

**THE EFFECT OF INCENTIVE, TECHNOLOGY READINESS, AND CHARGING
INFRASTRUCTURE ON ELECTRIC VEHICLE ADOPTION MEDIATED BY
PERCEIVED BEHAVIOR CONTROL
(EMPIRICAL STUDY: INTENTION TO ADOPT ELECTRIC VEHICLES IN
JAKARTA AND ITS SURROUNDINGS)**

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KEYWORDS:

Incentive; Charging
Infrastructure; Technology
Readiness; Perceived
Behavior Control; and
intention to adopt

ABSTRACT

Today, the world faces crucial challenges such as the energy crisis, air pollution, and greenhouse gas emissions. The transportation sector is considered a major contributor to these problems, which is driving climate change in various cities. To achieve the goal of zero emissions, electric vehicles are positioned as the transportation solution of the future and need to be widely adopted around the world. This research focuses on analyzing the factors that affect the intention to adopt electric vehicles, with variables such as Incentive, Charging Infrastructure, Technology Readiness, Perceived Behavior Control, and intention to adopt. The goal is to understand how these factors contribute to shaping people's decisions to use electric vehicles.

This study uses a quantitative approach with a sample of at least 150 respondents. Data collection was carried out through an online questionnaire, and data analysis was carried out using the structural equation modeling (SEM) method with Smart-PLS (Partial Least Squares Structural Equations Modeling) software version 3.0. Testing of validity, reliability, and goodness of fit was carried out to ensure the quality of the model.

INTRODUCTION

The world is faced with an increasingly acute energy crisis. Limited fossil energy reserves, rising greenhouse gas emissions, and the increasingly urgent impact of climate change are the need to switch to renewable energy. The transportation sector is one of the largest contributors to greenhouse gas emissions, with energy consumption reaching 30% of total global energy consumption. This encourages various countries to look for alternative solutions that are environmentally friendly, one of which is by switching to electric vehicles (Agency, 2022).

Transportation is believed to be a major contributor to pollution and greenhouse gas emissions, which cause climate change in urban areas (Jaiswal et al., 2022). This problem is related to the issue of greenhouse gas emissions that play a role in global climate change, triggering extreme weather phenomena, rising global temperatures, rising sea levels, and

changes in rainfall patterns that threaten the continuity of ecosystems and human life at large (Adnan et al., 2018).

Another problem is also added if the current extensive use of fossil fuels continues without a proper solution. In this case, there is a high possibility that there will be a fuel shortage, which has the potential to trigger an energy crisis in Indonesia. One potential solution is the conversion of fossil fuel-powered cars to electric vehicles (Pambudi & Juwono, 2023).

EVs offer a more environmentally friendly solution than conventional vehicles that use fossil fuels. EVs do not produce direct exhaust emissions, so they can help reduce air pollution and greenhouse gas emissions. In addition, EVs are also more energy-efficient than conventional vehicles, and can help reduce dependence on fossil fuels (Tampubolon, 2020).

Indonesia also welcomes the era of electrification with a strong commitment. The government has set a national target to achieve net-zero emissions by 2060, as announced at the UN Climate Change Conference in Glasgow in 2021. This effort is in line with Indonesia's vision to realize sustainable development and strengthen national energy security. Various strategic policies and programs have been launched to encourage EV adoption in Indonesia, in line with the global trend moving towards the era of electrification (ESDM, 2021).

Indonesia, with a population of 279,390,258 in 2024, is the fourth most populous country in the world (Diva Lufiana Putri, n.d.). Data as of February 2024 shows that there are 160,652,675 units of motor vehicles, 19,906,353 units of private cars, 269,476 units of buses, 6,120,307 units of goods transport vehicles, 134,181,607 units of motorcycles, and 154,372 units of special vehicles such as ambulances or fire brigades (Adji, 2024) which means that 1 in 12 people owns a motor vehicle. Motorcycles dominate 81.7% of the total vehicles, while cars only 18.3%. Indonesia targets the sale of 200,000 units of electric vehicles per year to achieve carbon neutrality by 2060. This ambitious target was announced by the Coordinating Minister for Economic Affairs, Airlangga Hartarto, in July 2022 (Ayudiana, 2024).

