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Evaluating the Feasibility of Electric Vehicles in Malaysia: Current challenges and future prospects

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Abstract
The transition to electric vehicles (EVs) is a pivotal element in combating climate change and fostering sustainable transportation. This paper explores the feasibility of EVs in Malaysia, focusing on the current landscape, challenges to adoption, and future predictions for the industry. Despite government initiatives aimed at promoting EV usage, several barriers such as insufficient infrastructure, high initial costs, and public awareness hinder widespread acceptance. This study provides insights into these challenges and offers strategic recommendations for stakeholders to enhance the adoption of EVs, contributing to a more sustainable transportation ecosystem in Malaysia.

Keywords: Electric Vehicle, Feasible study;

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1.0 Introduction

The global push towards sustainable energy sources and the reduction of greenhouse gas emissions has positioned electric vehicles (EVs) at the forefront of the automotive industry's evolution. With the transportation sector accounting for nearly 24% of global CO2 emissions, the transition to EVs is critical for addressing climate change (International Energy Agency, 2022). The government's commitment to promoting sustainable transport is evident through the implementation of policies such as the National Automotive Policy (NAP) 2020, which aims to position Malaysia as a regional hub for EV manufacturing and development (Ministry of International Trade and Industry, 2020).

Furthermore, ambitious targets have been set, such as achieving 100,000 EVs on the road by 2030, along with plans to establish a robust charging infrastructure (Khalid, 2022). A greater understanding of the significance of lowering reliance on fossil fuels and moving toward cleaner alternatives is reflected in these activities. Despite the encouraging environment, there are a number of major obstacles to EV adoption in Malaysia. Inadequate infrastructure continues to be a major obstacle to customer acceptance, especially in charging stations. There are only about 1,000 charging stations in the country as of 2023, which is not enough for the growing EV market and is disproportionately located in cities (Tan, 2023). Potential purchasers' reluctance is also exacerbated by the high initial cost of EVs and a lack of thorough consumer understanding.

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According to a survey conducted by the Malaysian Institute of Road Safety Research (MIROS), only 30% of the population is familiar with the advantages of EVs, underscoring the need for extensive public education campaigns (MIROS, 2022). Technological advancements also play a crucial role in shaping the future of EV adoption. The development of efficient battery technologies and the establishment of local manufacturing facilities for EV components are vital for reducing costs and improving vehicle performance. Companies like Geely and CATL are investing in battery production in Malaysia, which not only promises to lower costs but also aims to create a more sustainable and self-sufficient EV ecosystem (Lee, 2023). This paper aims to provide a comprehensive overview of the feasibility of electric vehicles in Malaysia by examining the current market dynamics, identifying challenges to widespread adoption, and predicting future trends in the industry. By exploring the intersection of policy, technology, and public perception, this study seeks to contribute valuable insights that can guide stakeholders in fostering a conducive environment for EV adoption, ultimately supporting Malaysia's broader sustainability goals. The objective of this study is to identify key barriers, evaluate economic and technological feasibility, and propose actionable strategies for electric vehicle adoption in Malaysia.

2.0 Literature Review: Current State of Electric Vehicles in Malaysia

2.1 Market Overview

As of 2023, the Malaysian electric vehicle market has witnessed significant growth, with an increasing number of manufacturers entering the sector. According to the Malaysia Automotive, Robotics and IoT Institute (MARii) (2023), EV sales rose by 50% in the previous year, totaling approximately 12,000 units sold. This growth indicates a growing acceptance among consumers, especially with the introduction of models priced below RM 100,000 (approximately USD 22,500), making EVs more accessible (Lim et al., 2022).

2.2 Government Initiatives

The Malaysian government has implemented several policies to incentivize the adoption of EVs. The National Automotive Policy (NAP) 2020 aims to establish Malaysia as a regional hub for EV production, emphasizing tax exemptions and subsidies for both manufacturers and consumers (Ministry of International Trade and Industry, 2020). For instance, the government offers a 100% exemption on import duties for EVs, along with a reduction in road tax. Additionally, Malaysia aims to have 100,000 EVs on the road by 2030, with plans to develop a comprehensive charging infrastructure (Khalid, 2022).

