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ORIGINAL ARTICLE

Encouraging Electric Vehicle Adoption Post COVID-19 Pandemic

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ABSTRACT

Electric vehicles adoption in Malaysia is still in its infancy, and there are still relatively few electric automobiles on the road in Malaysia. There is a lack of knowledge and information among Malaysia's transportation policymakers together with the automakers and marketers in the country. There is a relatively limited and insufficient amount of information that is publicly disclosed about how effectively electric automobiles are accepted and adopted from the views of Malaysian customers. The objective of this study is to determine key factors that influence the willingness to adopt electric vehicles among Malaysians post COVID-19 pandemic. In this study, snowball sampling was employed to gather 200 responses from the central regions of Malaysia. Consent was obtained and filter question "Are you using electric vehicles currently? were asked before the respondents were invited to participate in this questionnaire. Snowball sampling was used in identifying respondents before respondents were approached face-to-face from March 2022 to September 2022. Descriptive and inferential statistics are used to analyze the 200 data. Range anxiety, charging infrastructure, purchase cost, environmental concern positively influences the willingness to adopt electric vehicles while social influence is not. Purchase cost has the strongest influence on willingness to adopt electric vehicles as compared with range anxiety and charging infrastructure. Malaysia is still at its infant stage of adopting and marketing for electric vehicles. This study examines key factors affecting consumers' adoption of electric vehicles.

Keywords: Electric vehicles adoption, charging infrastructure, purchase cost, environmental concern

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1. Introduction

Electric vehicles are a huge technological advance that have the best noticeable sustainable answers to improve fuel efficiency[2]. According to Austmann and Vigne [2], electric vehicles have been recognized to be part of the most hopeful tactics and strategies in the automobiles industry. Electric vehicles are proven to increase fuel efficiency by 40-60% compared to conventional vehicles[12]. Global registrations of electric vehicles grew from 6,000 in 2010 to 750,000 and 150 million plug-in consumer light duty autos are projected to be in circulation by 2030[6].

Malaysia has the third highest percentage of automotive ownership in the world, with almost 93% of the Malaysia' total population having at least one single vehicle and 54 % of them owning many vehicles[1]. Malaysian government identified the significance and advantages of trying to adopt electric vehicles. On Malaysian roadways, they aim to see a 15% increase in the number of electric vehicles by the year 2030 at the latest[1]. By the year 2025, Malaysia planned to have built a total of 10,000 units of charging facilities, with a goal of constructing 9,000 alternating current units and 1,000 direct current units and the country has taken steps and made efforts to encourage the usage of electric vehicles[5].

Electric vehicles adoption in Malaysia is still in its infancy, and there are still relatively few electric automobiles on the road post COVID-19 pandemic compared to more conventional automobiles. Based on the Malaysian Automotive Association, the total number of electric vehicles sold in Malaysia amounted to just 2.2% of the total number of units delivered by automakers, which was 604,287 units[12]. A significant lack of public charging infrastructure in urban and suburban areas, high cost of electric vehicles, disrupted supply chain is among key barriers of electric vehicles adoption in Malaysia post COVID-19 pandemic[12].

The benefits provided by electric vehicles are not adequate to convince and persuade people to accept it as a mode of transportation. Customers' thoughts and opinions regarding electric vehicles play an important role in determining the extent to which they are accepted to adopt, which is one reason why electric car adoption rates are so low [5]. As a result, it is of the utmost importance to have a deeper understanding of the factors that are likely to impact a consumer's choice to acquire electric vehicles[6].