The trend of electric vehicle sales has also increased very high based on data from the Indonesia Motor Vehicle Industry Association (Gaikindo) electric car sales reached 51,831 units during the first 10 months of 2023, up 322% year-on-year (YoY) from 12,281 units (IESR, 2022), explained the Minister of Energy and Mineral Resources of Indonesia (ESDM) Arifin Tasrif Currently, the number of electric motorcycles and electric cars on Indonesia's roads is almost 100 thousand units, with details of 74 thousand electric motorcycles and 20 thousand electric cars, said Arifin in his remarks at the Electric Vehicle (EV) & Battery Conference 2023 at the Borobudur Hotel, Jakarta, (Tuesday 21/11/2023) (Anshori, 2023).

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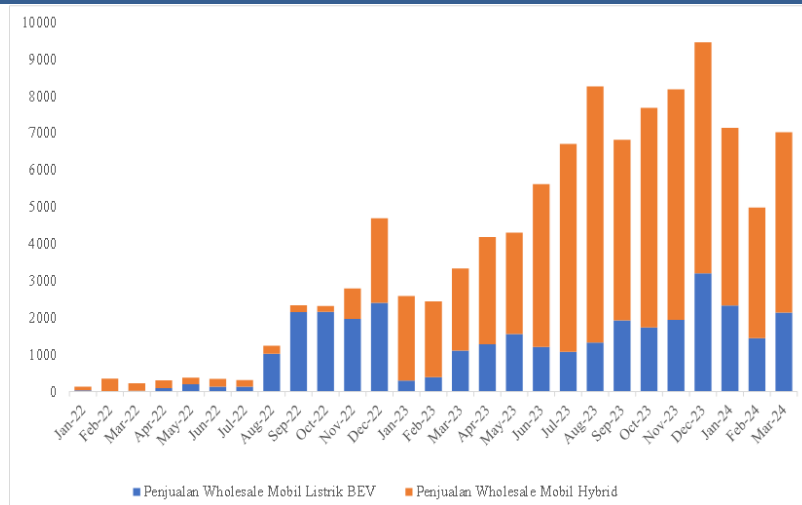


Figure 1 BEV and HEV Electric Car Sales in Indonesia
Source : Ahdiat (2024)

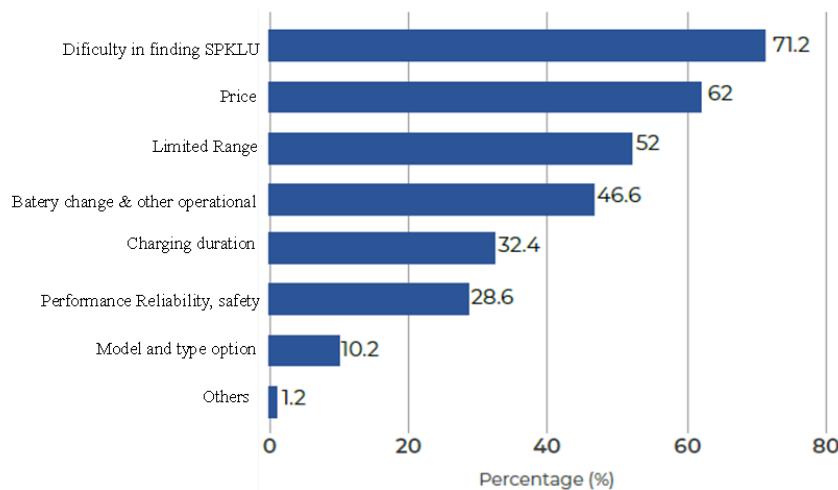


Figure 1 Barriers to adopting Electric vehicles

Source: (Faris Adnan Padhilah. Ilham Rizqian Fahreza Surya, 2023)

In line with data obtained from the Indonesia Electric Vehicle Outlook (2023) regarding barriers to the adoption of electric vehicles, the Government of Indonesia has taken steps to encourage EV adoption in Indonesia. These steps include providing various incentives, such as tax subsidies and import duty exemptions (Wibowo & Rasji, 2023). In addition, the government is also actively building EV charging infrastructure in various regions in Indonesia (Kristiana et al., 2024).

