

Factor Influencing Consumer's Adoption of Electric Car in Malaysia

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Abstract – The main purpose of this research is to uncover the factors influencing consumers in Malaysia to embrace electric vehicles (EV). This study aims to provide valuable insights for infrastructure providers, car manufacturers, and regulators, enhancing their understanding of the driving forces behind EV adoption in Malaysia. This study seeks to establish a relationship between environmental factors, price of electric cars, and availability of charging stations in relation to electric vehicle. To achieve this, we employ a quantitative research method. Survey questionnaires of around 400 sets have been distributed online due to convenience purposes of collecting and analysing the data sample. For data analysis, we utilized the Statistical Package for the Social Sciences (SPSS). The Theory of Planned Behavior (TPB) guides the selection of psychological variables in this study, including attitude, subjective norm, and perceived behavioral control. The findings reveal that the price of EVs and environmental factors significantly influence consumer adoption. This finding contradicts some previous research and highlights the need for more extensive charging infrastructure to promote EV adoption. The study's regression analysis indicates that environmental factors have the most substantial impact on consumer adoption, followed by car pricing. While the availability of charging stations is essential, it does not seem to significantly influence consumer adoption in Malaysia.

This study provide recommendation for policymakers and car manufacturers to provide incentives and subsidies to lower EV prices, implementing tax breaks for EV consumers, and collaborating to enhance charging station accessibility. An extensive awareness campaign on the environmental benefits of EV adoption is also advised.

Keywords – Electric vehicles, environmental factor consumer adoption, affordable and clean energy, hybrid renewable energy system.

1. Introduction

A major contributor to global warming is the usage of personal vehicles. For every gallon of gas, vehicles such as cars and trucks emit carbon dioxide and other greenhouse gases. The extraction, manufacture, and delivery of fuel account contain certain emissions, it is important to note that a significant portion of heat-trapping emissions is primarily generated by a car's exhaust system [29]. Greenhouse gasses are released by a variety of human activities, such as industrial and transportation operations, and they play a significant role in causing air pollution and global warming [39]. One of the primary methods for reducing greenhouse gas (GHG) emissions in the road transportation sector is the adoption of electric vehicles, including cars, motorcycles, and buses. Due to this worldwide trend that is shifting towards electric vehicles, it is anticipated that by 2050, electric vehicles would make up roughly 50% of all automobiles worldwide [24]. Electric vehicle adoption helps handle the national energy security issue and reduces pollutant emissions mostly in highly dense cities. Electric vehicles offer the advantage of replacing oil consumption and producing zero emissions during their operation [13]. The current research or literature available is lacking an in-depth overview of the present and the future of EVs adoption in Malaysia. By looking at Malaysia's 2022 context, the penetration of EVs in Malaysia associated with the fair pricing, availability of charging infrastructure, and environmental concerns can potentially enhance the overall EVs adoption in Malaysia would require a more in-depth investigation.

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2. Literature Review

The market for electric vehicles (EVs) has grown significantly over the last ten years, and this development tendency is anticipated to continue [11]. Despite a global rise in EV sales, industry predictions indicate that we have only just begun to realize the full potential of these vehicles [33]. Interestingly, the COVID-19 pandemic's effects on the global auto industry were the primary reason that 2020 saw a negligible rise in the number of new car registrations [10]. Due to the pandemic, initial predictions for global EV sales were uncertain. However, as the year went on, it became clear that 2020 was surprisingly successful, with global EV sales rising by 43% from 2019 to 2020 and reaching a record 4.6% market share in the electric car industry [20]. Global sales of electric vehicles increased somewhat despite the pandemic; nevertheless, more stimulus funding may have made this growth more significant [9]. With 6.75 million electric vehicles sold in 2021—doubling the market from the year before—records were shattered once more. Remarkably, in 2021, a single week saw more sales of electric vehicles than the entire year of 2012 [31].

