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Impact of Government Incentives on Electric Vehicle Adoption in Malaysia: A Forecasting Approach Using Govt Car Registration Data

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ABSTRACT – *Electric vehicles (EVs) play a crucial role in combating climate change and reducing reliance on fossil fuels. However, Malaysia has struggled to accelerate EV adoption due to limited infrastructure and high initial costs. To address this, the Malaysian government introduced targeted incentives in 2022 to encourage EV uptake. This study evaluates the immediate and long-term effects of these incentives using an Interrupted Time Series (ITS) model and Ordinary Least Squares (OLS) regression, analyzing vehicle registration data from 2019 to 2024. Over time, the incentives drove a sustained annual increase in EV registrations, demonstrating their long-term effectiveness. Consumer preferences shifted notably toward EVs, with brands like Tesla and BYD gaining significant market penetration, while hybrid petrol vehicles continued to grow steadily. By comparing these results with global trends, the study emphasizes the importance of robust policy frameworks, infrastructure investment, and consumer-focused incentives in sustaining EV adoption. The research concludes that the Malaysian government's incentives successfully promoted EV adoption, but addressing infrastructure gaps and enhancing policy measures remain crucial for achieving the country's sustainable mobility objectives.*

KEYWORDS: Electric vehicle, government incentives, interrupted time series, ordinary least squares regression, sustainable transportation Malaysia

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1. INTRODUCTION

The global transition toward electric vehicles (EVs) is gaining momentum, driven by the urgent need to address climate change, promote sustainability, and leverage technological advancements. According to the International Energy Agency, EVs are projected to constitute half of all global car sales by 2035, with the number of EVs expected to grow from 2.4 million units in 2020 to approximately 81 million by 2050 (Thorat et al., 2024). Europe and China are at the forefront of this shift, supported by comprehensive policies, robust infrastructure, and continuous technological innovation (Sathiyan et al., 2022). In Southeast Asia, Malaysia is increasingly positioning itself within this evolving landscape, though it remains in the earlier stages of development.

Malaysia's EV market is pivotal in advancing environmental sustainability and supporting both national and global decarbonization objectives. Figure 1 outlines the timeline of key policies and initiatives implemented between 2020 and 2024 to promote EV adoption. Among these efforts are the National Automotive Policy (NAP) 2014 and the National Energy Policy (NEP) 2022–2040, which collectively aim to achieve net-zero carbon emissions by 2050 (Songkin & Jaafar, 2023). These frameworks prioritize the promotion of energy-efficient vehicles (EEVs) and set a target of 100% EEV adoption by

2030, reinforcing Malaysia's ambition to become a regional leader in sustainable transportation (KASA, 2021).

Building upon earlier initiatives, the Malaysian government has set ambitious targets through the Low Carbon Mobility Blueprint (LCMB) and the National Energy Transition Roadmap (NETR). Key objectives include the installation of 10,000 public charging stations by 2025, achieving 15% of total industry volume (TIV) from electric vehicle (EV) sales by 2030, and increasing this share to 80% by 2050. To support these goals, a range of incentives has been introduced, such as tax exemptions for imported and locally assembled EVs, road tax waivers through December 2025, and substantial investments in charging infrastructure (KASA, 2021; Ministry of Economy Malaysia, n.d.).

The rollout of these incentives in January 2022 represents a pivotal effort to accelerate EV adoption by addressing critical barriers, particularly high initial costs and inadequate infrastructure. Nevertheless, the actual impact of these measures on consumer behavior and the growth of EV registrations remains insufficiently examined. Additionally, this study emphasizes Malaysia's EV infrastructure development. Initiatives aimed at expanding charging networks, incorporating renewable energy, and leveraging artificial intelligence (AI) for smart charging systems demonstrate the government's commitment to addressing technological and logistical challenges (Shern et al., 2024). Despite these advances, challenges such as the uneven distribution of charging stations and low public awareness continue to hinder widespread adoption (Umair et al., 2024).