The adoption of electric vehicles (EVs) has increased in recent years. In 2022 alone, the number of two-wheeled (E2W) and four-wheeled (E4W) electric vehicles on the road increased by almost 5 and 4 times, respectively, compared to 2021. However, despite significant growth in 2022, EV adoption rates are still far from Indonesia's target. Inadequate charging infrastructure, high initial costs, and limited driving range are the main barriers to EV adoption. In addition, the long charging duration of EVs is also considered a barrier (IESR, 2022).

Consumer perception and lack of understanding of EVs also hinder EV adoption (Candra, 2022).

The low adoption rate of electric vehicles in Indonesia can be attributed to several factors, one of which is the relatively low incentive to reduce EV costs compared to other countries. Although fiscal incentives such as the elimination of import duties and VAT reductions have been implemented, the impact has not been significant in increasing consumer purchasing power for electric vehicles. This is reinforced by the research of Mpoi et al, (2023) which shows that financial incentives, such as direct subsidies for the purchase of electric vehicles and the construction of adequate charging infrastructure, are crucial factors in driving the adoption of electric vehicles in European countries. The low incentives in Indonesia, coupled with the relatively high price of electric vehicles compared to conventional vehicles, are the main obstacles for people to switch to these more environmentally friendly vehicles (International Energy Agency, 2023).

Although the government has made various efforts to encourage EV adoption, there are still several challenges that need to be overcome, one of which is the limitations of EV charging infrastructure. Currently, the number of EV charging stations in Indonesia is still very limited, especially outside big cities. This can be an obstacle for consumers who want to buy an EV, as they are worried that they will not easily find a place to charge their vehicle (Asaad, 2024).

The availability of charging infrastructure plays an important role in the adoption of electric vehicles (EVs), as it reduces consumer range anxiety as most EVs have a lower driving range compared to gasoline-powered vehicles. This range limitation issue is particularly relevant for drivers of two-wheeled transportation services (E2W), as most E2Ws only have 50-60 km per charging cycle, which is insufficient for their daily coverage (Boo, 2024).

Financial incentives, such as those provided in the subsidy program, have proven to be very influential in increasing public interest in buying electric vehicles (Mpoi et al., 2023). The study found that respondents who considered these financial incentives "important" or "very important" had a higher probability of buying an electric vehicle. In addition, the existence of financial incentives to install charging stations at home and additional bonuses for replacing old conventional cars are also significant driving factors (Mpoi et al., 2023).

Perceived behavioral control (PBC), or perceived behavioral control, plays an important role in the adoption of electric vehicles (EVs). PBC refers to an individual's belief that they have the necessary abilities and resources to perform a behavior, in this case, buying and using an EV. Factors contributing to PBC in the context of EVs include access to adequate information about EVs, the availability of easily accessible and reliable charging infrastructure, and government policy support that encourages EV adoption. A high PBC can increase an individual's interest and intention to switch to EVs, as they feel more confident in their ability to overcome potential barriers and successfully adopt this new technology (Mpoi et al., 2023).

While customer preferences for electric vehicle adoption vary widely, especially in the combination of incentive variables, charging facilities, Technology Readiness and perceived behavioral controls, these variables can differ significantly from country to country. In addition, previous research on these factors in Indonesia is still limited. Given that Indonesia is a developing country, its environment may be different from that of developed countries. Therefore, further research on these factors in Indonesia is urgently needed to understand the interest of Indonesia society in adopting electric vehicles, with the ultimate goal of increasing the use of electric vehicles in Indonesia in accordance with the government's plan. This study

aims to analyze the effect of incentives on the intention to adopt electric vehicles in Jakarta and its surrounding areas.

RESEARCH METHODS

This study uses a quantitative approach to analyze data objectively and measurably. This approach was chosen because this study aims to test previously formulated hypotheses and measure the relationship between variables statistically. This study uses both types of data, with questionnaires as primary data sources to measure respondents' opinions and perceptions, as well as journal articles, books, and websites as secondary data sources to build theoretical foundations and support statements in the research. This study uses a method of collecting data from respondents by utilizing the questionnaire method. A questionnaire in the form of Google Forms was given to respondents to fill in data.

Hypothesis testing in this study will use path analysis using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, because this method is able to handle complex models with many variables and data that is not normally distributed (Hair, et al 2021).