With EVs playing a major role, the sector is preparing to meet the challenging target of zero emissions by 2050 [40]. The need to achieve net-zero emissions by the middle of the century makes it more urgent than ever to accelerate the energy system's transformation, especially in light of the fact that cumulative emissions after 2030 must be negative in order to comply with climate goals [30].

Global EV sales surged again in 2022, propelled by advanced economies' growing emphasis on decarbonization. Over 3.2 million electric vehicles were registered worldwide in the first half of the year. The number of electric vehicle registrations in Europe has significantly increased, mostly as a result of stimulus plans launched by European governments and financial incentives such as tax reductions [3]. The surge in EV sales has consequently led to a notable increase in the production of lithium-ion batteries for EVs. Due in large part to the growing popularity of EVs in China, which produces more than 75% of the world's batteries, the demand for EV batteries doubled in 2021 compared to the previous year [13], [12]. Significant progress is also being made in this area by Europe [18].

Government regulations have been a major factor in the adoption of EVs, and many nations have put in place effective programs to encourage EV ownership. Recent agreements state that Europe is driving the global electric vehicle revolution and establishing the standard for other countries [29]. EVs have significantly reduced greenhouse gas emissions from an environmental standpoint.

Since internal combustion engine vehicles do not produce any emissions during the manufacturing process, the public conversation has shifted in favor of electric vehicles (EVs) when it comes to their environmental impact [2].

2.1. *Underpinning Theory and Theory of Planned Behavior (TPB)*

Theory of planned behavior (TPB) is used to guide the selection of the psychological variables included in this study. The behavior intention is being categorized into three factors: (1) subjective norm, (2) attitude, and (3) perceived behavioral control [6]. Attitude relates to the extent to which a behavior is either positively or negatively appreciated. Subjective norm refers to the social pressure associated with being seen as participating in an activity. Perceived behavioral control is the perception of one's ability to execute a particular behavior [14].

The TPB offers economical explanations and predictions of deliberate action from a social psychological perspective. Besides that, meta-analysis and empirical research have consistently validated the TPB's explanatory power and predictive validity [44]. Buying electric vehicles is strongly compelled by consumers. TPB contends that consumers' purchase intentions are a key determinant of future purchasing behavior. The stronger a person's intention to buy, the greater the likelihood that they will follow through with the purchase [15].

2.2. *Factors Influencing Consumer's Adoption of Electric Cars in Malaysia*

2.2.1. *Price to Own Electric Vehicles*

The price of buying an electric vehicle is seen by many customers as a factor deterring electric vehicles adoption where more than half of respondents to a survey conducted in the United States show the purchasing price as a significant drawback. Electric vehicles purchasing data from numerous nations offering infrastructure and support policies for electric vehicles demonstrated that government rebate programs influenced electric vehicles adoption [32]. One of the primary obstacles to purchasing an electric vehicle is the relatively high initial cost, as customers may be hesitant to invest a significant amount in an electric vehicle. There are about 30 nations where market share and electric vehicles price are inversely related. Several researchers have observed that reducing costs could potentially enhance both consumers' inclination to buy electric vehicles and the industry's competitive standing [15], [16], [17].

2.2.2. Availability of Charging Stations

A significant challenge in achieving sustainable development lies in the adoption rate of electric vehicles within the transportation industry. The primary driver influencing the rising popularity of EVs are the accessibility of a reasonably cost charging station and a reasonable cost of electricity for battery charging [34]. The market adoption of electric vehicles is increasing at a very slow pace, but there is not enough charging stations to service every location [36]. It is frequently noted that "chicken and egg" paradox affects charging stations especially the customers' willingness to buy EVs depends on the availability of chargers, while market-driven expenditures on charging stations are less likely hence adoption is low. Therefore, it is expected that governments will provide the majority of the initial funding for such a vast charging infrastructure [4].

3. Research Methodology

This was quantitative research, and 400 questionnaires were distributed to different participant groups.

This approach increased the likelihood that we would need to collect a minimum of 384 responses for data analysis [18]. This study utilized non-probability convenience sampling as its sampling method.

