Barriers Limiting the Adoption of Electric Vehicles in Malaysia

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ABSTRACT

Electric vehicle (EV) adoption is essential for achieving sustainable transportation goals, yet its adoption in Malaysia remains low due to various barriers. This study investigates the primary barriers to EV adoption, focusing on technological, environmental, financial, and infrastructural obstacles. Data was collected using structured questionnaires which was distributed to 531 licensed Malaysian drivers. Statistical analyses were conducted to examine the relationships between barriers and adoption intention, as well as the influence of demographic factors such as age and car ownership. Findings revealed that infrastructural barriers, such as insufficient charging stations and maintenance services, are the most significant obstacles, followed by environmental, financial, and technological barriers. Age was found to significantly influence perceptions of these barriers, with older respondents perceiving higher barriers, while car ownership status showed mixed results. The study concludes by proposing targeted strategies, including enhancing charging infrastructure, offering financial incentives, and increasing public awareness to encourage EV adoption. These insights are crucial for policymakers and industry stakeholders in overcoming barriers and promoting sustainable transportation in Malaysia.

Keywords
Electric vehicles; EV adoption; Barriers; Sustainable transportation

Introduction

The adoption of Electric Vehicles (EVs) is a critical component of global strategies to combat climate change and transition towards a sustainable future (Zaino et al., 2024). Malaysia, as part of its commitment to achieving carbon neutrality by 2050, has actively promoted EVs to reduce greenhouse gas emissions and decrease dependency on fossil fuels (Ozawa et al., 2022). However, despite these efforts, the adoption rate of EVs in Malaysia remains low, hindered by various barriers that influence consumers' perceptions and intentions to adopt this technology (Veza et al., 2022).

Key barriers to EV adoption include technological, environmental, financial, and infrastructural challenges. Technological barriers such as limited driving range, long charging times, safety concerns, and doubts about reliability continue to deter potential EV adopters (Adhikari et al., 2020). Environmental barriers, including concerns over battery disposal and the environmental impact of battery production, further complicate the adoption process, raising questions about the sustainability of EVs (Pamidimukkala et al., 2023).

Financial barriers, such as high purchase prices, battery replacement costs, and high electricity tariffs for charging, impose significant economic burdens on consumers (Adepetu & Keshav, 2017). Additionally, infrastructural barriers, particularly the lack of accessible public charging stations and reliable maintenance services, exacerbate the issue, making the EV ownership experience less convenient and appealing (Ma et al., 2024). This research is designed to explore these barriers comprehensively, with particular attention to how demographic factors such as age and car ownership influence perceptions towards EV adoption in Malaysia. Addressing these barriers is crucial to formulating effective strategies and policies that can increase the adoption rate of EVs in the country, ultimately contributing to Malaysia's sustainability goals. Thus, the research objectives of this study are to firstly, identify the most significant barriers to EV adoption in Malaysia, secondly to examine the influence of demographic factors, particularly age and car ownership, on the perception of barriers and thirdly, to propose strategies and recommendations to overcome these barriers and enhance EV adoption in Malaysia.

Literature Review

The global transition toward electric vehicles (EVs) is influenced by a complex interplay of infrastructural, technological, financial, environmental, and behavioural factors. Research consistently shows that these dimensions shape consumer readiness and national adoption rates, particularly in developing economies such as Malaysia (Sovacool et al., 2019). While global trends highlight similar challenges, the Malaysian context reflects

unique constraints related to infrastructure planning, economic conditions, and public awareness. The adoption of electric vehicles (EVs) has been heralded as a key strategy for promoting sustainable transportation and reducing reliance on fossil fuels. However, the transition to EVs in Malaysia faces significant challenges stemming from various barriers, including technological, environmental, financial, and infrastructural constraints (Pamidimukkala et al., 2023). This section explores these barriers in detail, providing a basis for understanding the factors influencing EV adoption in the Malaysian context.

