. These variables include perceived ease of use (PEU), perceived usefulness (PU), perceived risk (PR), environmental concern (EC), knowledge about electric vehicles (KEV), financial incentive policies (FIP), attitude towards using (ATU), intentions to use (IU) (as shows in figure 2).

These variables are based on Technology Acceptance Model (TAM) approach, which argues that there are external variables that related perceived of usefulness and perceived ease of use attitudes to intentions to adopt a new technology. In addition to this study, several relevant variables are set to be able to measure the value of the reliability of a variable. The analytical approach is carried out using exploratory data analysis, with univariate and bivariate analysis.

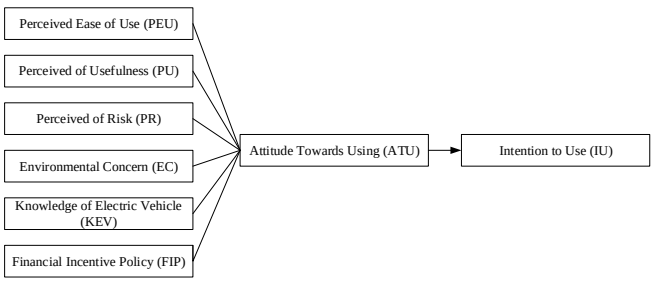

Figure 2 Research Framework

In exploring data, the univariate analysis conducts descriptively analyzes independently that could show in data visualization. While the bivariate analysis conducts to analyzes the correlation between two variables using Spearman's Rank Correlation Test. This test is used to find correlation or relationship between two variables using ordinal scale. If the significance value (α) < 0.05, there is positive correlation, while $\alpha > 0.05$ means that there is negative correlation.

III. RESULT

The results of data collection obtained 350 respondents who filled out questionnaires which were distributed in person or online. Of the 350 respondents, 81 percent were in the 17 up to 25-year age group. 51 percent are male, and 49 percent are female.

Univariate analysis

- *Type of electric vehicle*

In this study, the electric vehicles tend to be generalized based on the most popular for four-wheels (electric cars) and two-wheels (electric bike). Based on data in 2022, electric cars for the Tesla brand (47%) and Hyundai (27%), and Toyota (24%) are electric car brands which are the favorite of the Indonesian people. But in 2021, the best-selling electric car will be the Hyundai Kona EV brand [5]. The four-wheels electric vehicle that is used as a reference in the research questionnaire is the Hyundai Kona EV brand, with the mileage capacity up to 305 km.

It is known that the number of motorbikes is 69% more than the number of cars in 2021, so reference specifications regarding electric motorbikes are also needed in the research questionnaire. As for the electric bikes category, United (25%), Viar (24%), and Gesits (19%) are the favorite brands of electric motorbikes for Indonesians. Thus, the electric motor that became the reference was the United T1800 brand with a mileage of 65 km [6].

In addition, the survey was also conducted on the types of electric vehicles that were more attractive to respondents. Based on the survey results, as many as 67% of respondents were interested in electric motorbikes, while as many as 33% of respondents were interested in electric cars, 59.7 of respondents chose electric motorbikes due to the cheaper price compared to electric cars.

- *Mileage*

The surveys shows that as many as 7.6% of the respondents had daily mileage of less than 20 km, 19% of respondents have daily mileage in the range of 20-49 km, 4% of respondents have daily mileage in the range of 50-99 km, 1% 100-149 km, and no respondents have daily mileage day more than 149 km. Based on the mileage capability of electric vehicles, the specifications of both motorbikes and cars meet the criteria for the characteristics of the respondents' daily mileage.

Thus, based on the respondents, it can be said that the

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people of Medan City are suitable for using electric vehicles. Compared with Moeletsi [7] states that 58% of respondents are willing to buy electric vehicles even though they have limited mileage. This is because 89% of respondents have a daily mileage of less than 100 km, so they don't feel bothered by the limited vehicle mileage.

- *Price*

According to the brand of the electric vehicle used as a reference, it is known that the purchase price for an electric car branded Hyundai Kona EV is IDR 742,000,000, and the purchase price for an electric motor for the United T1800 brand is IDR 27,000,000. The price of an electric car is 27 times higher than the price of an electric motor. According to research by He et. al [8]., high prices for electric vehicles have a negative effect on consumer purchases. The research results are reinforced by Moeletsi's research (2021) in South Africa that 54% of respondents do not want to buy electric vehicles that cost more than USD 40,000 or IDR 593,568,000.00.

Based on the results of the research survey, the number of respondents was dominated by people with income ≤ IDR 3,000,000, which is 47%. Based on the minimum wage for the people of Medan City, the economic level of young people is still very challenging.