This approach enabled the researchers to identify precise and focused research inquiries, collect numerical data, and conduct an impartial inquiry. The sample selection was guided by sampling table of study [25]. The survey questionnaire was disseminated via an online platform, specifically a Google Form link. Out of the 313 sets received, three were excluded due to respondents' inability to meet the qualifying criteria. Consequently, the total count of valid questionnaires amounted to 310, resulting in a response rate of 78%.

4. Data Analysis - Pilot Test

A pilot experiment was carried out as a pre-test prior to gathering substantial quantities of information from respondents to make sure the concept was appropriate and to prevent any possible research failures [19].

Table 1. Pilot test result of KMO and Barlett's test (DV, Dependent Variable)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.600
Bartlett's Test of Sphericity	Approx. Chi-Square	47.100
	df	10
	Sig.	<.001

Table 2. Pilot test result of KMO and Barlett's test (IV, Independent Variable)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.648
Bartlett's Test of Sphericity	Approx. Chi-Square	168.143
	df	66
	Sig.	<.001

Based on the above two tables namely Table 1 and 2, the KMO (Kaiser-Meyer-Olkin) result is 0.600 for dependant variable (DV) and 0.648 for independent variable (IV) respectively. Since both values are above 0.6, which means these results are meeting the required benchmark. On the other hand, the significant level of BTS based on Tables 1 and 2 was lower than 0.05, which means the data obtained is sufficient and acceptable for next step of the research since the values are within the acceptable benchmark [35].

4.1. Reliability Test of Actual Study

The Cronbach alpha value of dependent variable is 0.609 based on Table 3. Since the number of Cronbach's alpha is above 0.6 which shows high reliability and consistency [26]. The consensus among most individuals is that the Cronbach's alpha coefficient falls within the range of 0 to 1. The reliability is poor, and a new questionnaire version needs to be adjusted if the value is lower than 0.6 [8].

Table 3. Reliability statistic (Dependent Variable)

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.609	.627	5

4.2. Independent Variables

According to Table 4 the Cronbach's alpha value for the independent variables is 0.672.

This again shows that the data is reliable and consistent since the Cronbach's alpha value is above 0.6 [8].

Table 4. Respondents' demographic profile

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.672	.724	12

4.3. Demographic Profile

The demographic profile of 310 respondents is considering race, gender, age, education level, marital status, and household income.

The demographic characteristics of the respondents were researched and put forward as indicated in the following tables utilising descriptive statistics.

Table 5. Respondents' demographic profile

		Frequency	Percent
Race	Others	7	2.3
	Indian	18	5.8
	Malay	31	10
	Chinese	254	81.9
Gender	Female	151	48.7
	Male	159	51.3
Age	60 and above	1	3
	50-59	23	7.4
	40-49	36	11.6
	30-39	106	34.2
	18-29	144	46.5
Education	High School and below	24	8.1
	Diploma	36	11.6
	Graduate	52	16.8
	Bachelor's degree	197	63.5
Marital	Marrieds	101	32.6
	Single	209	67.4
Income	RM3000 and below	32	10.4
	RM9001-RM12000	57	18.4
	RM6001-RM9000	59	19.0
	RM12000 and above	62	20.0
	RM3001-RM6000	100	32.3

Ethnicity is known as four races categories namely Malay, Chinese, Indian, and others. Based on Table 5, most of the participants identified as Chinese (N=254, 81.9%), Following the Chinese group, the next largest group in the survey consists of Malay respondents (N=31, 10%). Gender is known as two gender selections categories namely male and female. Based on the table above have represented majority of the respondents are male (N=159, 51.3%) and female (N=151, 48.7%). The age category is being split into five groups namely, 18-29 years, 30-39 years, 40-49 years, 50-59 years and 60 and above. As per Table 5, the data indicates that most respondents fell within the 18-29 years of age category, comprising 144 individuals or 46.5% of the total. The next most substantial group consisted of respondents aged 30-39 years, accounting for 106 individuals or 34.2%. In contrast, smaller proportions of respondents were found in the age groups 40-49 years (N=36, 11.6%), 50-59 years (N=23, 7.4%), and 60 years and above (N=1, 0.3%). The level of education has been categorized into four different categories namely high school and below, diploma, bachelor's degree, and graduate. Based on the table above, bulk of the respondents are holding a bachelor's degree (N=197, 63.5%) followed by graduate (N=52, 16.8%).