Technological Barriers

Technological readiness, particularly regarding battery performance, durability, and safety, has been shown to affect consumer trust and perceived usefulness (Zhang et al., 2019). Although battery technology has improved globally, concerns about degradation, driving range, and charging duration remain prevalent among potential adopters. Malaysian studies report low levels of technological literacy surrounding EVs, contributing to misconceptions about efficiency and maintenance (Yong et al., 2020). This aligns with international findings that emphasize consumer education as a critical component of EV adoption strategies. Technological barriers represent a critical impediment to EV adoption. Issues such as limited driving range, prolonged charging times, safety concerns related to batteries, and doubts about EV reliability create hesitation among potential users (Adhikari et al., 2020). Studies have shown that these barriers undermine consumer confidence, particularly in regions where infrastructure to support technological advancements remains underdeveloped. Innovations in battery technology and more efficient charging systems have been proposed as solutions to alleviate these concerns.

Environmental Barriers

While EV adoption is often motivated by environmental concerns, research shows that many consumers remain uncertain about the true ecological benefits of EVs (Breetz et al., 2018). Misperceptions about battery disposal and electricity generation sources contribute to scepticism. Strengthening recycling programs and communicating lifecycle environmental benefits have been identified as effective strategies to enhance consumer confidence (Dai et al., 2019). Malaysian studies highlight similar trends, emphasizing the importance of clear messaging on emissions reduction and sustainability outcomes. In addition, the environmental aspects of EV adoption, particularly those related to battery production and disposal, pose significant challenges. The extraction of raw materials for battery manufacturing is associated with considerable environmental degradation. Moreover, the lack of established recycling facilities for used batteries exacerbates the issue, creating additional concerns for potential adopters. Research highlights the need for a circular economy approach to minimize the environmental impact of EV batteries while maximizing their lifecycle benefits (Dogan and Ozmen, 2019).

Financial Barriers

Financial considerations remain one of the most significant obstacles to EV uptake. Higher upfront costs compared to conventional vehicles continue to deter potential buyers in both developed and emerging markets (Rezvani, Jansson, & Bodin, 2015). International evidence suggests that subsidies, tax exemptions, and innovative financing substantially increase adoption rates (Li et al., 2017). In Malaysia, the absence of a mature second-hand EV market restricts affordability options for middle-income groups, a barrier also noted in studies of early-stage EV markets elsewhere (Jenn, 2019). High upfront costs, including purchase prices and expenses related to battery replacement and home charging installations, represent major financial barriers to EV adoption in Malaysia. While EVs offer lower operational costs over time, the immediate financial burden discourages many consumers. Policies providing subsidies and incentives have proven effective in other nations and could serve as a viable approach in the Malaysian context (Allcott and Wozny, 2014). The literature therefore highlights the need for sustained financial incentives and market stimulation.

Infrastructural Barriers

Numerous studies identify limited public charging availability as a key contributor to range anxiety, which significantly reduces purchase intention (Li et al., 2020; Wolbertus et al., 2018). A robust and reliable charging infrastructure is vital for widespread EV adoption. In Malaysia, the concentration of charging stations in urban areas magnifies accessibility issues for rural populations. Research indicates that both public and residential charging infrastructure are equally important, with home-charging convenience strongly linked to positive adoption behaviour (Hardman et al., 2018). These findings underscore the need for targeted infrastructure expansion to support long-term EV market growth. In addition, the inadequacy of public charging stations and

insufficient maintenance services are notable challenges in Malaysia. These issues lead to range anxiety, reducing consumer confidence in adopting EVs. Collaborative efforts between policymakers, industry stakeholders, and local governments are required to address these infrastructural deficits effectively (Ma et al, 2024).

Socio-Demographic and Behavioural Factors

Consumer behaviour research indicates that socio-demographic variables such as age, technological familiarity, and social influence, play significant roles in adoption decisions (Axsen & Kurani, 2013). Older demographics often demonstrate higher levels of hesitation due to limited exposure to EV technology. Malaysian findings mirror global patterns, showing that targeted educational campaigns can reduce behavioural resistance and strengthen perceived ease of use (Moradi & Vaziri, 2020). Social norms, trust in government policies, and perceived convenience further shape adoption intentions.