2.3 Technological Developments

Technological advancements have played a critical role in enhancing the appeal of EVs. Battery technology has significantly improved, leading to increased driving ranges and reduced charging times. The establishment of local production facilities for batteries, such as those initiated by companies like Geely and Contemporary Amperex Technology Co. Limited (CATL), reflects Malaysia's commitment to developing a sustainable EV ecosystem (Lee, 2023). Furthermore, research indicates that advancements in battery recycling technologies could reduce the lifecycle environmental impact of EVs, supporting long-term sustainability goals (Yusoff et al., 2022). While several studies have addressed technological and policy dimensions of EV adoption, few have critically examined regional disparities in infrastructure or integrated behavioral theory. This paper addresses this by focusing on rural infrastructure distribution and public acceptance shaped by socio-cultural norms.

3.0 Methodology

3.1 Literature Selection Process

The choice of a qualitative synthesis was made to holistically evaluate Malaysia’s EV landscape, given the emerging nature of this domain. The four thematic areas—economic, technological, policy, and social feasibility—were selected based on recurring themes identified across the literature. The literature review follows a systematic approach to identify and analyze existing research on electric vehicle (EV) feasibility, challenges, and future projections in Malaysia. The study utilized multiple academic databases and authoritative sources. Databases included IEEE Xplore, ScienceDirect, Google Scholar, and SpringerLink for peer-reviewed journals. Additionally, governmental and industry reports were obtained from the official websites of the Malaysian Automotive Association, Ministry of Transport Malaysia, and Malaysia’s Ministry of Environment and Water to capture the latest policy and market updates. Selected articles were then assessed through full-text review to confirm relevance, specifically focusing on feasibility aspects such as market trends, economic impacts, infrastructure, and consumer attitudes.

3.2 Data Extraction and Analysis Framework

A structured data extraction process was implemented to categorize information from selected literature according to key themes. The review identified four core themes relevant to EV feasibility:

i. Economic Feasibility: Evaluated consumer costs, vehicle affordability, maintenance expenses, and the role of government incentives (e.g., tax exemptions, rebates, and grants) that aim to reduce the financial burden on consumers.

ii. Technological Challenges: Assessed technical hurdles like battery life, range limitations, and Malaysia’s need for a robust EV charging network to address its urban-rural divide. The review also included studies on battery recycling and energy storage solutions that could enhance EV sustainability.

iii. Policy and Regulatory Environment: Analyzed Malaysia's EV policy landscape, including emission regulations, government-led EV targets, and current policy gaps. Studies exploring regulatory challenges were reviewed to understand how legal frameworks might support or hinder EV adoption.
iv. Social and Cultural Acceptance: Literature on consumer attitudes, public awareness of EVs, and behavioral willingness to adopt new vehicle technologies was synthesized to understand the societal readiness for EV adoption. Cultural aspects such as preference for petrol/diesel vehicles and skepticism toward new technology were also considered.

4.0 Synthesis of Finding

4.1 Infrastructure Issues

One of the primary barriers to EV adoption in Malaysia is the lack of adequate charging infrastructure. As of 2023, the country has approximately 1,000 charging stations, which is insufficient to meet the needs of a growing EV population (Tan, 2023). The uneven distribution of charging points, particularly in rural areas, further complicates the situation. Studies suggest that for EV adoption to be viable, Malaysia would need to increase its charging infrastructure by at least 300% within the next five years to meet projected demand (Ahmad & Tan, 2022). The current electricity grid in Malaysia is not fully equipped to handle the potential surge in demand caused by widespread EV adoption. According to the Energy Commission of Malaysia (Suruhanjaya Tenaga, 2022), the charging of EVs, particularly during peak hours, could lead to increased pressure on the grid, necessitating upgrades to existing infrastructure. The integration of smart grid technologies, which allow for better management of electricity distribution and demand response, is essential to accommodate the expected growth in electric mobility. However, the implementation of such technologies requires time, investment, and coordinated efforts among stakeholders. This geographic disparity creates a fear of range anxiety among potential EV users, as they may be hesitant to drive long distances without accessible charging points.