The minor frequency is diploma (N=36, 11.6%) and high school and below (N=25, 8.1%). The marital status has been categorized into two categories which is single and married. Based on Table 5, the leading category is single (N=209, 67.4%) and followed by married (N=101, 32.6%). Household income have been split into five different categories: RM 3,000 and below, RM3,001-RM6,000, RM6,001-RM9,000, RM9,001-RM12,000 and RM12,001 & higher. Most of the respondents have responded RM3,001-RM6,000 (N=100, 32.3%) followed by RM12,001 and above (N=62, 20%) and RM6,001-RM9,000 (N=59, 19%). The minority categories are RM9,001-RM12,000 (N=57, 18.4%) and RM3,000 and below (N=32, 10.3%).

Table 6. Model summary

Model	R	R Square	Adjusted R Square	St. Error of The Estimate	R Square Change	F Change	df1	df2	Sig F Change	Durbin-Watson
1	.621	.386	.380	.55563	.386	64.190	3	306		1.946

4.4. Multiple Regressions - Model Summary

After adjusting for the number of independent variables and sample size, the model below Table 6 explains approximately 38.6 percent of the variation in consumers' adoption of electric vehicles in Malaysia. This suggests that the model has some explanatory power, but there is still a significant amount of unaccounted for variability in adoption behaviour that the model does not account for. More research and refinement of the model may be required to improve its predictive capabilities.

4.5. Beta Coefficient

When the beta coefficient is close to 1, it suggests that the independent variable is likely to have a substantial influence on the dependent variable. At the same time, if it is close to 0, the dependent variable will not have much of an influence towards the research. The intensity from each independent variable's impact towards dependent variable is shown by its absolute value, which increases with the beta coefficient (Mujiatun and Ferina, 2021). Based on Table 7, the 3 independent variables within this research where price of electric vehicles (V1) (P= 0.001) and environmental factor (V3) (P=0.000) are considered significant as the p-values <0.05 and could become consumer's adoption on electric cars factors. Conversely, the availability of charging station (V2) with a p-value of 0.295 is

greater than 0.05, signifies that the independent variable is not statistically significant. Based on the result, hypothesis of H2 will be rejected since there is no significant influence between availability of charging stations with consumer's adoption on electric vehicles. The environmental factor is having the highest beta coefficient at 0.504, which then becomes the highest indicator of consumer's adoption of electric vehicles. This will articulate where 0.504% enhancement in consumer's adoption of electric vehicles will improve environmental factor with 1 unit. Whereas for price of cars where its beta coefficient is 0.174, it is considered as the second highest value. Ultimately, the availability of charging stations has a beta coefficient of 0.053, signifying that it exerts no discernible influence on consumers' adoption of electric vehicles, as the p-value is greater than 0.05.

Table 7. Multiple regression – coefficients

Coefficients ^a											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics		Result
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF	
1	(Constant)	0.567	0.254		2.232	0.026	0.067	1.067			
	IV1	0.223	0.064	0.174	3.480	0.001	0.097	0.349	0.799	1.251	Accepted
	IV2	0.059	0.056	0.053	1.049	0.295	-0.052	0.170	0.775	1.290	Rejected
	IV3	0.464	0.047	0.504	9.778	0.000	0.370	0.557	0.754	1.326	Accepted

a. Dependent Variable: DV

4.6. Hypotheses Findings

The sustainability of global economic growth has been considerably aided by electric vehicles. Understanding and analysing the variables influencing consumer’s intention regarding the adoption of electric vehicles is crucial [5]. The people in Malaysia are becoming more aware of and interested in electric vehicles. In contrast to other nations, publicity, understanding, and adoption of electric vehicles are still minimal. The difficulties which the Malaysian government, policymakers, manufactures, and EV consumers encounter in terms of EV cost, EV charging stations availability, and environmental aspect are all comprehensively examined in this research of the factors connected with adopting the electric vehicle culture in the nation [27], [28]. There are a total of three identified independent variables (purchase price of cars, availability of charging stations and environmental factor) within this research to have positive relationship with consumer adoption in electric cars. The below hypotheses are being supported using multiple regression and V29 SPSS to run analysis on the relationship among the independent variables and dependent variables.