Based on the discussion of past literature, Figure 1 presents the research framework for this study.

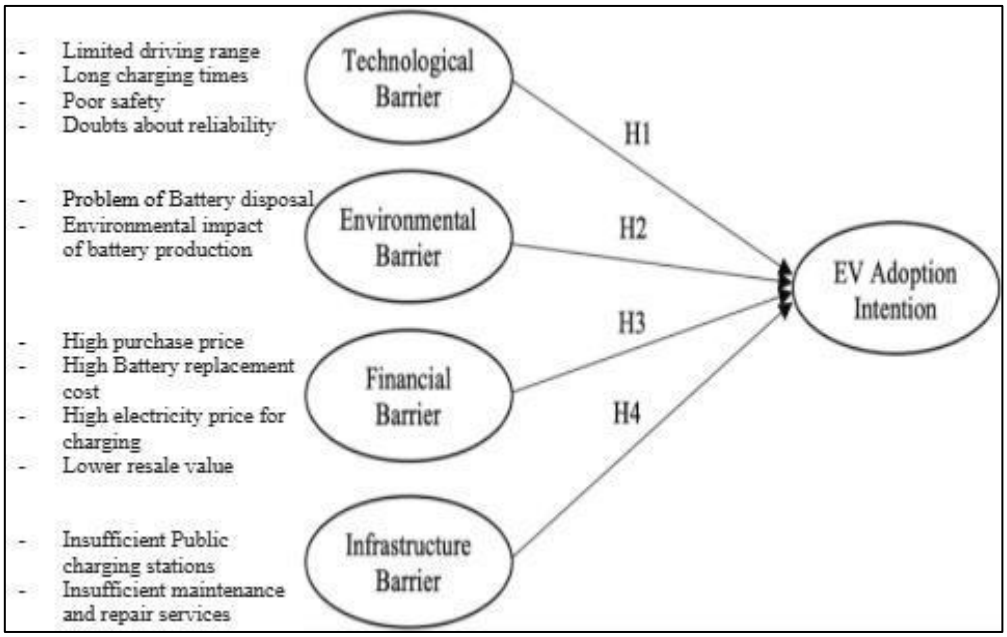

Figure 1. Conceptual Framework for the Study

To analyze these barriers, a structured research framework was developed, identifying four independent variables; technological, environmental, financial, and infrastructural barriers and one dependent variable, EV adoption intention. This framework is designed to evaluate the degree to which each barrier influences consumer behavior in Malaysia.

Hypotheses

In alignment with the research framework and literature, the following hypotheses have been established:

H1: The technological barrier is positively correlated with the adoption of electric vehicles.
H2: The environmental barrier is positively correlated with the adoption of electric vehicles.
H3: The financial barrier is positively correlated with the adoption of electric vehicles.
H4: The infrastructural barrier is positively correlated with the adoption of electric vehicles.
H5: There is a significant difference in the perception of technological barriers to EV adoption based on age.
H6: There is a significant difference in the perception of technological barriers to EV adoption based on car ownership status.
H7: There is a significant difference in the perception of environmental barriers to EV adoption based on age.
H8: There is a significant difference in the perception of environmental barriers to EV adoption based on car ownership status.
H9: There is a significant difference in the perception of financial barriers to EV adoption based on age.
H10: There is a significant difference in the perception of financial barriers to EV adoption based on car ownership status.

H11: There is a significant difference in the perception of infrastructural barriers to EV adoption based on age.
H12: There is a significant difference in the perception of infrastructural barriers to EV adoption based on car ownership status.