There is a lack of knowledge and information among Malaysia's transportation policymakers together with the automakers and marketers in the country. There is a relatively limited and insufficient amount of information that is publicly disclosed about how effectively electric automobiles are accepted and adopted from the views of Malaysian customers[12]. Ecer[3] argue that marketers still lack appropriate tools and methods for measuring eco-friendly performance metrics, evaluating consumers' environmental perspectives, buying intention, and sustainable marketing behavior. This is even though eco-friendly marketing strategies and efforts are growing. Few vehicle manufacturers produced them in Malaysia due to a lack of information and knowledge. Companies, local, and international marketers struggled to create effective marketing strategies to accomplish those goals due to a lack of information about the country's eco-friendly adoption level and user behaviour towards eco-friendly vehicles and automobiles[4]. Thus, understanding the factors that may impact an electric vehicle purchase is essential.

The objective of this study is to determine key factors that influence the willingness to adopt electric vehicles among Malaysians post COVID-19 pandemic. The research is essential to be conducted to put one's finger on the determinants that influence the adoption of electric vehicles. The findings of these studies can be helpful and supplementary data to determine the sententious determinants so that an appropriate blueprint can be formulated or established to support the government and marketers in encouraging the consumers to employ and adopt the electric vehicles post COVID-19

pandemic. Apart from that, the results would provide better understanding and valuable information for the government, marketers as they can find this information as their reference material to know about the concern and security issues when using electric vehicles. In the context of customers, this research may help them to enhance their knowledge of what determinants will affect the adoption of electric vehicles.

2. Literature Review

2.1. Willingness to Adopt Electric Vehicles

According to a previous study conducted by Jain, Bhaskar, and Jain, the higher purchase price of electric vehicles compared to conventional vehicles is a significant obstacle to the sales of electric vehicles. However, the research done by Krishna[7] concluded that the relatively low cost of gasoline is an influential determinant that helps to promote the sales of electric vehicles. This is even though the high buying cost of electric vehicles is a barrier to their widespread use[8]. People who prioritize saving money on their energy bills are more likely and willing to adopt electric vehicles as their transport[9]. Drivers will experience embarrassment if the performance and capabilities of their electric vehicles are poor, such as a short driving range. As a result, Franzò, Nasca, and Chiesa[4] discovered a positive relationship between willingness to adopt electric vehicles and environmental awareness and driving range. The adoption of electric vehicles in Malaysia could be influenced by several factors, including the country's charging infrastructure, the price of vehicles and others relevant determinant. The idea from the perspectives of environmental consciousness and self-perceived social influence will be examined.

2.2. Range Anxiety

The primary factor that influences whether they will purchase an electric vehicle is the customer’s worry about the battery dying[3]. The ideal driving range, as perceived by customers, is somewhere between 300 and 450 kilometers[8]. In practice, this isn't always possible for electric vehicles, and this could lead to range anxiety when the car driver has been behind the wheel for a long time, the battery charge is starting to run down, and the driver has no great suggestion on how far they can drive on the remaining power. Because of their limited and unreliable range, drivers were reluctant to use electric vehicles for long journeys[9]. Range anxiety would therefore reduce the electric vehicles' adoption. Furthermore, according to Gallo and Marinelli[5], the variable charging time, range, and battery difficulties were the determinants that hindered some of the potential target customers from using electric vehicles. Although battery pack and electric vehicle technology is advancing and ranges are extending, electric vehicle buyers remain worried about their ability to go long distances between charges[9]. Inadequate technological infrastructure like charging points may have a direct negative impact on the adoption of electric vehicles since consumers may perceive risks[9]. Therefore, the following hypothesis is formed and tested in this study:

H1: There is a significant relationship between range anxiety and willingness to adopt electric vehicles.

2.3. Charging Infrastructure

The charging infrastructure is crucial to the long-distance use of electric vehicles. Inadequate charging infrastructure is a major barrier to long-distance driving. Based on the studies conducted by Moon, Park, and Woo[10] and Mukherjee and Ryan[11], if consumers know they can charge their electric vehicles quickly and easily, they are more likely to buy one.