H1: Purchase price of the electric cars has a significant impact on the consumer adoption of electric cars in Malaysia.

Following the data analysis where the p-value is <0.001 and the beta coefficient is at 0.174 which is significant statistically according to 0.05 level. This have shown the purchase price of electric cars have significant impact towards consumers adoption in electric cars. This finding is consistent with the research conducted by [1], where it was found that the purchase price of electric cars has a significant impacts consumer adoption of electric cars in Malaysia.

H2: Availability of charging stations has a significant impact on the consumer adoption of electric cars in Malaysia.

When examining the second independent variable, which is the availability of charging stations, it has become apparent that there is little to no discernible relationship with consumer adoption of electric cars in Malaysia. Hence, this hypothesis is being rejected. The availability of charging stations is resulting in a beta coefficient of 0.053 and p-value of 0.295 and it is not significant based on the 0.05 level. This is showing different opinion of what [43] mentioned from this findings that the availability of charging stations is having positive effect on consumers adoption on electric vehicles. He further added that consumers in Malaysia are worried about the availability of public charging stations in addition to the price [43]. Their concerns about utilising EVs for transportation would be allayed by a sufficient charging infrastructure, which would also boost electrified transport acceptance and accessibility in Malaysia. As pointed out by [43], DC chargers are a particularly essential item for consumers to bring while travelling with an EV, even though AC chargers are excellent for overnight charging. This issue has been brought up with the government, relevant organisations, and relevant businesses. Several initiatives were launched in 2021 to solve the issue. The quantity of electric vehicle charging stations in Malaysia remains relatively limited, and the rate at which they have been constructed since 2016 has been gradual. This is related to the slow transition of consumers from combustion engines to electric cars, which is consistent with a Twitter poll by BFM radio station that found 40% of responders still wouldn't choose an EV because of Malaysia's inadequate charging infrastructure.

Most countries have a high concentration of charging stations in one area, which poses a problem for users in terms of when and where to utilise them.

For instance, according to the Malaysian Automotive Association (MAA), today, the country has 4000 EV charging stations, the majority of which are spread in major cities on Malaysia's west side, including Klang Valley, Johor, and Penang. Unfortunately, the eastern regions of the country do not enjoy the same level of service [27].

Based on a study on electric cars adoption in 30 countries, it was found that it is impossible to anticipate considerable EV adoption in nations with underdeveloped or non-existent consumer incentives. This finding generally implies that governments need to promote the shift to electrical vehicles in a proactive manner [38].

Based on research from Taylor's University [22], by looking at current statistic of Malaysia's Electric vehicle's charging station, the number of charging stations offered in Malaysia cannot accommodate the country's present population of electric vehicles.

H3: Environmental factor has a significant impact on the consumer adoption of electric cars in Malaysia.

Following the data analysis where the p-value is <0.001 and the beta coefficient is at 0.504 which is significant statistically based on the 0.05 level. The data justified that the environmental factor is having a significant impact on consumer adoption in electric cars. Expanding upon the discoveries in the study by [41], it is evident that environmental factors play a substantial role in influencing consumers' adoption of electric cars in Malaysia.

5. Recommendations

This research has reflected that the factors such as price of cars and environmental factor have significant influence on consumer adoption of electric vehicles in Malaysia. It is crucial for the automobile manufacturers and government policy makers to consider the price of cars and environmental factors as part of their strategies and planning.