The analysis was carried out by referring to a critical t-statistical value greater than 1.96 with a p-value or a smaller significant level equal to 0.05 (Hair, et al 2021). The criteria for acceptance or rejection of a hypothesis in PLS-SEM are as next:

- If the value of $p < 0.05$ and $t\text{-Statistic} > 1.96$ (for a significance level of 5%), then H_0 is rejected and H_a is accepted.
- If the $p\text{-value} > 0.05$ and the $t\text{-value} < 1.96$ (for a significance level of 5%), then H_0 is accepted and H_a is rejected.

In addition, in PLS-SEM, we can also use confidence intervals (CI) to test hypotheses. If a value of zero is not included in the 95% CI, then H_0 is rejected and H_a is accepted. Conversely, if a value of zero is included in the 95% CI, then H_0 is accepted and H_a is rejected.

RESULTS AND DISCUSSION

Incentive -> Intention to Adopt (Proven)

In this study, it was found that the results of Incentives had a positive effect on Intention to Adopt, so it can be said that incentives increase the intention to use electric vehicles (EVs). This is especially important in Indonesia, which is pushing for the use of EVs as an environmentally friendly means of transportation. Effective incentives include direct subsidies, tax exemptions, or tax breaks. Non-financial incentives such as free parking or special lane access can also lower financial barriers and make EVs more affordable for buyers. With more people using electric vehicles, air quality in Indonesia will improve, the EV industry will develop, and greenhouse gas emission reduction targets will be achieved. To maximize this positive impact, governments must evaluate and change existing incentives, and work with cross-sector organizations. These findings are in line with and supported by research by (Deka, 2023) which explains that in India, incentives such as subsidies, low-interest loans, toll tax reductions, and parking facilities can facilitate EV purchases.

This study emphasizes that the current incentive policies should be complemented by

attitude- and norm-based incentives to accelerate EV adoption and in line with the research conducted by Shakeel (2022) also found that both monetary incentives (such as tax breaks and low-interest financing) and non-monetary incentives (such as bus lanes and free parking) have a positive impact on EV purchase intentions in Pakistan.

Incentive -> Perceived Behavioral Control (Proven)

In this study, it was found that the results of Incentives had a positive and significant effect on Perceived Behavioral Control (PBC) in the context of electric vehicle (EV) adoption had interesting and important implications. PBC refers to an individual's perception of how easily or difficult they can perform a behavior, in this case, adopting and using an EV. Several things about PBC here are found, the first is that this incentive reduces barriers because incentives, both financial and non-financial, can reduce the perceived barriers in the use of EVs. For example, price subsidies can make EVs more affordable, while incentives such as dedicated lane access or free parking can improve comfort and ease of use.

Second, Increasing Self-Confidence, Incentives can provide a positive signal to potential EV users that the government and manufacturers support EV adoption. This can increase their confidence in their ability to use this new technology. The third is informed: Incentive programs are often accompanied by information and education campaigns about EVs. This information can help potential users understand how EVs work, their benefits, and how to overcome them, thereby increasing their PBC.

In line with research conducted by Mpoi et al (2023), financial incentives, such as discounts, subsidies, or tax breaks, can increase interest in buying electric vehicles (EVs) by reducing financial barriers. This incentive increases consumer confidence in their ability to buy and use EVs, strengthens the relationship between incentives and perception of behavioral control, and in research conducted by Shakeel (2022) incentives also provide individuals with confidence that they can overcome obstacles related to electric vehicle ownership, thereby encouraging interest and adoption of electric vehicles.

Technology Readiness -> Perceived Behavioral Control (Unproven)

This study reveals interesting findings related to the relationship between Technology Readiness (TR) and Perceived Behavioral Control (PBC) in the context of electric vehicle (EV) adoption in Jakarta and its surroundings. The results showed that the level of understanding and comfort of respondents to EV technology did not directly affect their perception of ease or control in using the vehicle. This means that even though respondents feel familiar and comfortable with EV technology, this does not necessarily make them feel more confident and able to use it.

This finding contradicts previous research by Yang & Kim (2024) which found a positive influence of TR on consumer perceptions of ease of use, usability, enjoyment, and suitability of technology. Similarly, Salari's research (2022) also indicates that individuals who are more tech-ready and innovative tend to have a higher perception of behavioral control towards EV adoption. However, the results of this study show that in the context of Jakarta and its surroundings, other factors may play a greater role in forming PBC. Like incentives, charging infrastructure that undoubtedly shapes PBC and the possibility of hands-on experience driving EVs, social norms and supports may have a stronger influence on the perception of individual behavioral control than simply knowledge and comfort with EV technology.

