Measuring the Effectiveness of Subsidy Policies in Increasing Electric Vehicle Sales in Indonesia: A Study Based on Sales Data of All Brands and Statistical Methods

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Abstract

Indonesia's commitment to achieving net zero emissions by 2060 is marked by the issuance of Presidential Regulation No. 55/2019, updated by Presidential Regulation No. 79/2023, concerning the acceleration of the battery electric vehicle (BEV) program for road transportation. This policy includes incentives such as a 10 percent Value-Added Tax (VAT) exemption starting on April 1, 2023, for electric vehicles meeting a minimum Domestic Component Level (TKDN) requirement of 40 percent. Additionally, based on the Ministry of Home Affairs Regulation No. 1/2021, electric vehicles are subject to a tax of only 10 percent of the normal annual tax rate. This study uses sales data of all car brands in Indonesia from 2017 to April 2024 to analyze the impact of these policies. The statistical methods used include the Shapiro-Wilk normality test, the Mann-Whitney U test, and linear regression. The statistical analysis results indicate an increase in electric vehicle sales before and after the policy was implemented. Based on linear regression results, electric vehicle sales increased from 1,187 units per month before the policy to 1,877 units per month after the policy, representing an increase of 58.1 percent. Additionally, the number of electric vehicle models increased from 18 models in 2022 to 44 models in 2023 and 52 models in 2024. The conclusion of this study indicates that the electric vehicle subsidy policy has a significant impact on increasing electric vehicle sales, which is also reflected in the increased variety of electric vehicle models following the implementation of the policy.

Keywords: subsidies; electric cars; sales; environmental policies

1. Introduction

The current challenges of global climate change have prompted significant shifts towards sustainable practices and policies to mitigate its impacts (Firmansyah, 2023). Countries worldwide, including Indonesia, have committed to achieving net-zero emissions to combat climate change (Nur, 2022). In Indonesia, the government has taken steps to accelerate the adoption of electric vehicles (EVs) through regulations such as Presidential Regulation No. 79 of 2023, which aims to promote the use of battery-based vehicles (Pandyaswargo et al., 2021). This regulation signifies Indonesia's acknowledgment of the importance of transitioning to more environmentally friendly transportation options to reduce carbon emissions and combat climate change.

To support these efforts, through Minister of Industry Regulation No. 6 of 2023, the Indonesian government officially provides a 10 percent VAT tax subsidy for electric vehicles that pass the 40 percent Domestic Component Level (TKDN) requirement. This policy is expected to increase public interest in electric vehicles compared to conventional cars (Palmer et al., 2021). It is hoped that this subsidy policy can emulate the success achieved by China, where incentives have reduced initial investment burdens, provided social and environmental benefits, and aligned the interests of all stakeholders involved (Yang et al., 2019).

Analyzing the effectiveness of subsidy policies in increasing electric vehicle sales in Indonesia is crucial in evaluating the government's initiatives to promote sustainable transportation (Maghfiroh et al., 2021). Understanding the readiness status of electric vehicles in Indonesia and stakeholders' perceptions can provide valuable insights into the challenges and opportunities for electric vehicle adoption in this country (Maghfiroh et al., 2021).

2. Literature Review

2.1 Regulation

To support the acceleration of the development of battery-based electric motor vehicle industries in Indonesia, both the central and regional governments have issued various fiscal and non-fiscal policies and incentives. Incentives are provided to those who meet a minimum Domestic Component Level (Tingkat Komponen Dalam Negeri or TKDN) of 40 percent. Two of these are Presidential Regulation No. 55 of 2019 and No. 79 of 2023, which specifically state in Pasal 17 Ayat 2:

"The Central and Regional Governments provide incentives in the form of fiscal and non-fiscal incentives."

Legal Basis

This regulation provides a strong legal basis for the implementation of various incentives in other ministry regulations. Here are some regulations that implement incentives in accordance with the direction of the Presidential Regulation:

1. Electric Vehicle Subsidies
   Minister of Industry Regulation No. 6 of 2023
   - Regulation Content: Provides a 10 percent subsidy for the purchase of electric vehicles.

- Effective Date: April 1, 2023.
- Details: This subsidy is expected to encourage the adoption of electric vehicles by reducing the selling price to make them more affordable.

2. Electric Vehicle Tax
   Minister of Home Affairs Regulation Number 1 of 2021
   - Relevant Articles: Pasal 10 and 11.
   - Regulation Content: Electric cars are subject to a tax of 10 percent of the normal rate.
   - Details: This policy applies to both private and public vehicles. With lower taxes compared to conventional vehicles, it is expected to increase the attractiveness of electric vehicles.
3. Value Added Tax (VAT)
   Minister of Finance Regulation Number 8 of 2024
   - Regulation Content: The purchase of electric vehicles is only subject to a 1 percent VAT on the selling price.
   - Details: The reduction in VAT is a significant fiscal incentive to reduce the total ownership costs of electric vehicles, thus increasing public interest in switching to these environmentally friendly vehicles.