Based on the research analysis, car price is known as an important element in consumer adoption of electric cars in Malaysia. The cost of typical electric vehicles (EVs) plays a significant role in the widespread adoption of EV culture. In Malaysia, the pricing of an electric vehicle is more than that of a regular vehicle. According to [27], an eco-friendly car like the Myvi comes at a price that is 23.7% lower than that of a MINI Cooper SE with a very similar body design. Although governments work to reduce the price gap through incentives like tax breaks and subsidies, electric cars nevertheless cost more than vehicles powered by internal combustion engines now.

Price value has been identified by many researchers as one of the main obstacles for green products [23].

Other than car price, another factor that is having significant influence towards consumer adoption of electric cars in Malaysia is the environmental factor. Environmental knowledge is frequently evaluated as a determinant of how people will behave in the framework of pro-environmental research. The researchers stated from the standpoint of the intent to acquire hybrid automobiles, the possibility of consumers adopting hybrid cars can grow as their environment knowledge increases [41]. Several studies have shown that environmentally friendly and electric car technologies can influence consumers' purchasing decisions. Environmental concerns serve as a critical indicator of the shifting consumer perspective on electric vehicles (EVs) and have a notably positive influence on EV purchase behavior [1].

Although the result of this research has shown that availability of charging station did not really reflect significant influence towards consumer adoption of electric cars in Malaysia. Policy makers, government, and car manufacturers should still continue to look into as the low availability of charging stations in Malaysia have resulted in low adoption of electric vehicles in Malaysia [7]. According to a survey conducted among ASEAN consumers, it was found that customers prefer having charging stations available at their workplace over having them at their homes, public charging stations, or shopping mall parking lots. This preference suggests that people tend to select the areas where they are spending the most time. The more time they spend in a single location, the greater the opportunity for uninterrupted charging [21]. Research done in the USA by Tesla, used a multi-objective optimization method to maximize the location of charging stations across the United States by taking into account the charging variables, such as coverage for charging stations, the quantity of cars that need to be charged per zone, recharge time, as well as the general factors of consumer need. The availability of electric vehicle (EV) drivers will expand when charging stations are situated within a five-kilometer radius. This accessibility factor significantly influences their choice to invest in an EV. The absence of publicly accessible charging stations, which can pose inconvenience or even unavailability to EV owners, underscores the importance of a well-thought-out strategy for determining the number of charging stations to deploy and the timing and locations for their implementation [37].

Car manufacturers and governments are strongly urged to support and advance the adoption of electric cars by considering the three pivotal factors emphasized in this study, with a particular focus on environmental factors. Conversely, certain essential factors for EV adoption, such as socioeconomic conditions, dealership services, and population density resilience, have received limited research attention and are recommended as areas for future investigation, as proposed by [42].

Additionally, the research will provide a few recommendations towards Malaysia's policy makers and car manufacturers:

1. Government to lower the price of electric cars by providing more incentives and subsidies when purchasing electric cars.
2. Government to implement tax breaks towards electric cars consumer.
3. The government should collaborate with automobile manufacturers to enhance the accessibility of charging stations across the entire nation.
4. Car manufacturers and the government should develop an extensive awareness campaign focused on the environmental aspects of electric car adoption. Government to implement low road tax towards electric cars due to zero emissions of CO₂.

6. Conclusion

Research examining the relationship between car pricing, charging station availability, and environmental factors with consumers' adoption of electric vehicles in Malaysia can provide valuable insights for future researchers aiming to identify the factors that drive increased adoption rates.

The Pearson's R correlation coefficient method is being implemented to this study of relationship among the factors. This research result has concluded that pricing of cars and environmental factors have a positive influence on consumer adoption of electric vehicles in Malaysia. No discernible correlation was found between the presence of charging stations and the adoption of electric vehicles by consumers in Malaysia.

The final method used to determine the elements that exert the most significant influence on consumer adoption of electric vehicles in Malaysia is regression analysis. The data have shown that environmental factors have the highest importance on consumer adoption of electric vehicles in Malaysia.

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