Malaysia's initiatives are consistent with its commitments under the Paris Agreement and the Sustainable Development Goals (SDGs), reinforcing the country's efforts to reduce greenhouse gas emissions, improve air quality, and promote public health. Although the growing adoption of electric vehicles (EVs) demonstrates their potential to enhance quality of life, challenges such as economic barriers, public acceptance, and technological limitations must be addressed to ensure sustainable market expansion (Shetty et al., 2020; Ogunkunbi et al., 2022; Asadi et al., 2022). To the best of the authors' knowledge, this study represents the first comprehensive analysis of EV registration trends in Malaysia utilizing official government vehicle registration data. By evaluating the impact of incentives, examining consumer preferences, and offering policy recommendations, this research provides critical insights into Malaysia's evolving EV sector. The findings aim to support stakeholders in overcoming adoption challenges and to contribute to the nation's transition toward low-carbon mobility in line with global developments.

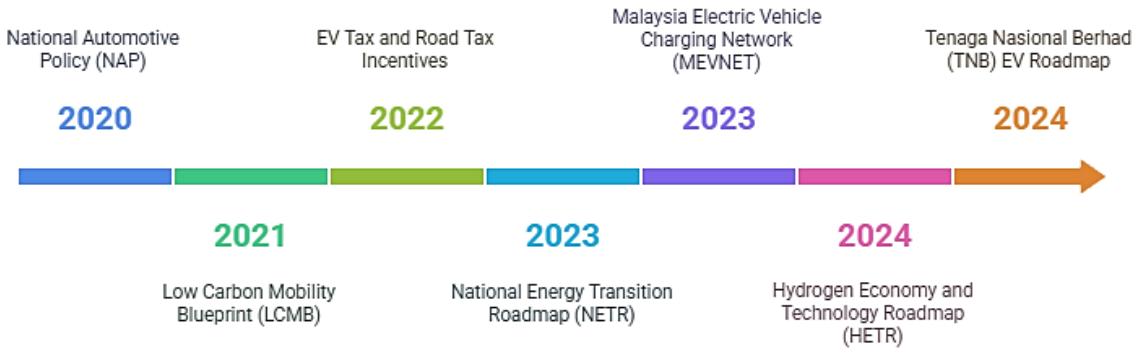

FIGURE 1: Timeline of key policies and initiatives driving EV adoption in Malaysia (2020–2024)

2. METHODOLOGY

2.1 Research Design

This study employed a quantitative research design, utilizing car registration data to analyze the effects of government incentives on EV adoption. The research methodology is illustrated in Figure 2, highlighting the detailed procedure of the study, including the problem statement, research design, data sources, and analytical framework.