Research Methodology

This study adopted a survey approach to investigate the barriers to electric vehicle (EV) adoption in Malaysia. In order to achieve the objectives, the study targeted licensed Malaysian drivers, totalling 15.8 million of population (Mamat, 2021). A sample size of 384 respondents was recommended for a 95% confidence level and a 5% margin of error. This study exceeded the recommendation, collecting data from 531 respondents to enhance representativeness. Convenience sampling via social media car community groups facilitated efficient and diverse data collection.

A structured questionnaire was designed to align with the study's objectives and consisted of three sections with a total of 25 items shown in Table 1.

Table 1 Questionnaire Design Overview

Section	Aspect	Type of Scale	Number of Items
A	Demographic Information	Choice Questions	5
B	Barriers to EV Adoption	Likert Scale	16
C	EV Adoption Intention	Likert Scale	4
Total			25

Section A gathered demographic data such as gender, age, education, household income, and car ownership. Section B measured the four barriers (technological, environmental, financial, and infrastructural) using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Section C assessed EV adoption intention. In analyzing the data collected, several statistical procedures were employed to ensure accuracy and validity. First, descriptive analysis was used to summarize the demographic characteristics of respondents and to provide an overview of their responses to the study variables. A reliability test using Cronbach's Alpha indicated strong internal consistency, with all sections exceeding the acceptable threshold value of 0.6. The normality of the data was verified through skewness and kurtosis values, both of which fell within the ±1.0 range, confirming that the dataset was normally distributed. Pearson correlation analysis was then conducted to examine the relationships between the identified barriers and respondents' intentions to adopt electric vehicles. Additionally, ANOVA was performed to determine whether perceptions of these barriers differed significantly across age groups and between car owners and non-owners, using a significance level of 0.05.

Findings

Demographics of the respondents

The study comprised a total of 415 respondents, with male participants forming the majority at 249 individuals (60%) and females accounting for 166 individuals (40%), reflecting a balanced gender distribution consistent with Malaysia's licensed driver population. Age distribution was evenly spread across all groups while educational attainment varied widely, A similarly even distribution was observed for household income. Car ownership was high among respondents, with 332 individuals (80%) owning a car and 83 individuals (20%) not owning one. This distinction provides useful insights into comparing perceptions of electric vehicle adoption between car owners and non-owners. Table 2 illustrates the demographics of the respondents.

Table 2 Demographics of the Respondents

Category	Subcategory	Frequency (n)	Percentage (%)
Gender	Male	249	60.0
	Female	166	40.0
Age	Under 20	83	20.0
	21–30	85	20.5
	31–40	84	20.2
	41–50	81	19.5
	51–60	82	19.8
	Above 60	0	0.0
Education Level	Secondary School	83	20.0
	Diploma	85	20.5
	Bachelor's Degree	84	20.2
	Master's Degree	81	19.5
	Doctorate	82	19.8
Household Income (RM)	< 2,000	83	20.0
	2,001 – 4,000	85	20.5
	4,001 – 6,000	84	20.2
	6,001 – 8,000	81	19.5
	8,001 – 10,000	82	19.8
	> 10,000	0	0.0
Car Ownership	Yes	332	80.0
	No	83	20.0

Findings for H1 to H4: Correlation Analysis

The findings for hypotheses H1 to H4 focus on the relationship between the four independent variables; technological, environmental, financial, and infrastructural barriers and the dependent variable, the intention to adopt electric vehicles (EVs). The hypotheses were tested using Pearson correlation analysis, as shown in Table 3 below. Pearson correlation was employed to determine the strength and direction of the relationship between each independent variable and the adoption intention of EVs among Malaysian drivers.

H1: The technological barrier is positively correlated with the adoption of electric vehicles.
H2: The environmental barrier is positively correlated with the adoption of electric vehicles.
H3: The financial barrier is positively correlated with the adoption of electric vehicles.
H4: The infrastructural barrier is positively correlated with the adoption of electric vehicles.