Additionally, the types of charging stations available are limited. The majority of existing stations offer only standard charging, which can take several hours to fully charge a vehicle. Fast-charging stations, which can recharge a vehicle in under an hour, are still relatively few in number, further discouraging long-distance travel by EV (Khalid, 2022). Expanding the charging network to include more fast-charging options and ensuring widespread access is crucial for improving consumer confidence in EVs. In summary, the current infrastructure for electric vehicles in Malaysia faces multiple challenges, including insufficient charging stations, high installation costs, limitations in grid capacity, lack of public awareness, and inconsistencies in policy support. To overcome these barriers and foster a sustainable EV ecosystem, a coordinated approach involving government, private sector, and community stakeholders is essential. Addressing these challenges will not only enhance the feasibility of electric vehicles but also contribute to Malaysia's broader sustainability goals.

4.2 Cost Barriers

The high upfront cost of EVs remains a significant obstacle. While the Malaysian government provides incentives, the price of electric models is still higher than their internal combustion engine counterparts. A study by Lim et al. (2022) indicates that the average cost of an EV in Malaysia is about 20% higher than a similar gasoline vehicle, which deters potential buyers. The initial purchase price of EVs is often higher than ICE vehicles, primarily due to the high cost of battery technology. However, EVs tend to benefit from lower lifetime operating costs, with reduced expenses in fuel and maintenance. For instance, EV owners save significantly on fuel, as electricity is typically cheaper than gasoline, and there are fewer moving parts in EVs, which means lower maintenance expenses over time. According to studies, the total cost of ownership (TCO) for EVs can often be lower in the long run than for ICE vehicles, especially with government subsidies factored in (Ouyang et al., 2021; Palmer et al., 2018).Moreover, although operational costs are lower for EVs, the initial investment remains a critical factor in consumer decision-making.

4.2.1 Fuel Costs Comparison between Electric Vehicles (EVs) and Internal Combustion Engine (ICE) Vehicles

Fuel costs are a critical factor in the overall cost of ownership of a vehicle. When comparing electric vehicles (EVs) and internal combustion engine (ICE) vehicles in Malaysia, EVs are significantly more economical in terms of fueling due to the lower price of electricity compared to petrol. The following provides a detailed analysis of fuel costs for both types of vehicles, considering Malaysia's current rates for petrol and electricity.

Table 4.1 Cost Comparison Between Electric Vehicles (Evs) And Internal Combustion Engine Vehicles (ICE)

Aspect	Electric Vehicles (EVs)	Internal Combustion Engine(ICE) Vehicles
Fuel Type	Electricity (kWh)	RON95 Petrol
Fuel Cost per Unit	RM0.57 per kWh	RM2.05 per liter
Efficiency	~5.67 km/kWh	~14 km/liter
Cost per Kilometer	RM0.10	RM0.15
Monthly Fuel Cost (1,000 km)	RM100	RM150
Annual Fuel Cost (15,000 km)	RM1,500	RM2,250

(Source: https://www.carsome.my/news/item/cost-of-owning-ev-in-malaysia)

Electric vehicles (EVs) offer a 33% reduction in fuel costs compared to traditional Internal Combustion Engine (ICE) vehicles. This is largely attributed to the significant difference in the cost per unit of fuel used. For instance, EVs consume electricity at a cost of

approximately RM0.57 per kWh, whereas ICE vehicles rely on subsidized petrol at RM2.05 per liter (Ministry of Finance Malaysia, 2024; Carsome, 2024). Given the average energy consumption of 0.18 kWh per kilometer for EVs and 14 km per liter for ICE vehicles, the cost per kilometer for an EV is RM0.10, compared to RM0.15 for an ICE vehicle (Motorist Malaysia, 2024; Energy Commission Malaysia, 2024).

a) Electric Vehicles (EVs):

EVs are powered by electricity, which is typically cheaper than petrol. In Malaysia, the cost of electricity for EV charging is approximately RM0.60 per kilowatt-hour (kWh). For example, charging an EV like the GWM Ora Good Cat costs around RM10 for a full charge, which allows it to travel up to 400 kilometers, while an ICE vehicle would cost considerably more to cover the same distance (Carsome, 2023).