Technology Readiness -> Intention to Adopt (Proven)

This study, which focuses on the Jakarta area and its surroundings, found a positive and significant influence between technology readiness and intention to adopt electric vehicles (EVs). Respondents who feel more prepared and comfortable with EV technology show a higher intention to use adopting electric vehicles. These findings are in line with the view that understanding and comfort with EV technology are the main driving factors for adoption. Individuals who feel prepared and confident in dealing with new technologies tend to be more receptive to and integrate them into their lives. This indicates that education and socialization about EV technology, including how it works, benefits, and care, is very important to improve people's technological readiness and encourage EV adoption in Jakarta and its surroundings.

The results of this study are also supported by previous research. Yang & Kim (2024) showed that optimism and innovation, as a positive dimension of TR, have a positive effect on consumers' perception of the usability, ease of use, enjoyment, and suitability of new technologies, thereby increasing adoption intentions. Salari (2022) also found that individuals with a higher Technology Readiness Index (TRI) are more likely to adopt EVs because they feel more confident and capable in understanding and using EV technology.

Charging Infrastructure -> Perceived Behavioral Control (Proven)

There is a positive and significant influence between the availability of charging infrastructure and perceived behavioral control. This means that respondents' perception of their ease or control in using electric vehicles is positively influenced by the availability of charging facilities. The better the charging infrastructure, the more likely respondents are to feel able and comfortable using electric vehicles.

One of the main concerns of potential EV users is mileage anxiety, which is the worry that the EV battery will run out before reaching the destination or charging station. The availability of adequate and widespread charging infrastructure can reduce this anxiety, as users feel more confident that they can easily charge their EVs when needed.

Adequate Charging Infrastructure Improves Comfort and Convenience: Good charging infrastructure, whether at home, workplace, or public places, can increase the comfort and ease of use of EVs. Users don't have to worry about the difficulty of finding a charging spot or waiting for a long time to charge.

Adequate Charging Infrastructure builds respondents' confidence that the availability of adequate charging infrastructure can give a positive signal to prospective EV users that the government and industry are serious about supporting EV adoption. This can increase their confidence that EVs are a viable and practical option.

The results of this research are also in line with research conducted by Fang et al (2020) showing that the availability of adequate public charging stations can increase consumer interest in switching to electric vehicles (EVs) by reducing anxiety about mileage and charging inconvenience, in another study conducted by Boo & Tan (2024) found that the availability of charging facilities has a significant influence on PBC. This shows that consumers' perception of ease and convenience in EV charging is an important factor in their decision to adopt the technology

Charging Infrastructure -> Intention to Adopt (Unproven)

The results of the study show that a person's desire to use electric vehicles is not directly influenced by the availability of charging infrastructure. From this study, respondents in Jakarta and its surroundings prefer electric cars to electric motorcycles. Where currently the price of

electric cars is still relatively expensive and can be the main obstacle in the adoption of EVs, the reality is that when people buy electric vehicles, especially cars, they get their charging packages at home so that the perception of risk experienced by the community is low related to the availability of charging infrastructure. Respondents who live in Jakarta and its surroundings may feel confident that they can charge at their home or workplace, or they may have enough space to charge at public charging stations.

People who want to buy electric vehicles usually already have a vehicle with a gasoline engine so they don't care too much about charging infrastructure. This is because they often see electric cars as additional vehicles, not as the main vehicle. With gasoline cars as the main option, they feel more flexible and less dependent on the presence of charging stations in each location.

In addition, because the majority of respondents in Jakarta and its surroundings have a relatively high level of education so they tend to have expectations for the development of charging infrastructure in the future. Where in line with the focus of the government so that respondents consider the lack of infrastructure as the main obstacle already believe that this problem will be solved over time.

The results of this study are contrary to previous research conducted by Boo & Tan (2024) that consumers' perception of the ease of EV charging, which is influenced by the availability of charging facilities, significantly affects their intention to buy EVs, Jaiswal et al, (2022) also highlight the importance of charging infrastructure in EV adoption. Their research in India shows that the lack of adequate charging infrastructure is a major barrier for consumers to consider EV adoption, but the results of this study are in line with research conducted in Viet Nam by Hsu et al (2023). In their study in Viet Nam, they found no evidence of the influence of charging infrastructure on the intention to adopt electric vehicles.