Bivariate Analysis

The data processing in bivariate analysis uses the Spearman Rank Correlation Test. This test is used to determine the relationship between the independent variable and the dependent variable. Table 1 is a summary of the results of the hypothesis testing. Based on the test results, Hypothesis 1 (H1), Hypothesis 2 (H2), Hypothesis 3 (H3), and Hypothesis 6 (H6) have a significance value α (alpha) > 0.05 so the hypothesis is rejected. While Hypothesis 4 (H4), Hypothesis 5 (H5), and Hypothesis 7 (H7) have a significance value α (alpha) < 0.05 so that the hypothesis is accepted.

Hypothesis 1 (H1) states that there is a relationship between Perceived Ease of Use (PEU) and Attitude Towards Using (ATU). Based on the results of the Spearman Rank Correlation test, the significance value obtained was 0.144 > 0.05. So, Hypothesis 1 is rejected, meaning that there is no significant relationship between Perceived Ease of Use (PEU) and Attitude Towards Using (ATU). The results of this study could be comparing with Tu & Yang [12] and S. Wang et al. [13], which state that there is an influence of Perceived Ease of Use (PEU) on Attitude Towards Using (ATU). Hypothesis 1 is rejected because the respondents in this study were dominated by non-electric vehicle users (97%).

In the Tu & Yang research [12] are people who live in coastal areas because most of the number of electric vehicles are in coastal areas, while in Jaiswal et. al. [14] are new users or potential buyers of electric vehicles in the future. It can be said that the characteristics of the respondents in previous research studies better understand the ease of use of electric vehicles because they are users of electric vehicles and have observed a lot of the use of electric vehicles.

Hypothesis 2 (H2) states that there is a relationship between Perceived Usefulness (PU) and Attitude Towards Using (ATU). Based on the results of the test, the significance value obtained is 0.015 α > 0.05. So, Hypothesis 2 (H2) is rejected, meaning that there is no significant relationship significant difference between Perceived Usefulness (PU) and Attitude Towards Using (ATU). The rejection of hypothesis 2 can be caused by several conditions, such as 97% of research respondents are not users of electric vehicles.

Table 1. Hypothesis

Hypothesis	Significance Value	Correlation	Result
H1: PEU → ATU	0,144	0,147	Rejected
H2: PU → ATU	0,015	0,242	Rejected
H3: PR → ATU	0,273	-0,111	Rejected
H4: EC → ATU	0,000	0,609	Accepted
H5: KEV → ATU	0,000	0,437	Accepted
H6: FIP → ATU	0,068	0,183	Rejected
H7: ATU → IU	0,000	0,648	Accepted

The results of this study from Tu & Yang [12] and S. Wang et al. [13], which state that Perceived Usefulness (PU) has a positive effect on Attitude Towards Using (ATU). The rejected hypothesis can be caused by several conditions, such as 97% of research respondents are not users of electric vehicles, so respondents have never had direct experience in using electric vehicles. Thus, it is evident that someone who has no previous experience will have difficulty in expressing the perceived benefits of the attitude of using electric vehicles [14].

Hypothesis 3 states that there is a relationship between Perceived Risk (PR) and Attitude Towards Using (ATU). Based on the test results, the significance value obtained is 0.273 (α > 0.05). Thus, Hypothesis 3 is rejected, meaning that there is no significant relationship between Perceived Risk (PR) with Attitude Towards Using (ATU).

The research results contradict the research of Wang et al., [13], which states that there is an influence of Perceived Risk (PR) on Attitude Toward Using (ATU). Based on Hasan [15] state that someone who has no experience using electric vehicles will find it difficult to express perceptions. Our finding shows 97% of the respondents in this study were not users of electric vehicles and had no experience in using electric vehicles. Therefore, the results of the hypothesis are rejected and are different from previous research, which can be caused by the characteristics of the respondents.

Hypothesis 4 (H4) states that there is a relationship between Environmental Concern (EC) and Attitude Towards Using (ATU). Based on the results of the test, the significance value obtained was 0.000 (α <0.05). So, Hypothesis 4 (H4) is accepted, meaning that there is a significant relationship between Environmental Concern (EC) and Attitude Towards Using (ATU). A high level of environmental awareness can encourage the desire to use electric vehicles because this awareness can strengthen people's responsibility towards the environment. The results of the study are in accordance with

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the results of research by Wu et al. [16]. The correlation value obtained was 0.609, so it can be said that there is a positive relationship strong relationship between Environmental Concern (EC) and Attitude Towards Using (ATU).