Therefore, a full charge would cost around RM12.00 (20 kWh × RM0.60), which allows the vehicle to cover 400 km. This equates to about RM0.03 per kilometer, a far more economical rate than petrol vehicles.

b) Internal Combustion Engine Vehicles (ICEs):

In comparison, ICE vehicles run on petrol, and the cost of refueling is higher. As of 2023, the price of RON95 petrol in Malaysia is approximately RM2.05 per liter. A typical ICE vehicle like the Toyota Corolla, which has a fuel efficiency of 7 liters per 100 kilometers, would cost around RM14.35 (7 liters × RM2.05) to travel 100 kilometers. This equates to approximately RM0.14 per kilometer, which is almost five times more expensive than running an EV.

c) Maintenance Costs and Roadtax

EVs are cheaper to maintain than ICE vehicles due to their simpler mechanics. EVs do not require regular oil changes, exhaust systems, or complex mechanical components, which ICE vehicles rely on. A comparison between the BMW iX (EV) and the BMW X5 (ICE) reveals that maintenance costs for the iX are more than 60% lower than for the X5 (Paul Tan's Automotive News, 2023). Moreover, although the battery in an EV is a significant initial expense, it generally offers a longer lifespan compared to ICE vehicle components, such as the transmission, exhaust, and fuel system, which may need frequent replacements. In Malaysia, road tax for EVs is calculated based on their kilowatt (kW) output, which is generally cheaper than the road tax for ICE vehicles, which is based on engine displacement (cc). Road tax for lower-powered EV models (below 80 kW) starts at RM20, making it considerably cheaper than for higher-powered ICE vehicles (Carsome, 2023).

Table 4.2: Maintenance Cost Comparison for Evs And Ices

Maintenance Aspect	EVs	ICE Vehicles
Oil Changes	Not required	RM400–RM600 annually
Brake System	Lower wear due to regenerative braking	Higher wear; frequent replacements
General Servicing	RM400–RM800 per year	RM800–RM1,500 per year

(source:www. https://www. https://energielite.com.my/price-guide-on-electric-vehicle-maintenance-in-malaysia-2024/)

EVs incur lower maintenance costs as recorded in the table 4.2 due to the absence of complex engine components like spark plugs, fuel pumps, and exhaust systems. Conversely, ICE vehicles require regular oil changes, fuel system maintenance, and engine servicing, leading to higher long-term expenses (Motorist Malaysia, 2024). In the Malaysian context, where vehicle maintenance is a significant consideration for long-term cost-effectiveness, EVs offer considerable maintenance savings. Over a 5-year ownership period, EVs save between RM3,000 to RM5,000 in maintenance costs compared to ICE vehicles. This financial benefit, combined with the fuel cost savings previously discussed, makes EVs a compelling option for consumers, particularly those with high annual mileage

4.3 Policy and Regulatory Framework

Applying Rogers' Diffusion of Innovation theory, infrastructure gaps reduce the 'relative advantage' and 'compatibility' of EVs, which hinders widespread diffusion. Similarly, behavioral economics highlights the role of present bias and risk aversion in delaying adoption despite long-term cost benefits.

While the Malaysian government has made strides in promoting EV adoption through policies and incentives, inconsistencies and gaps in the regulatory framework can hinder progress. For example, while certain states offer tax exemptions and rebates for EV purchases, these incentives may not be uniformly available across the country, leading to disparities in adoption rates (Lim et al., 2022). Additionally, unclear regulations regarding the installation of charging stations and the roles of various stakeholders can create barriers for businesses looking to invest in EV infrastructure.

4.4 Future Predictions for Electric Vehicles in Malaysia

4.4.1 Market Trends

In 2021, Malaysia's electric vehicle market began to show signs of significant growth despite challenges posed by the COVID-19 pandemic. The government's announcement of the National Automotive Policy (NAP) 2020, which included incentives for EV manufacturing and ownership, laid the groundwork for this growth. According to MARii, the total number of EVs registered in Malaysia reached approximately 5,000 units by the end of 2021, reflecting a notable increase from previous years (MARii, 2022). The market was driven primarily by electric scooters and passenger vehicles, with models like the Nissan Leaf and BMW i3 gaining traction among early adopters. The Malaysian Automotive Association (MAA) reported a 40% increase in EV registrations in 2021 compared to 2020, highlighting a shift in consumer preferences towards cleaner mobility options. However, infrastructure remained a significant barrier, with only about 500 charging stations operational across the country, primarily concentrated in urban areas (MAA, 2021).