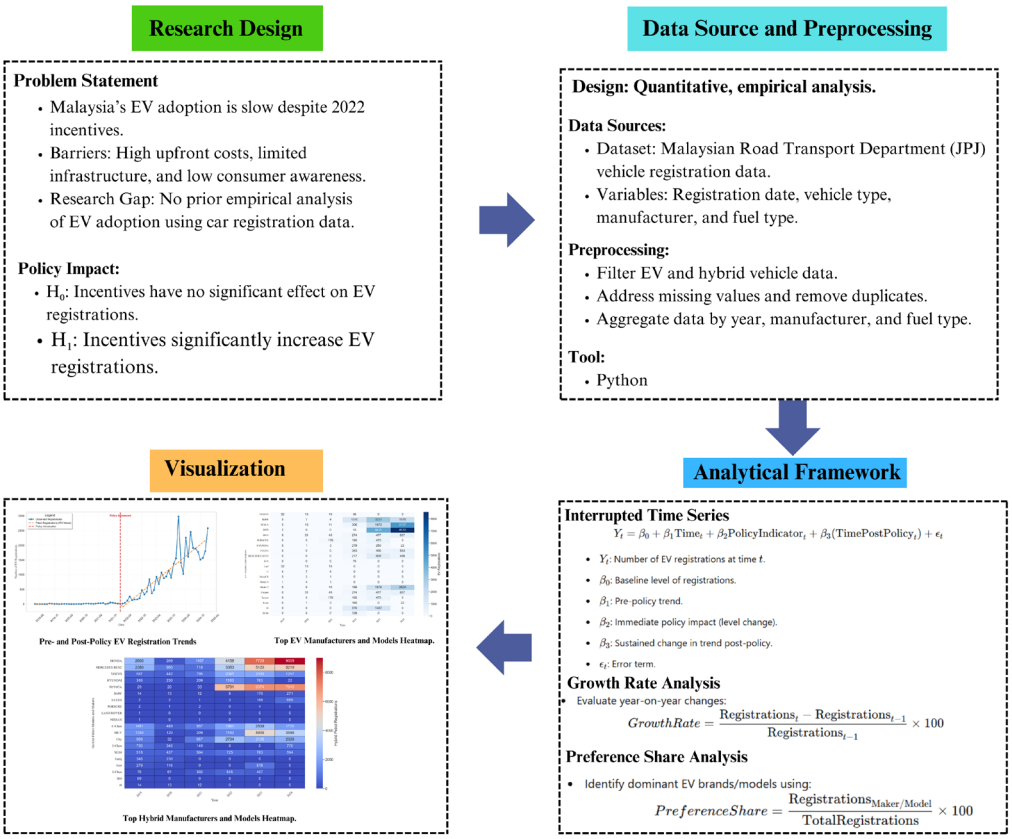

FIGURE 2: Research methodology framework

Unlike sales data, which captures only immediate purchasing activity, registration data provides a comprehensive view of vehicles actively registered for road use, making it a more reliable indicator of long-term market penetration. This study analyses key trends, including shifts in consumer preferences between electric vehicles (EVs) and hybrid petrol vehicles, the dominance of specific manufacturers and models, and registration patterns before and after the 2022 policy intervention. This approach enables a robust evaluation of the policy's impact over time. The analysis is based on a detailed, transaction-level vehicle registration dataset obtained from the Malaysian Road Transport Department (JPJ) via data.gov.my. Each entry in the dataset corresponds to an individual vehicle registration, making it the most detailed source available for this type of analysis in Malaysia. In accordance with national law, all vehicles intended for road use must be registered with JPJ and assigned a registration plate (Malaysian Government, n.d.). The dataset excludes sales and import records, focusing exclusively on registered vehicles, thereby providing a highly relevant basis for assessing trends, consumer behaviour, and policy effects. A detailed description of the dataset is presented in Table 2.

State-level data were excluded from the analysis due to the presence of registrations labeled as "Rakan Niaga", which referred to vehicles registered through partner portals rather than specific geographic locations. As a result, the dataset could not reliably support state-level analyses, prompting the study to focus on national-level trends to preserve analytical validity and reliability.

Several preprocessing steps were conducted to ensure the dataset's quality and appropriateness for analysis. Minor missing values were addressed through mean imputation, while variables with substantial missingness were removed to maintain the dataset's integrity. The dataset was then filtered to include only electric vehicles (EVs) and hybrid petrol vehicles by retaining records with fuel types classified as 'electric' or 'hybrid_petrol,' aligning the data with the study's research objectives.

Duplicate records were identified and eliminated to prevent duplication bias, ensuring that each vehicle registration was uniquely represented. Subsequently, the data were organized by year, manufacturer, and fuel type, facilitating the calculation of total registrations and enabling the analysis of trends and

growth patterns across these key dimensions. These preprocessing procedures resulted in a clean, consistent dataset suitable for rigorous statistical analysis.