Table 3 Pearson Correlation Matrix for Dependent and Independent Variables

		DV	IV1	IV2	IV3	IV4
Pearson Correlation	DV	1.000	.962	.973	.973	.967
	IV1	.962	1.000	.966	.967	.949
	IV2	.973	.966	1.000	.976	.962
	IV3	.973	.967	.976	1.000	.965
	IV4	.967	.949	.962	.965	1.000
Sig. (1-tailed)	DV	.	<.001	<.001	<.001	<.001
	IV1	.000	.	.000	.000	.000
	IV2	.000	.000	.	.000	.000
	IV3	.000	.000	.000	.	.000
	IV4	.000	.000	.000	.000	.
N	DV	531	531	531	531	531
	IV1	531	531	531	531	531
	IV2	531	531	531	531	531
	IV3	531	531	531	531	531
	IV4	531	531	531	531	531

As shown in Table 3 all four independent variables; technological, environmental, financial, and infrastructural barriers showed strong positive correlations with the dependent variable, the adoption intention of EVs.

Specifically:

- The technological barrier ($r = 0.962, p < 0.001$) demonstrated a very strong positive correlation with EV adoption intention, indicating that perceptions of technological barriers, such as driving range and charging times, strongly influence the willingness to adopt EVs.
- The environmental barrier ($r = 0.973, p < 0.001$) exhibited the strongest correlation among all barriers. This suggests that concerns related to battery production, disposal, and environmental impacts significantly affect drivers' adoption decisions.
- The financial barrier ($r = 0.973, p < 0.001$) also displayed a very strong correlation with EV adoption intention. High purchase prices, battery replacement costs, and electricity prices for charging are pivotal factors in influencing adoption decisions.
- The infrastructural barrier ($r = 0.967, p < 0.001$) showed a very strong positive correlation, highlighting that a lack of public charging stations and maintenance services is a substantial barrier to EV adoption.

These findings provide empirical evidence supporting hypotheses H1 to H4. The strong positive correlations across all barriers underscore the multifaceted challenges that must be addressed to enhance the adoption of EVs in Malaysia. The findings suggest that improving technological features, minimizing environmental concerns, addressing financial constraints, and enhancing EV infrastructure are all critical to promoting EV adoption among Malaysian drivers. The results are consistent with prior studies that emphasize the importance of these factors in influencing consumer behaviour towards EV adoption.

Differences in Barriers Based on Car Ownership Status

The hypotheses H6, H8, H10, and H12 investigate whether perceptions of barriers (technological, environmental, financial, and infrastructural) to electric vehicle (EV) adoption differ based on car ownership status. These hypotheses are tested using independent samples t-tests, with car ownership status as the grouping variable.

H6: Technological Barrier and Car Ownership

Table 4 Correlation Between Technological Barrier Attributes and EV Adoption Intention (No Ownership)

Correlations of Technological Barriers	T1	T2	T3	T4	TAVERAGE
Pearson Correlation	0.998	0.980	0.998	0.980	0.989
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	199	199	199	199	199

Table 5 Correlation of Technological Barrier Attributes and EV Adoption Intention Based on Car Ownership (Yes)

Correlations of Technological Barriers	T1	T2	T3	T4	TAVERAGE
Pearson Correlation	0.551	0.584	0.610	0.534	0.570
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	332	332	332	332	332

As presented in Table 4 and Table 5, the results of the **t-test** reveal a statistically significant difference in the perception of technological barriers between car owners and non-car owners. Non-car owners reported

higher mean scores, indicating a greater perception of barriers such as limited driving range, long charging times, and safety concerns. The higher scores suggest that individuals who do not own a car may lack first-hand experience with vehicle technology, influencing their concerns.