The implementation of these incentives is the government's effort to encourage the adoption of electric vehicles in Indonesia. Presidential Regulation No. 55 of 2019 and No. 79 of 2023, Pasal 17 Ayat 2, serve as a strong basis for various ministries to issue policies supporting the development of the electric vehicle industry. With these fiscal and non-fiscal incentives, Indonesia is expected to achieve its targets in terms of renewable energy use and carbon emission reduction.

2.2 Statistical Analysis

The Shapiro-Wilk normality test is a statistical method commonly used to assess whether a dataset follows a normal distribution. It is particularly recommended for small sample sizes and is considered one of the most powerful tests for normality (Ghasemi & Zahediasl, 2012 ; Pounds & Shesh, 2009). This test is crucial for ensuring that data meet the assumptions of various statistical analyses, such as the t-test, ANOVA, and regression analysis (Pounds & Shesh, 2009; Evans, 2023). In the context of statistical analysis, the Mann-Whitney U test, also known as the Wilcoxon rank-sum test, is a non-parametric test used to compare two independent groups when the assumption of normality is violated or when the data are ordinal or skewed (Şatır, 2024). This test is valuable for analyzing data that do not meet the requirements of parametric tests and can provide reliable results even with small sample sizes or non-normally distributed data.

Linear regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables. It aims to establish a linear equation that best predicts the value of the dependent variable based on the independent variables (Dimitrovski et al., 2019). Linear regression analysis is widely employed in various fields, including economics, social sciences, and healthcare, to understand and quantify the relationships between variables.

3. Material and Method

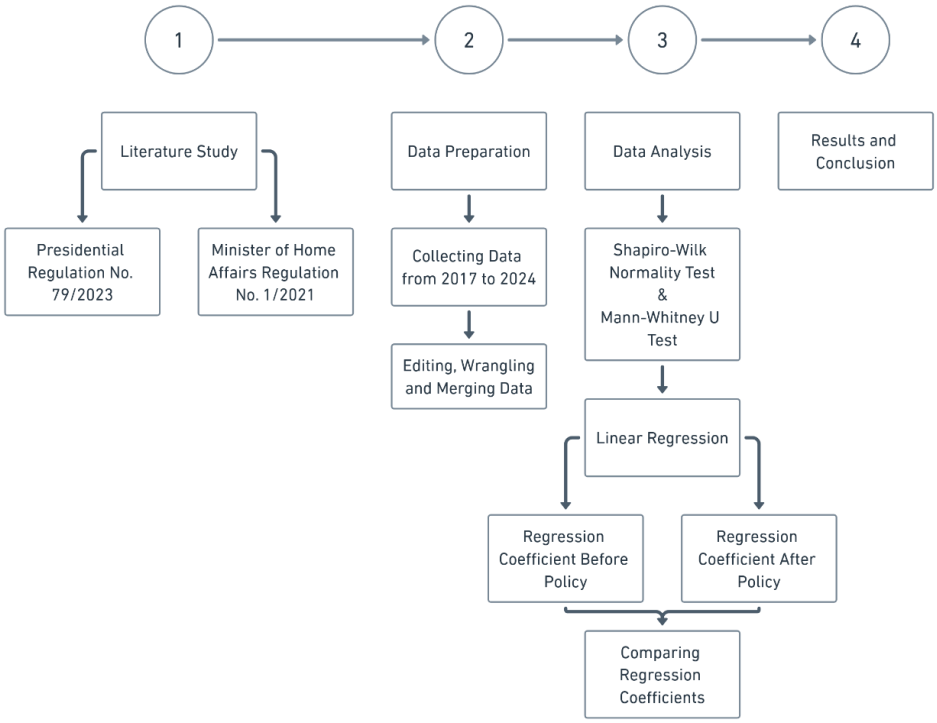

Figure 1. Methodology

3.1 Design Study

This study is a quantitative analysis focusing on the sales of electric vehicles from various brands in Indonesia. We conducted a literature review of several regulations, such as Presidential Regulation No. 79 of 2023, Ministry of Industry Regulation No. 6 of 2023, and other relevant regulations that serve as guidelines for electric vehicle subsidies. Electric vehicle sales data were collected from January 2017 to April 2024. Analysis was performed using various statistical testing methods to interpret the data. The results of this analysis were then used to draw conclusions that describe the trends and impacts of regulations on electric vehicle sales in Indonesia.

3.2 Data Analysis

We used the Python programming language as the primary tool for data science in the context of electric vehicle sales in Indonesia, involving the processing of large datasets. Python was chosen due to its extensive capabilities in data analysis and visualization. To manage and analyze the data, we used the Pandas library, which allows efficient manipulation of data in DataFrame structures. Data visualization was performed using Matplotlib, which helps illustrate trends and patterns in sales data.