TABLE 2: Description of variables in the govt car registration dataset

Variable Name	Type	Description	Examples	Description
date_reg	Date	The date of registration in YYYY-MM-DD format, representing when the vehicle was officially registered for road use.	2022-03-15	Used to analyze registration trends over time (e.g., pre- and post-policy comparisons).
type	Categorical	The type of vehicle, categorized into five classes: motorcars, MPVs, jeeps, pick-up trucks, and window vans.	motocar, pick_up	Included in the analysis to examine trends across different vehicle categories.
maker	String	The manufacturer of the vehicle.	Proton, Toyota, Honda	Used to identify dominant car makers in the EV and hybrid markets.
model	String	The specific model of the vehicle.	Saga, Bezza, City	Analyzed to determine the top 10 most-registered models.
color	String	The color of the vehicle is broadly categorized. Shades of the same color are grouped together (e.g., light blue and dark blue are both "blue").	blue, black, white	Excluded from this research as it is not relevant to the research questions.
fuel	String	This type of fuel is used by the vehicle's engine. Categories include petrol, diesel, natural gas (NG), liquefied natural gas (LNG), hydrogen, electricity, and hybrid combinations.	electric, hybrid_petrol	Central to the research for categorizing and comparing EVs and Hybrid Petrol vehicles.
state	String	The state of registration, indicating where the vehicle was registered or the partner portal ('Rakan Niaga') used. This does not correlate directly with the actual state where the car is operated or purchased.	Selangor, Penang, Rakan Niaga	Excluded from the analysis because the inclusion of 'Rakan Niaga' registrations renders the dataset unreliable in accurately representing the state of vehicle registrations.

2.2 Equations and Mathematics

2.2.1 ITS Analysis

ITS analysis is a quasi-experimental method commonly used to evaluate the impact of policy interventions over time (Bernal et al., 2020). By analyzing trends both before and after a policy is implemented, ITS allows researchers to assess immediate and sustained changes in the dependent variable in this case, EV registrations. This method is particularly suitable for this research because it captures both the short-term and long-term effects of the 2022 government incentives on EV adoption.

Model Specification:

$$Y_t = \beta_0 + \beta_1 \times time_t + \beta_2 \times post - policy_t + \beta_3 \times (time_t \times post - policy_t) + \varepsilon_t \quad (1)$$

Where:

Y_t: Number of EV registrations at time t.
$time_t$: Continuous time variable representing each year (2019–2024).
$post - policy_t$: Dummy variable (0 for pre-policy years [2019–2021], 1 for post-policy years [2022–2024]).
β_2: Immediate policy effect (level shift).
β_3: Sustained trends shift post-policy.
ε_t: Error term, assumed to be normally distributed with mean zero and constant variance.

2.2.2 OLS Regression

To estimate the parameters of the model, OLS regression was employed. This approach was chosen for its robustness in quantifying relationships between predictors and the outcome variable, as well as its interpretability in assessing the contribution of individual predictors (Sanders & Brynin, 1998).

The regression model is defined as follows:

$$y = X\beta + \epsilon \tag{2}$$

Where:

y: The outcome variable, representing monthly registrations of electric vehicles.
X: The design matrix containing the predictors (independent variables).
β: The vector of estimated coefficients.
ϵ: The error term, representing unexplained variation in y.

The model's explanatory power was evaluated using R^2. Higher values of R^2 indicates better model fit.

2.2.3 Growth Rate Analysis

Growth rate analysis measures the relative change in EV and Hybrid Petrol vehicle registrations over time (Griliches, 1987). It helps assess whether the 2022 incentives led to a significant acceleration in EV adoption.

The formula for growth rate is:

$$\text{Growth Rate}_t = \frac{\text{Registrations}_t - \text{Registrations}_{t-1}}{\text{Registrations}_{t-1}} \times 100 \tag{3}$$

Where:

Registrations_t: Total registrations for EVs or Hybrid Petrol vehicles in year t.
$\text{Registrations}_{t-1}$: Total registrations in the previous year.

This method helps detect shifts in consumer behaviour and provides insights into market dynamics post-policy.

2.2.4 Preference Share Analysis

Preference share analysis evaluates the proportion of registrations attributable to specific car makers and models (Keller & Kotler, 2016). It identifies market leaders and highlights shifts in consumer preferences, addressing the second research question.

The formula is:

$$\text{Preference Share}_{i,m,t} = \frac{\text{Registrations}_{i,m,t}}{\text{Total Registrations}_t} \times 100 \tag{4}$$

Where:

$\text{Registrations}_{i,m,t}$: Number of registrations for car maker i and model m in year t.
$\text{Total Registrations}_t$: Total registrations (EVs and Hybrid Petrol vehicles) in year t.