Hypothesis 5 (H5) states that there is a relationship between Knowledge of Electric Vehicles (KEV) and Attitude Towards Using (ATU). Based on the results of the test, the significance value obtained was 0.000 (α <0.05). Thus, Hypothesis 5 (H5) is accepted, meaning that there is a significant relationship between Knowledge of Electric Vehicles (KEV) and Attitude Towards Using (ATU). A high level of knowledge about electric vehicles can trigger people's desire to use electric vehicles. The correlation value obtained is 0.437, so it can be said that there is a strong relationship between Knowledge of Electric Vehicle (KEV) with Attitude Towards Using (ATU). The results of this study are in accordance with the research of S. Wang et al. [13]. The correlation value obtained is 0.437, so it can be said that there is a strong relationship between Knowledge of Electric Vehicle (KEV) with Attitude Towards Using (ATU).

Hypothesis 6 (H6) states that there is a relationship between Financial Incentive Policy (FIP) and Attitude Towards Using (ATU). Based on the results of the test, the significance value obtained was 0.068 (α > 0.05). Thus, Hypothesis 6 is rejected, meaning that there is no significant relationship between Financial Incentive Policy (FIP) and Attitude Towards Using (ATU).

Several previous studies said that providing incentives is one way to attract public interest in using electric vehicles [17] [18]. Based on the Financial Incentive Policy variable, 44 % of respondents agreed and 33% strongly agreed that subsidy policies and preferential tax policies were important for respondents to buy electric vehicles, while 26% of respondents were neutral. The survey results show the price factor is the main thing that is considered by respondents in choosing the type of electric vehicle; the provision of incentives such as tax subsidies or purchase subsidies has the potential to support people's behavior in using electric vehicles.

However, based on the results of the bivariate test, the hypothesis was rejected. The possibility of the hypothesis being rejected could be due to the lack of understanding of the respondents regarding the policy of giving incentives to users of electric vehicles in Indonesia or policies regarding electric vehicles in Indonesia which are still inadequate. [19]

Hypothesis 7 (H7) states that there is a relationship between Attitude Towards Using (ATU) and Intention to Use (IU). Based on the results of the test, the significance value obtained was 0.000 (α <0.05). So, Hypothesis 7 (H7) is accepted, meaning that there is a significant relationship between Attitude Towards Using (ATU) and Intention to Use (IU). If someone has a positive attitude towards a technology, then the intention to use the technology will be higher. The results of this research hypothesis are in accordance with Jaiswal et al. [20].

IV. DISCUSSION

Based on the results, it is known that there are two variables that are positively related to attitude towards using (ATU), namely environmental concern (EC) and knowledge of electric vehicles (KEV). In addition, attitude towards using (ATU) also has a positive relationship with intention to use (IU).

In this study, it can conclude that the young generation of Medan City tend to adopt electric vehicles as their transportation mode. The factors that influence the attitude towards using of the young generations related to environmental concern and knowledge about electric vehicles. The attitude towards using relatively positive to intention to use.

Thus, stakeholders can focus on increasing public education about electric vehicles, especially related to the environmental concern regarding carbon emission. The other concern is about knowledge of electric vehicles such as attribute specifications, performance, and benefits for both users and the environment.

Efforts to increase education can be carried out jointly by the government industries through online news media, social media, radio, and television. The use of social media is one of the strategies to educate the young generations. In January 2021, the number of social media users in Indonesia reached 170 million people. YouTube platforms (93.8%), WhatsApp (87.7%), Instagram (86.6%) and Facebook (85.5%) are the social media platforms most used by Indonesians. Social media is a tool that has the potential to increase public awareness and enhance the identity of a brand based on Hutter et al., [21].

The government can also try to increase the awareness of the people of Medan City on environmental issues and their impact on the future of humanity through interactive learning. The interactive learning method can be implemented in museums or galleries. Based on research by Ohlei et al. [22], it is said that interactive learning in museums and galleries can increase public awareness of the environment. Through interactive learning strategies, a fun and educative learning atmosphere will be created. achieve a sustainable environment.

Industries, especially the companies that produce electric vehicles, can also provide opportunities for the public or potential users to conduct trials on the use of electric vehicles to improve people's experience of electric vehicles [23]. The efforts undertaken can be applied by exhibitions of electric vehicles that are directly tested and renting electric vehicles or car sharing. Car sharing is an access-based service to provide field trials of new technologies. Based on Schlüter & Weyer's [24], the perception of respondents who had car-sharing experience regarding the benefits of electric vehicles was significantly higher than respondents who had no experience.

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