Typically, charging stations will be set up in the following places: in the parking lots of homes and businesses, in public spaces, and at gas stations along major highways[8]. When purchasing an electric vehicle, the shop may take the responsibility to provide free installation of charging points in residential homes. As a result, consumers may experience increased anxiety on long-distance journeys and business trips including car travel[8]. Customers' propensity to buy electric vehicles can be influenced favorably by the quality of the charging infrastructure that is currently in place[10]. Therefore, the following hypothesis is formed and tested in this study:

H2: There is a significant relationship between charging infrastructure and willingness to adopt electric vehicles.

2.4. Purchase Cost

In a consumer choice of electric vehicles, financial constraints are present[12]. Consumers are on a limited budget, so weighing the costs and benefits of a purchase is essential[4]. This is especially true in the electric vehicles industry as it is, where prices are significantly higher than for conventional automobiles[4]. If consumers do not have a significant enough budget, they can feel pressured and then opt to purchase traditional vehicles. Electric vehicle prices are higher than gas-powered car prices mostly because of the high cost of the battery pack, but also due to a lack of economies of scale in particular countries[11]. High price of electric vehicles compared to traditional vehicles is a major obstacle to their sales[10]. Therefore, the following hypothesis is formed and tested in this study:

H3: There is a significant relationship between purchase cost and willingness to adopt electric vehicles.

2.5. Environmental Concern

According to Moon, Park, and Woo[10] and Mukherjee and Ryan[11], the level of environmental awareness or belief held by consumers is a potential element that can influence their buying decision of environmentally friendly products.

Environmental concerns are exacerbated by the transportation sector but can be mitigated thanks to eco-innovations like electric automobiles[5]. Previous studies also pinpointed the impact of environmental concerns, with electric car adopters mentioning environmental concerns as a prime reason in their vehicle selection[8]. Therefore, the following hypothesis is formed and tested in this study:

H4: There is a significant relationship between environmental concern and willingness to adopt electric vehicles.

2.6. Social Influence

Social influence refers to the effect that the opinions of one's peers or society have on an individual's choice to make use of a newly developed product or piece of technology[12]. Therefore, social pressure is exerted on an individual or a decision-maker through subjective norms or social influence[1]. According to Moon, Park, and Woo[10], the opinions of one's contemporaries can influence one's propensity to purchase an electric vehicle. Mukherjee and Ryan[11] acknowledged the role that social influence plays a significant role in the decision-making process prior to the purchase of an electric vehicle[3]. Social influence is weighed by consumers when making the decision to buy an electric vehicle[3]. Therefore, the following hypothesis is formed and tested in this study:

H5: There is a significant relationship between social influence and willingness to adopt electric vehicles.

3. Research Methodology

In this study, snowball sampling was employed to gather 200 responses from the central regions of Malaysia. Snowball sampling was used because it is less expensive to identify existing electric vehicles owners who have experience of adopting electric vehicles[13]. Respondents are approached face-to-face from March 2022 to September 2022. Consent was obtained and filter question "Are you using electric vehicles currently? were asked before the respondents were invited to participate in this questionnaire. Forty questions were asked in the questionnaires with regards to range anxiety, charging infrastructure, purchase cost, environmental concern, social influence, and willingness to adopt electric vehicles, measuring using 5-point Likert scale, ranging from 1-strongly disagree to 5- strongly agree. Two hundred respondents with knowledge and exposure on electric vehicles, from Kuala Lumpur, Selangor, Johor, Negeri Sembilan, Perak and Penang were approached. These states were suitable to conduct this research for electric vehicle adoption because they are the most developed states in Malaysia. The questionnaire was personally administered to respondents at public places. Each respondent was approached face-to-face so that purpose of the research purpose and the content of the questionnaire were clearly explained to the respondents before data collection. A total of 200 target respondents in Malaysia who participated in the survey. One hundred and eight of the respondents are male while 92 are female. Most target respondents are 46 percent female and 54 percent are male. The personal annual gross income of 109 respondents falls below RM 36,000 and 56 respondents belong to the category of RM 36,001 - RM 48,000. Meanwhile, there are 14 respondents' personal annual gross income is from RM 48,001 - RM 60,000. Among the 200 respondents who participate in this research, 47 respondents have less than 3 years driving experiences, 51 respondents have 3 to 5 years driving experiences and 57 respondents have driving experiences for 6 to 8 years. Likewise, 24 target respondents' driving experience fall in 9 - 12 years, 9 respondents' driving experience is between 13 - 15 years and 12 of them have more than 15 years driving experience.