By 2022, the momentum for electric vehicles in Malaysia continued to build. The total number of EVs on the road surged to approximately 8,000 units, representing a year-on-year growth rate of 60% (MARii, 2023). This growth was bolstered by the introduction of new models from both local and international manufacturers, including the first locally assembled EVs by companies such as Perodua and Proton, which lowered the cost barrier for consumers. Government initiatives played a crucial role in promoting EV adoption. The introduction of a new tax exemption policy for EVs under the 2022 Budget aimed to further reduce the cost of ownership, resulting in a significant increase in consumer interest. Additionally, the government announced plans to expand the charging network, targeting 1,000 charging stations by the end of 2022. By mid-2022, the number of charging points had reached approximately 800, reflecting proactive efforts to address infrastructure concerns (Tan, 2023).

Public awareness campaigns, coupled with the global shift towards sustainability, contributed to the increased acceptance of electric vehicles. A survey conducted by the Malaysian Institute of Road Safety Research (MIROS) found that awareness of EV benefits rose to 45% in 2022, indicating a growing interest among consumers (MIROS, 2022). As of 2023, the electric vehicle market in Malaysia experienced an unprecedented leap, with total registrations surpassing 12,000 units, marking a 50% increase from 2022 (MARii, 2023). This growth can be attributed to several factors, including the ongoing expansion of EV model offerings, with manufacturers launching more affordable options and diverse vehicle types, including SUVs and commercial vehicles. The Malaysian government has set ambitious targets, with aims to achieve 100,000 EVs on the road by 2030 and a charging infrastructure of 4,000 stations by the same year.

By mid-2023, the charging network had expanded to approximately 1,000 operational charging stations nationwide, a significant step towards meeting the growing demand (Khalid, 2022). Furthermore, the global supply chain disruptions following the pandemic have heightened the focus on localizing EV component production. In response, several automotive firms are investing in local battery production facilities to ensure a stable supply of essential components. This local production aims to reduce costs and enhance Malaysia's position as a regional hub for EV manufacturing (Lee, 2023). Analysts predict that by 2025, EV sales could reach approximately 50,000 units per year, driven by favorable policies, technological advancements, and heightened public awareness of environmental issues. The market share of EVs in Malaysia's overall vehicle sales could rise to 15% by 2030 if current trends persist (Automotive News Asia, 2023). This growth in the EV sector aligns with global trends, as many countries strive for ambitious emission reduction targets. Malaysia's commitment to achieving a carbon-neutral economy by 2050 further supports the integration of electric vehicles into its transportation framework (Yusoff et al., 2022).

4.4.2 Technological Advancements and Policy Recommendations

Future developments in battery technology, such as solid-state batteries and fast-charging solutions, will enhance the practicality of EVs. Innovations in autonomous driving technology could also play a significant role in attracting consumers to EVs (Kumar et al., 2023). Moreover, collaborations between local universities and industry partners are expected to foster research and development, further driving innovation in the EV sector (Lee, 2023).

To bolster the adoption of EVs, policymakers should focus on expanding charging infrastructure, offering further incentives to consumers, and launching public awareness campaigns to educate the public about the benefits of EVs. Collaborative efforts between the government, automotive industry, and private sector will be essential to creating a comprehensive strategy for EV adoption (Shah & Azman, 2023). Implementing smart charging solutions and integrating renewable energy sources into charging stations could also enhance the sustainability of the EV ecosystem.