3. RESULTS AND DISCUSSION

The ITS plot, presented in Figure 3, visually supported these findings. The plot displayed actual EV registrations (blue line) and model-fitted registrations (orange dashed line), with the red dashed vertical line marking the policy intervention. The plot revealed that EV registrations remained relatively stable with minor fluctuations before 2022.

Following the implementation of the 2022 policy, a marked increase in EV registrations was observed, confirming that the policy substantially enhanced EV adoption in Malaysia. The close alignment between the observed and fitted values further reinforces the conclusion that the policy had a lasting and significant impact. This outcome is consistent with prior studies, which indicate that well-designed incentives can effectively stimulate market growth in the EV sector (Shetty et al., 2020; Toolib et al., 2023).

The results show that the 2022 government incentives successfully encouraged EV adoption, characterized by an initial short-term decline followed by sustained growth. These findings highlight the critical role of carefully structured policies in advancing cleaner transportation solutions. To further accelerate EV market expansion in Malaysia, policymakers are advised to broaden such incentives while simultaneously addressing challenges related to infrastructure development and public awareness (Zawawi et al., 2022; Naseri et al., 2023; Wiratmoko et al., 2023).

The OLS regression analysis, presented in Table 3, provides several important insights. The constant term (β_0 = -2.4279) was not statistically significant (p = 0.978), suggesting the absence of a significant baseline level of EV registrations prior to the policy intervention. This indicates that, before the introduction of incentives, the Malaysian EV market remained relatively stagnant, without any clear upward or downward trend. This finding aligns with previous research highlighting that the EV market in Malaysia faced significant barriers to growth, including high costs and limited infrastructure (Zawawi et al., 2022; Wiratmoko et al., 2023).

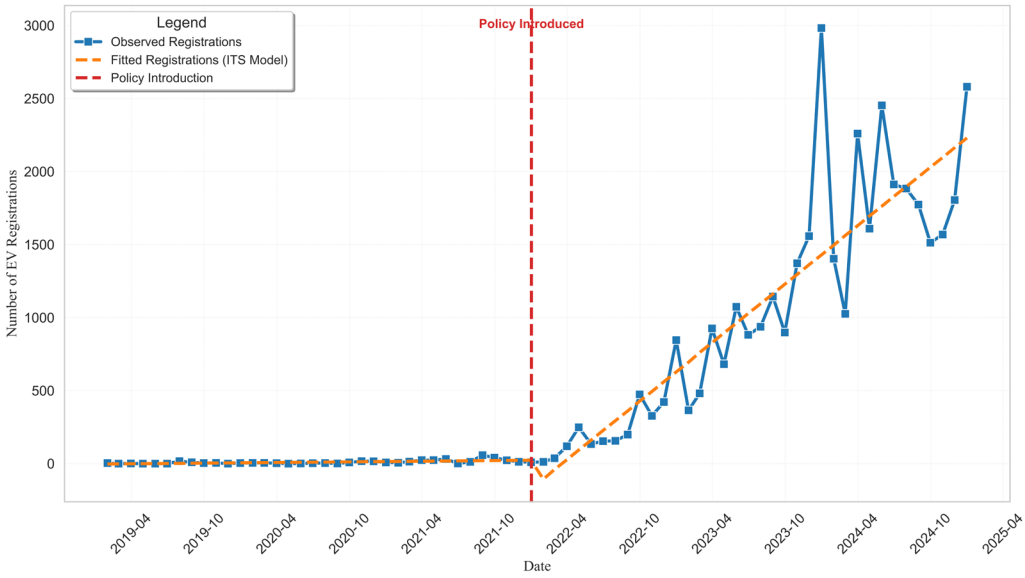

FIGURE 3: Trends in EV registrations in Malaysia (2019–2024)

The model fit statistics suggest that the regression model is robust. The R^2 value of 0.880 indicates that the model explains 88% of the variance in EV registrations, demonstrating strong explanatory power. The F-statistic of 165.6 ($p < 0.001$) confirms that the model is statistically significant, meaning that the explanatory variables significantly contribute to the variation in EV registrations. This level of explanatory power is consistent with findings in the literature that highlight the importance of government incentives and infrastructure in driving EV adoption (Hansaram et al., 2024).