4. Results

The result was analysed by using SPSS (Statistical Package for the Social Sciences) software. Reliability of the questionnaire instrument was confirmed with Cronbach's Alpha values ranging from 0.73 to 0.95, which were above the threshold value of 0.70, convergent validity was confirmed as the factor loading of questionnaire items were above the threshold value of 0.50[13].

Multiple regression analysis is used for exploring the influence of five independent variables which are range anxiety, charging infrastructure, purchase cost, environmental concern, social influence on the willingness to adopt electric vehicles among consumers in Malaysia. The result of this multiple linear regression shows t R square is 0.697, indicating 69.7% of willingness to adopt electric vehicles can be explained through the five independent variables: range anxiety, charging infrastructure, purchase cost, environmental concern as well as social influence. Every one unit increase in range anxiety, there is an associated 0.322 unit increase in the willingness to adopt electric vehicles. Every one unit increase in purchase cost, there is an associated 0.605 unit increase in the willingness to adopt electric vehicles. Every one unit increase in charging infrastructure, there is an associated 0.105 unit increase in the willingness to adopt electric vehicles. Every one unit increase in environmental concern, there is an associated 0.146 unit increase in the willingness to adopt electric vehicles.

Multiple regression tests are used for exploring the five variables (range anxiety, charging infrastructure, purchase cost, environmental concern, and social influence) that can be adopted to explain the willingness to adopt electric vehicles among consumers. The strongest predictor for willingness to adopt electric vehicles is purchase cost while the lowest predictor is

social influence. Range anxiety, charging infrastructure, purchase cost as well as environmental concern are important factors affecting willingness to adopt electric vehicles.

Table 1. Multiple Regression Result

Independent Variables	**Coefficient**	**Significance**
Constant	-.433	.067
Range anxiety	.322	.000
Charging infrastructure	.105	.017
Purchase cost	.605	.000
Environmental concern	.146	.014
Social Influence	.034	.691

Dependent Variable: Willingness to adopt electric vehicles.

According to Table 2, Hypothesis 1,2,3 and 4 are supported and Hypothesis 5 is not supported.

Table 2. Summary of Hypothesis Testing

Hypothesis	**Result**
Hypothesis 1: There is a significant relationship between range anxiety and willingness to adopt electric vehicles.	Supported
Hypothesis 2: There is a significant relationship between charging infrastructure and willingness to adopt electric vehicles.	Supported
Hypothesis 3: There is a significant relationship between purchase cost and willingness to adopt electric vehicles.	Supported
Hypothesis 4: There is a significant relationship between environmental concern and willingness to adopt electric vehicles.	Supported
Hypothesis 5: There is a significant relationship between social influence and willingness to adopt electric vehicles.	No Supported

5. Discussion and Implications

The objective of this present study is to determine key factors that influence the willingness to adopt electric vehicles among Malaysians post COVID-19 pandemic. Five variables were examined and their relationship to the willingness to adopt electric vehicles was also tested as well. This objective has been achieved by adopting the multiple regression analysis. which demonstrates that the range anxiety, charging infrastructure, purchase cost, environmental concern has significant relationships on willingness to adopt electric vehicles while social influence is not. The findings also demonstrate that purchase cost has the strongest effects on willingness to adopt electric vehicles as compared with other factors.