H8: Environmental Barrier and Car Ownership

Table 6 Correlation between Environmental Barrier Attributes and EV Adoption Intention for No Ownership

Correlations of Technological Barriers	E1	E2	E3	E4	EAVERAGE
Pearson Correlation	0.997	0.996	0.996	0.997	0.997
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	199	199	199	199	199

Table 7 Correlation of Environmental Barrier Attributes and EV Adoption Intention Based on Car Ownership (Yes)

Correlations of Technological Barriers	E1	E2	E3	E4	EAVERAGE
Pearson Correlation	0.616	0.565	0.629	0.517	0.582
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	332	332	332	332	332

As presented in tables 6 and 7, the t-test results show a significant difference in the perception of environmental barriers between the two groups. Non-car owners expressed greater concern about issues such as the environmental impact of battery production and disposal. This may be due to heightened environmental awareness or a lack of understanding of EVs' potential to mitigate pollution compared to internal combustion engines.

H10: Financial Barrier and Car Ownership

Table 8 Correlation between Financial Barrier Attributes and EV Adoption Intention for No Ownership

Correlations of Technological Barriers	F1	F2	F3	F4	FAVERAGE
Pearson Correlation	0.997	0.987	0.997	0.981	0.990
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	199	199	199	199	199

Table 9 Correlation of Financial Barrier Attributes and EV Adoption Intention Based on Car Ownership (Yes)

Correlations of Technological Barriers	F1	F2	F3	F4	FAVERAGE
Pearson Correlation	0.681	0.665	0.596	0.589	0.633
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	332	332	332	332	332

For financial barriers, the t-test results as shown in Tables 8 and 9 also show significant differences between car owners and non-car owners. Non-car owners perceived financial constraints, such as the high purchase price of EVs, battery replacement costs, and charging costs, as more prohibitive than car owners. This suggests that non-car owners may face greater economic challenges or perceive EVs as less affordable overall.

H12: Infrastructural Barrier and Car Ownership

Table 10 Correlation between Infrastructural Barrier Attributes and EV Adoption Intention for No Ownership

Correlations of Technological Barriers	I1	I2	I3	I4	IAVERAGE
Pearson Correlation	0.998	0.989	0.996	0.987	0.993
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	199	199	199	199	199

Table 11 Correlation of Infrastructure Barrier Attributes and EV Adoption Intention Based on Car Ownership (Yes)

Correlations of Technological Barriers	I1	I2	I3	I4	IAVERAGE
Pearson Correlation	0.698	0.660	0.652	0.630	0.660
Sig. (2-tailed)	<.001	<.001	<.001	<.001	-
N	332	332	332	332	332

Finally, Table 10 and 11 report the t-test results to confirm a significant difference in the perception of infrastructural barriers based on car ownership status. Non-car owners rated issues such as insufficient public charging stations and limited repair services as greater obstacles compared to car owners. This may reflect non-car owners' higher reliance on public infrastructure due to a lack of access to personal vehicles.

Differences in Barriers Based on Age

The hypotheses H5, H7, H9, and H11 examine whether perceptions of barriers to electric vehicle (EV) adoption—technological, environmental, financial, and infrastructural barriers—differ significantly based on respondents' age groups. Since age is a categorical variable with more than two groups (e.g., under 20, 21 –30, 31–40, etc.), the appropriate statistical test is ANOVA (Analysis of Variance), which identifies whether there are statistically significant differences in mean perceptions across the age groups. Refer Table 12 and 13.

Table 12 Result of ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TAVERAGE	Between Groups	532.957	4	133.239	142.670	<.001
	Within Groups	491.230	526	.934		
	Total	1024.186	530			
EAVERAGE	Between Groups	551.296	4	137.824	134.224	<.001
	Within Groups	540.108	526	1.027		
	Total	1091.403	530			

FAVERAGE	Between Groups	567.953	4	141.988	143.791	<.001
	Within Groups	519.405	526	.987		
	Total	1087.358	530			
IAVERAGE	Between Groups	662.810	4	165.703	152.949	<.001
	Within Groups	569.858	526	1.083		
	Total	1232.668	530			