TABLE 3: OLS regression results summary

Variable	Coefficient (β)	Standard Error	t-value	p-value	95% Confidence Interval
Constant	-2.4279	89.356	-0.027	0.978	[-180.736, 175.880]
Time	0.7292	4.391	0.166	0.869	[-8.032, 9.491]
Policy Indicator	-2508.1564	255.431	-9.819	<0.001	[-3017.861, -1998.451]
Time Post-Policy	66.0413	6.209	10.636	<0.001	[53.651, 78.432]

The coefficient for the time variable (β1 = 0.7292) was also not statistically significant (p = 0.869), further supporting the notion that there was no significant overall trend in EV registrations before the policy. This result is crucial because it implies that any changes in EV registrations following the policy cannot be attributed to pre-existing trends but rather to the direct effects of the policy intervention. This observation is consistent with findings from Mustapa et al., who noted that the lack of consumer awareness and infrastructure has hindered EV adoption in Malaysia.

The policy indicator variable (β2 = -2508.1564) was found to be highly significant (p < 0.001), indicating a sharp immediate negative impact on EV registrations following the policy intervention. This initial drop in registrations may be attributed to an adjustment period where consumers and industry stakeholders were still adapting to the new policy environment. The findings suggest that the introduction of the incentives may have initially caused market uncertainty, which temporarily reduced EV registrations. This phenomenon has been observed in other contexts, where policy changes can lead to short-term disruptions in market behaviour (Ogunkunbi et al., 2022).

Conversely, the coefficient for the time post-policy variable (β3 = 66.0413) was highly significant (p < 0.001), indicating a sustained positive effect on EV registrations after the policy was fully implemented. Specifically, the model suggests an average annual increase of 66 EV registrations per year post-policy. This sustained increase implies that while the policy initially caused a dip in registrations, it ultimately stimulated long-term growth in EV adoption, confirming the policy's effectiveness in the Malaysian context. This aligns with the conclusions drawn by Zawawi et al., who emphasized the importance of government incentives in promoting EV adoption (Naseri et al., 2023).

The coefficients provide strong support for the alternative hypothesis (H_1), which posits that the 2022 policy significantly impacted EV registrations. The initial negative effect of the policy, followed by a sustained growth trend, is consistent with the expected effects of such incentives. The findings underscore the importance of carefully designed government interventions in fostering sustainable transportation solutions.

4. CONCLUSION

This study has demonstrated that the 2022 Malaysian government incentives significantly impacted the EV market, causing an initial dip in registrations followed by sustained growth. The findings emphasize the importance of government interventions in promoting sustainable transportation. However, the hybrid petrol market continues to maintain a steady presence, reflecting the need for a more gradual transition towards fully electric vehicles. The insights from global best practices provide actionable recommendations for policymakers in Malaysia, particularly in terms of integrating subsidies with infrastructure development and addressing consumer concerns about EV adoption. Ultimately, a comprehensive and well-coordinated policy framework will be essential in achieving Malaysia's long-term EV adoption goals and contributing to global sustainability efforts.

REFERENCES

Asadi, S., Nilashi, M., Iranmanesh, M., Ghobakhloo, M., Samad, S., Alghamdi, A., Almulihi, A., & Mohd, S. (2022). Drivers and barriers of electric vehicle usage in Malaysia: A DEMATEL approach. Resources, Conservation & Recycling, 177, 105965.

Bernal, J. L., Cummins, S., & Gasparrini, A. (2020). Corrigendum to: Interrupted time series regression for the evaluation of public health interventions: A tutorial. Intl. Journal of Epidemiology, 50(3), 1045.

Griliches, Z. (1987). R&D and productivity: Measurement issues and econometric results. Science, 237(4810), 31–35.