Perceived Behavioral Control -> Intention to Adopt (Unproven)

The results of this study, which shows that there is no significant relationship between The Perceived Behavioral Control (PBC) and Intention to Adopt (IA) of electric vehicles in Jakarta and its surroundings, presented interesting findings, especially considering the respondent profiles and indicators used in the study. The majority of respondents are residents of Jakarta and its surroundings who are highly educated and have permanent jobs, indicating the potential for better access to information and resources and openness to new technologies. However, while respondents feel able to overcome practical barriers such as access to EV purchase, price, and maintenance (PBC1-3), the reality of still high EV prices, the limitations of specialist workshops, and concerns about parts could be stronger inhibiting factors than their perceptions. In addition, confidence in technical and driving aspects (PBC4, PBC5) may not be enough to overcome external obstacles such as inadequate charging infrastructure.

These findings are contrary to previous studies such as Deka et al (2023) and Shakeel (2022) which emphasized the important role of PBCs in EV adoption intentions. They found that consumers' perceptions of ease of use and ability to overcome EV-related barriers significantly influenced their intention to adopt or purchase EVs.

CONCLUSION

Incentives are related and significant to Intention to Adopt, These findings show that incentives, such as subsidies, discounts, or other benefits offered by the government or

manufacturers, have an important role in increasing respondents' interest in adopting electric vehicles. This is in line with expectations, considering that the relatively higher price of electric vehicles compared to conventional vehicles is one of the main obstacles to adoption. Incentives can help reduce these financial barriers, making electric vehicles more affordable and attractive to consumers, especially for respondents with significant lower-middle-income incomes in this study.

Incentives are related and significantly adapted to Perceived Behavioral Control, This study shows that incentives have a positive influence on Perceived Behavioral Control (PBC) in the adoption of electric vehicles (EVs), which means that incentives not only increase adoption intentions, but also individuals' perceptions of the ease of use of EVs. This happens because incentives reduce financial and practical barriers, increase the confidence of potential users, and provide the necessary information to understand and use EV technology.

Technology Readiness is not related and not significant to Perceived Behavioral Control, These results indicate that respondents' understanding and comfort of electric vehicle technology do not directly affect their perception of ability and control in using it. Although the majority of respondents have a high level of education, there may be other factors that play a greater role in shaping the perception of behavioral control, such as first-hand experience using EVs or concerns about charging infrastructure.

Technology Readiness is related and significant to Intention to Adopt This finding emphasizes that the more prepared and comfortable respondents are with electric vehicle technology, the greater their intention to adopt. This shows the importance of education and socialization about EV technology to increase public interest. Given that the majority of respondents have good educational backgrounds, providing clear and easy-to-understand information about the benefits, working, and care of EVs can be an effective strategy.

Charging Infrastructure is related and significant to Perceived Behavioral Control, The availability of adequate charging infrastructure has a positive influence on the perception of behavioral control (PBC) in the adoption of electric vehicles (EVs). This is because a good charging infrastructure can reduce anxiety about mileage, increase the comfort and ease of use of EVs, and build the confidence of potential users that EVs are a viable and practical option.

Charging Infrastructure is not significant to the Intention to Adopt, this is due to several factors, including respondents' preference for electric cars which are still expensive, their confidence in the ability to charge at home, and expectations for future infrastructure developments. Although the charging infrastructure is quite good in the region, price remains a major obstacle, especially since the majority of respondents want electric cars. In addition, confidence in home charging and expectations for infrastructure developments reduced respondents' concerns about the availability of public charging facilities. Overall, factors such as price, vehicle preferences, and confidence in infrastructure development influence EV adoption intentions in Jakarta and surrounding areas more than the current availability of charging infrastructure.

Perceived Behavioral Control is not related and insignificant to Intention to Adopt, This study reveals that in Jakarta and its surroundings, although respondents feel capable of adopting

electric vehicles, external factors such as high prices, infrastructure limitations, and concerns about maintenance become bigger obstacles than their perception of behavioral control. Although respondents have good access to information and resources, as well as confidence in technical aspects, these apparent barriers seem to be more influential in shaping their electric vehicle adoption intentions.

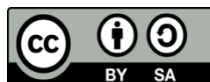
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