Table 13 Descriptive Analysis

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TAVERAGE	Under 20	69	2.5543	1.63536	.19687	2.1615	2.9472	1.00	4.25
	21-30	156	2.1330	1.09486	.08766	1.9599	2.3062	1.00	4.25
	31-40	106	4.1769	.97527	.09473	3.9891	4.3647	1.00	4.50
	41-50	108	4.3958	.34877	.03356	4.3293	4.4624	1.00	4.50
	51-60	92	4.2228	.34262	.03572	4.1519	4.2938	1.00	4.50
	Total	531	3.4181	1.39012	.06033	3.2996	3.5366	1.00	4.50
EAVERAGE	Under 20	69	2.7029	1.74119	.20962	2.2846	3.1212	1.00	4.50
	21-30	156	2.1779	1.15004	.09208	1.9960	2.3598	1.00	4.50
	31-40	106	4.2028	.98023	.09521	4.0140	4.3916	1.00	4.50
	41-50	108	4.4676	.33679	.03241	4.4033	4.5318	1.00	4.50
	51-60	92	4.4402	.41828	.04361	4.3536	4.5268	1.00	4.50
	Total	531	3.5080	1.43501	.06227	3.3857	3.6303	1.00	4.50
FAVERAGE	Under 20	69	2.6957	1.74362	.20991	2.2768	3.1145	1.00	4.50
	21-30	156	2.1378	1.08222	.08665	1.9667	2.3090	1.00	4.50
	31-40	106	4.2028	.98023	.09521	4.0140	4.3916	1.00	4.50
	41-50	108	4.4676	.33679	.03241	4.4033	4.5318	1.00	4.50
	51-60	92	4.4348	.44609	.04651	4.3424	4.5272	1.00	4.50
	Total	531	3.4944	1.43235	.06216	3.3722	3.6165	1.00	4.50

IAVERAGE	Under 20	69	2.8261	1.86113	.22405	2.3790	3.2732	1.00	4.75
	21-30	156	2.1827	1.14065	.09133	2.0023	2.3631	1.00	5.00
	31-40	106	4.0448	.94981	.09225	3.8619	4.2277	1.00	5.00
	41-50	108	4.7245	.36484	.03511	4.6549	4.7941	1.00	5.00
	51-60	92	4.8804	.51017	.05319	4.7748	4.9861	1.00	5.00
	Total	531	3.6224	1.52505	.06618	3.4924	3.7524	1.00	5.00

H5: Technological Barriers and Age

The results of the ANOVA test indicate a significant difference in the perception of technological barriers among different age groups. Younger respondents (e.g., under 30) reported lower levels of concern regarding technological barriers, such as insufficient driving range, long charging times, and safety concerns, compared to older respondents (e.g., above 50). This could reflect generational differences in technological familiarity and acceptance, with younger individuals potentially being more open to EV technology.

H7: Environmental Barriers and Age

The ANOVA test results also show significant differences in the perception of environmental barriers across age groups. Older respondents expressed greater concerns about the environmental impact of EV batteries, such as production and disposal, compared to younger respondents. This trend suggests that older individuals may be more sceptical about EVs' overall environmental benefits.

H9: Financial Barriers and Age

For financial barriers, the ANOVA test revealed a significant difference between age groups. Respondents aged 31 to 40 years reported the highest financial concerns, such as the high purchase price of EVs and the cost of battery replacements, possibly due to this age group being at a life stage with higher financial obligations (e.g., family expenses). Younger and older respondents perceived financial barriers as less severe, potentially due to differing priorities or levels of purchasing power.

H11: Infrastructural Barriers and Age

The results also confirm significant differences in the perception of infrastructural barriers based on age. Respondents aged above 50 rated infrastructural barriers, such as the lack of charging stations and maintenance services, higher than younger respondents. This finding suggests that older individuals may rely more on well-established infrastructure and perceive current EV support systems as inadequate.