Hansaram, R. K., Nik Abdul Rahim, N. A., & Loy, C. K. (2024). Determining Generation Y intention to purchase electric vehicles (EVs) in Klang Valley, Malaysia. International Journal of Academic Research in Business and Social Sciences, 14(4), 681–703.

KASA (2021). Low carbon mobility blueprint 2021–2030: Decarbonizing land transportation. Ministry of Environment and Water, Putrajaya, Malaysia.

Keller, K. L., & Kotler, P. (2016). Marketing management. Pearson Education.

Malaysian Government. (n.d.). Vehicle registrations. data.gov.my. https://data.gov.my

Ministry of Economy Malaysia. (n.d.). Energy transition roadmap. Retrieved from https://energytransitioninfo.com/malaysia-energy-transition-roadmap/

Naseri, R. N. N., Raja Abdullah, R. N., Mohd Esa, M., Amir Hamzah, A. S. M., & Azis, S. N. (2023). Factors influencing purchase intention on electric vehicle: A conceptual framework. International Journal of Academic Research in Business and Social Sciences, 13(11), 7936–7943.

Ogunkunbi, G. A., Al-Zibaree, H. K. Y., & Mészáros, F. (2022). Modeling and evaluation of market incentives for battery electric vehicles. Sustainability, 14(7), 4234.

Sanders, D., & Brynin, M. (1998). Ordinary least squares and logistic regression analysis. Sage Publications.

Sathiyan, S. P., Pratap, C. B., Stonier, A. A., Peter, G., Sherine, A., Praghash, K., & Ganji, V. (2022). Comprehensive assessment of electric vehicle development, deployment, and policy initiatives to reduce GHG emissions: Opportunities and challenges. IEEE Access, 10, 53614–53639.

Shern, S. J., Sarker, M. T., Ramasamy, G., Thiagarajah, S. P., Al Farid, F., & Suganthi, S. T. (2024). Artificial intelligence-based electric vehicle smart charging system in Malaysia. World Electric Vehicle Journal, 15(10), 440.

Shetty, D. K., Shetty, S., Rodrigues, L. R., Naik, N., Maddodi, C. B., Malarout, N., & Sooriyaperakasam, N. (2020). Barriers to widespread adoption of plug-in electric vehicles in emerging Asian markets: An analysis of consumer behavioral attitudes and perceptions. Cogent Engineering, 7(1), 1796198.

Songkin, M., & Jaafar, M. Y. (2023). Electric vehicle readiness in Sabah: Overview of market forecast and adoption challenges. In Proceedings of the 2023 6th International Conference on Energy Conservation and Efficiency (ICECE) (pp. 1–6). IEEE.

Thorat, J., Kumar, D., & Sandhu, J. (2024). Powering sustainable mobility: Electric and hybrid vehicles leading the way (SAE Technical Paper No. 2024-28-0137). SAE International.

Toolib, S. N., Hanafi, W. N. W., Daud, S., & Afsarizal, H. A. (2023). Factors influencing electric vehicle adoption: A conceptual paper. European Proceedings of Finance and Economics.

Umair, M., Hidayat, N. M., Nik Ali, N. H., M Nasir, N. S., Hakomori, T., & Abdullah, E. (2024). A review of Malaysia's current state and future in electric vehicles. Journal of Sustainable Development of Energy, Water and Environment Systems, 12, 1–35.

Wiratmoko, A., Apriyanto, H., Tamtomo, T. D., Alkadri, N., Suripto, N., Soewargono, B. D., Dwiananto, Y. I., & Suhendra, A. (2023). Policy analysis of electric vehicle infrastructure supporting sustainable energy use. IOP Conference Series: Earth and Environmental Science, 1267, 012036.

Zawawi, N. F. M., Yaacob, M. R., Wahab, S. A., Awang, K. W., Ahmed, S. F., & Nuh, R. (2022). Green vehicles, incentives and policies: A view from logistics companies in Malaysia. IOP Conference Series: Materials Science and Engineering, 1244, 012013.