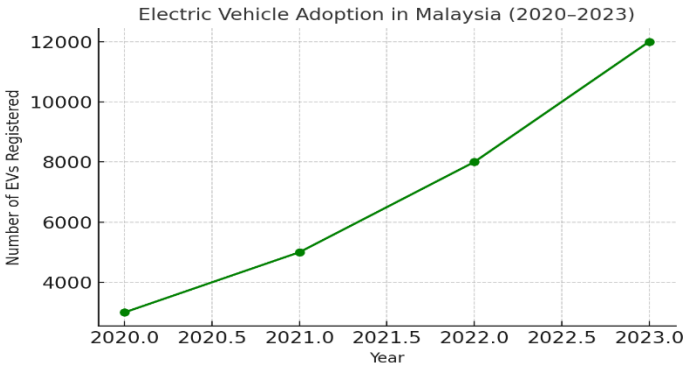

Figure 1: EV Adoption Trend in Malaysia

Figure 1 illustrates the upward trajectory of electric vehicle (EV) adoption in Malaysia, particularly from the year 2021 onwards. This increase can be attributed to a combination of supportive government policies, growing environmental awareness, and improved infrastructure. One of the most significant drivers of EV uptake has been the implementation of government incentives, such as the exemption of import and excise duties for fully electric vehicles, as introduced in Malaysia's Budget 2022 and extended under Budget 2023. The Malaysian EV adoption trend also mirrors the broader regional and global momentum in transitioning toward cleaner transportation. According to the International Energy Agency (IEA, 2023), global EV sales rose by over 55% in 2022, and Southeast Asian countries, including Malaysia, have begun to show similar progress. This surge in adoption is supported by the rapid expansion of the EV charging infrastructure within the country, driven by initiatives from private and public sectors, such as those undertaken by

Tenaga Nasional Berhad (TNB), Petronas through Gentari, and other stakeholders. Furthermore, the increasing availability of EV models, including affordable imports like BYD Atto 3 and Tesla Model 3, along with locally assembled units, has broadened consumer options and contributed to this growing trend. Consumer awareness of environmental issues and the long-term cost savings of EVs compared to internal combustion engine vehicles have also contributed to the rise in adoption (Lee & Othman, 2023). Taken together, these factors suggest that Malaysia is steadily progressing toward a more sustainable transport ecosystem, in alignment with both national goals and global climate commitments.

5.0 Conclusion

The feasibility of electric vehicles in Malaysia hinges on overcoming several challenges, including infrastructure limitations, cost barriers, and public perception. However, with the government's commitment to promoting EV adoption and the growing market potential, Malaysia is poised to become a significant player in the regional EV landscape. By addressing the identified challenges and implementing strategic recommendations, Malaysia can pave the way for a sustainable transportation future. The government and private sectors should fund research programs focused on advanced EV battery technologies. Establishing incentives for local universities and tech companies to develop cost-effective, environmentally friendly battery solutions could drive Malaysia's competitiveness in the Southeast Asian EV market. National campaigns to educate the public on the benefits of EVs, such as lower lifetime costs and environmental impact, would support more informed decision-making. Partnering with media outlets and community organizations could help spread awareness, especially in urban areas where emissions reductions are most needed. Schools and universities can also integrate EV and renewable energy topics into curricula to foster knowledge from a young age.

Limitations:

This study is subject to several limitations that should be acknowledged. Firstly, the analysis primarily relies on secondary data from published reports, journal articles, and government sources. While this provides a broad understanding of electric vehicle (EV) feasibility in Malaysia, the absence of primary data, such as surveys or interviews with stakeholders and consumers, limits the ability to capture context-specific insights, especially regarding rural adoption challenges. Furthermore, the study adopts a qualitative synthesis approach without empirical validation, which may constrain the generalizability of the findings. These limitations suggest the need for future research that incorporates mixed-method approaches to validate key findings and capture evolving public perceptions.

Recommendations:

To support the widespread adoption of electric vehicles in Malaysia, several strategic recommendations are proposed. In the short term, the government should prioritize expanding the national charging infrastructure, especially in underserved rural areas, while also standardizing EV-related policies across different states. Public awareness campaigns should be intensified to educate consumers about the long-term cost savings and environmental benefits of EVs. In the long term, greater investment is needed in local research and development (R&D) for battery technology and EV manufacturing capabilities to reduce dependence on imports and lower production costs. Public-private partnerships should be encouraged to co-develop innovative financing models and smart charging technologies. These recommendations, tailored for both public institutions and private industry, are vital for establishing a resilient and inclusive EV ecosystem in Malaysia.

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