The results show that consumers in Malaysia care about the driving range that can be performed by electric vehicles while making a purchase decision. This is due to the reason that some people are still struggling with range anxiety, particularly in regions where the number of electric vehicles on the road is increasing at a faster rate, yet public charging infrastructure may be lagging or is centred in areas such as cities or along highways[12]. In addition, fears about long lines at peak times, equipment that has been vandalized or destroyed, faulty software or hardware, or even the possibility of finding a charging site that is occupied by a gasoline- or diesel-powered vehicle are also the factor than may increase the range anxiety of the user while driving[12]. Thus, in this scenario, the users may have concerns over the driving range of electric vehicles if they are thinking about adopting electric vehicles.

COVID-19 pandemic disrupts the supply chain of electric vehicles worldwide and accentuates the importance of supply chain analytics to alleviate the range anxiety of the electric vehicle adoption[1]. Electric vehicle companies need to enhance the resilience and transparency of the electric vehicle equipment, facility, hardware, and software supply through effective supply chain analytics post COVID-19 pandemic,

The result shows a significant relationship between charging infrastructure and the willingness to adopt electric vehicles. Long-distance driving in an electric vehicle is now unachievable due to the limited range currently available in these vehicles[8]. It is essential to develop more charging infrastructure in either urban or suburban. In recent years, the government of Malaysia has undertaken an active campaign to encourage the public of Malaysia to adopt electric vehicles [12]. In addition to that, it provides a substantial amount of help to companies who manufacture electric vehicles. In addition, with the support of the government, it is possible to effectively establish a sizable quantity of charging equipment in strategic locations. This indicates that the government is starting to encourage the producers of electric vehicles in their efforts to develop more charging infrastructure.

Reduced car sales emerged as one of critical challenges facing the automotive industry during COVID-19[8]. Building more charging infrastructure in either urban or suburban areas are among the best ways to boost the sales of electric vehicles post COVID-19 pandemic.

Malaysians are willing to pay a higher price for adopting electric vehicles. According to Franzò, Nasca, and Chiesa[4], the cost of electricity for one hundred kilometres of travel in an electric vehicle is approximately RM 30, which is significantly cheaper than the cost of fuel vehicles. Fuel savings are a key factor in convincing Malaysians to buy electric vehicles[1]. The rise in fuel prices may also be a factor that causes buyers to be concerned about the buying price of electric vehicles. Furthermore, as proposed by Austmann and Vigne[2], the decision of a consumer to purchase electric vehicles is significantly influenced by fluctuations in the cost of gasoline as it is sold in the marketplace.

The Economic downturn and rise in inflation post COVID-19 pandemic brought about a considerable change in the buying patterns of electric vehicles[4]. Cost leadership is a good strategy to attract customers as more customers are looking

for cost-effective electric vehicles due to reduction in spending power post COVID-19 pandemic.

According to Jain, Bhaskar, and Jain[6], awareness of environmental issues has been growing, which has motivated them to purchase and adopt electric vehicles as their primary mode of transportation. Consumers in Malaysia purchase electric vehicles because it contributes to less carbon emission and helps to preserve the environment by reducing air pollution.

This study has a unique finding that social influence does not influence willingness to adopt electric vehicles. Buyers in Malaysia may believe that driving a car that considers luxury does not demonstrate their identity as a wealthy person, an intelligent person as others might not notice if an individual drives an electric vehicle because electric vehicles are a product with new technology, and this does not reflect the wealthiness of that person[5]. Consumers will not increase their attention to electric vehicles because of this particular social habit. Electric vehicles are associated with several unique features, such as environment friendly products, fashion, and high technology. Hence, when consumers purchase or adopt electric vehicles, they are less likely to let others influence their decision to purchase an electric vehicle and are more likely to consider other factors first like driving range, features, charging infrastructure[3].