Discussions

Addressing Research Objective 1

The findings indicate that infrastructural barriers are the most significant barriers to EV adoption in Malaysia. These include concerns over the insufficient availability of public charging stations, inadequate maintenance services, and limited residential charging facilities. The second most significant barrier is environmental barriers, which highlight consumer concerns regarding battery production's ecological impact and disposal challenges. Financial barriers rank third, emphasizing issues such as the high upfront costs of EVs, battery replacement expenses, and concerns over long-term affordability. Lastly, technological barriers are the least significant but still relevant, reflecting apprehensions about the driving range, long charging times, and safety considerations. These findings showcase the complex and hierarchical nature of the challenges hindering EV adoption in Malaysia .

Addressing Research Objective 2

The study examined the impact of demographic factors; age and car ownership on perceptions of barriers to EV adoption. Age was found to significantly influence perceptions, with older respondents perceiving barriers more strongly. This trend may stem from technological unfamiliarity, financial caution, or a greater reliance on traditional vehicles. Car ownership status also played a role, with individuals who do not own a car perceiving barrier as higher compared to those who already own vehicles. This difference might be attributed to non-owners lacking first-hand experience with vehicle-related infrastructure, costs, and technology, making barriers appear more daunting. These findings suggest the need for tailored strategies that address the concerns of older individuals and non-car owners, focusing on education, confidence-building, and accessible infrastructure to ease their adoption journey.

Addressing Research Objective 3

Efforts to address the barriers limiting electric vehicle adoption in Malaysia require a multifaceted approach that focuses on infrastructure, technology, financial support, environmental initiatives, and education. First, improving infrastructure remains a critical priority. Expanding the availability of public charging stations, particularly in underserved and rural areas, would alleviate range anxiety and make EV usage more convenient. Incentivizing residential charging installations could also encourage more households to adopt EVs by providing accessible and reliable charging options at home. In addition, ongoing technological improvements are essential. Enhancing battery performance, durability, and safety can help build consumer confidence, while targeted communication efforts are needed to educate the public on recent advancements and dispel misconceptions.

Financial considerations continue to be one of the biggest barriers for many Malaysians. Providing subsidies, tax incentives, and accessible financing schemes would help lower the high upfront cost of EVs. Developing a second-hand EV market could also significantly improve affordability, making EV ownership more attainable for middle- and lower-income groups. From an environmental standpoint, strengthening battery recycling programs and promoting circular economy practices are vital to ensuring sustainable EV adoption. Equally important is educating consumers about the environmental advantages of EVs compared to traditional internal combustion engine vehicles, especially regarding carbon emissions and long-term ecological benefits.

Finally, education and awareness campaigns should be strategically designed to reach key demographic groups. Older populations, in particular, often have limited exposure to EV technology and may be more hesitant to adopt new forms of mobility. Tailored awareness programs can bridge this knowledge gap, clarify misconceptions, and highlight the practical, financial, and environmental benefits of EV ownership. Collectively, these strategies can help overcome existing barriers and support Malaysia's transition toward a more sustainable transportation ecosystem.

Conclusion

This study explored the significant barriers to Electric Vehicle (EV) adoption in Malaysia, focusing on technological, environmental, financial, and infrastructural challenges, as well as the influence of demographic factors such as age and car ownership on these perceptions. Among the findings, infrastructural barriers, such as the lack of public charging stations and maintenance services, emerged as the most significant hindrance, followed by environmental, financial, and technological barriers. Additionally, demographic analysis revealed that older individuals perceived barriers more strongly, and those without car ownership faced higher perceived barriers compared to car owners. The findings underscore the complexity of EV adoption, requiring a multifaceted approach to overcome these barriers. Key recommendations include improving EV infrastructure, enhancing affordability, and addressing environmental concerns through stricter policies and incentives. Educational initiatives targeting older demographics and non-car owners can further help build confidence and interest in EV technology. The study highlights the importance of tailored strategies to foster widespread EV adoption and support Malaysia's transition toward sustainable transportation.

Future research could explore longitudinal studies to assess changing perceptions over time, investigate policy impacts, and analyze consumer behaviour trends in different regions of Malaysia. A broader examination of additional demographic factors, such as income and education, could provide further insights into strategies to promote EV adoption.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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