6. Conclusion

Range anxiety, charging infrastructure, purchase cost, environmental concern positively influences the willingness to adopt electric vehicles while social influence is not. Purchase cost has the strongest influence on willingness to adopt electric vehicles as compared with range anxiety and charging infrastructure. Malaysia is still at its infant stage of adopting and marketing for electric vehicles. This study examines key factors affecting consumers' adoption of electric vehicles.

7. Limitation and Direction for Future Research

This study examines key factors affecting consumers' adoption of electric vehicles in Malaysia only. The questionnaire instrument used in this study could be replicated to examine consumers' adoption of electric vehicles in other Asia countries. This study examines key factors affecting electric vehicle adoption using multiple linear regression. Future study could be conducted to further examine the effect of demographics (age, gender, educational background) on electric vehicle adoption in developing countries using different statistical analysis methods.

References

1) Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M. H., et al. Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia. *Journal of Cleaner Production.* 2021, 282, 124474. DOI: 10.1016/j.jclepro.2020.124474

2) Austmann, L. M. & Vigne, S. A. Does environmental awareness fuel the electric vehicle market? A Twitter keyword analysis. *Energy Economics*. 2021, 101, 105337. DOI: 10.1016/j.eneco.2021.105337

3) Ecer, F. A consolidated MCDM framework for performance assessment of battery electric vehicles based on ranking strategies. *Renewable and Sustainable Energy Reviews.* 2021, 143, 110916. DOI: 10.1016/j.rser.2021.110916

4) Franzò, S., Nasca, A. & Chiesa, V. Factors affecting cost competitiveness of electric vehicles against alternative powertrains: A total cost of ownership-based assessment in the Italian market. *Journal of Cleaner Production*. 2022, 363, 132559. DOI: 10.1016/j.jclepro.2022.132559

5) Gallo, M. & Marinelli, M. Sustainable mobility: A review of possible actions and policies. *Sustainability*. 2020, 12, 7499. DOI: 10.3390/su12187499
6) Jain, N. K., Bhaskar, K., & Jain, S. What drives the adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support. *Research in Transportation Business & Management*. 2022, 42, 100730. DOI: 10.1016/j.rtbm.2021.100730
7) Krishna, G. Understanding and identifying barriers to electric vehicle adoption through thematic analysis. *Transportation Research Interdisciplinary Perspectives.* 2021, 10, 100364. DOI: 10.1016/j.trip.2021.100364
8) Kumar, R. R. & Alok, K. Adoption of electric vehicle: A literature review and prospects for sustainability. *Journal of Cleaner Production.* 2020, 253, 119911. DOI: 10.1016/j.jclepro.2019.119911
9) Lin, B. & Shi, L. Do environmental quality and policy changes affect the evolution of consumers' intentions to buy new energy vehicles? *Applied Energy*. 2020, 310, 118582. DOI: 10.1016/j.apenergy.2022.118582
10) Moon, H., Park, S. Y. & Woo, J. Staying on convention or leapfrogging to eco-innovation? Identifying early adopters of hydrogen-powered vehicles. *Technological Forecasting and Social Change*. 2021, 171, 120995. DOI: 10.1016/j.techfore.2021.120995
11) Mukherjee, S. C. & Ryan, L. Factors influencing early battery electric vehicle adoption in Ireland. *Renewable and Sustainable Energy Reviews.* 2020, 118, 109504. DOI: 10.1016/j.rser.2019.109504
12) Muzir, N. A. Q., Mojumder, M. R. H., Hasanuzzaman, M., & Selvaraj, J. Challenges of electric vehicles and their prospects in Malaysia: A comprehensive review. *Sustainability*. 2022, 14, 8320. DOI: 10.3390/su14148320
13) Raifman, S., DeVost, M. A., Digitale, J. C., Chen, Y. H. & Morris, M. D. Respondent-driven sampling: a sampling method for hard-to-reach populations and beyond. *Current Epidemiology Reports*. 2022, 9*,* 38-47. DOI: 10.1007/s40471-022-00287-8