Data preparation included merging raw annual sales data from various sources to produce a comprehensive and consistent dataset. After collecting the data, we conducted various statistical analyses to gain deeper insights. The Shapiro-Wilk test was used to assess the normality of the data distribution, while Levene's test was used to assess the equality of variances. For comparative analysis, we applied the Mann-Whitney U test, which is suitable

for non-parametric data. Additionally, linear regression was used to analyze the relationships between specific variables within the dataset.

The interpretation of statistical results is crucial in this research, as it provides a strong foundation for drawing conclusions. By examining the outcomes of these various statistical tests, we can understand the impact of government regulations and subsidies on electric vehicle sales in Indonesia.

4. Result

4.1 Car Sales in Indonesia

Car sales in Indonesia, as shown in Figure 2, calculated from the sales data of all brands from January 2017 to April 2024, demonstrate significant numbers. Non-electric car sales nearly reached 7 million units, while electric car sales were much lower, only in the range of hundreds of thousands of units. This disparity underscores the government's rationale for implementing subsidies for electric cars. These subsidies aim to boost the sales trend of electric vehicles and support efforts to achieve the net zero emission target.

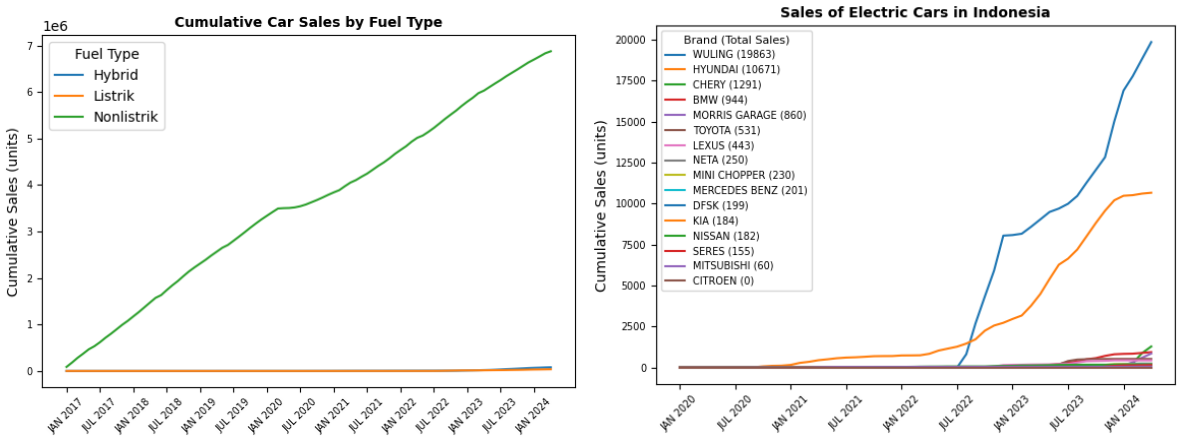

Figure 2. Cumulative car sales, all type of fuel (left), Electric type (right)

To analyze electric vehicle sales in Indonesia in more detail, we calculated cumulative sales as shown on the right side of Figure 2. This data shows that Wuling and Hyundai are the brands with the highest sales currently. Both brands receive electric vehicle subsidies because they have met the minimum 40 percent Domestic Component Level (TKDN) requirement. Hyundai began marketing its electric vehicles in 2020, while Wuling only launched its electric vehicles in 2022. As of April 2024, cumulative sales for Wuling and Hyundai reached 19,863 and 10,671 units, respectively. This data indicates a significant increase in sales in recent times.

4.2 Statistical Result

We conducted statistical analysis to assess whether there was a significant impact from the subsidy implemented on April 1, 2023. For this purpose, electric vehicle sales data were separated into two groups: before the subsidy and after the subsidy. Subsequently, we conducted the following statistical tests:

1. Shapiro-Wilk Normality Test: This test is used to assess whether data from both periods (before and after the subsidy) are normally distributed. The test results indicate that the data are not normally distributed.

2. Levene's Test for Homogeneity: This test is used to assess whether the two groups of data have the same variance. The test results indicate that the variances of the two groups are not the same.

Based on the results of the normality and homogeneity tests, the data distribution is more suitable for analysis using the Mann-Whitney U test rather than the t-test.

We hypothesized that there is a significant impact from the implemented subsidy policy. Therefore, we tested this hypothesis using the Mann-Whitney U test with a 95 percent confidence level. The Mann-Whitney U test results showed a p-value of 0.024, which is less than 0.05. This indicates that we reject the null hypothesis (H0), meaning there is a significant difference between sales before and after the subsidy.

Furthermore, the obtained U-statistic value was 40, which is smaller than its critical value. This provides strong evidence that there is a significant influence of the subsidy policy on electric vehicle sales in Indonesia.

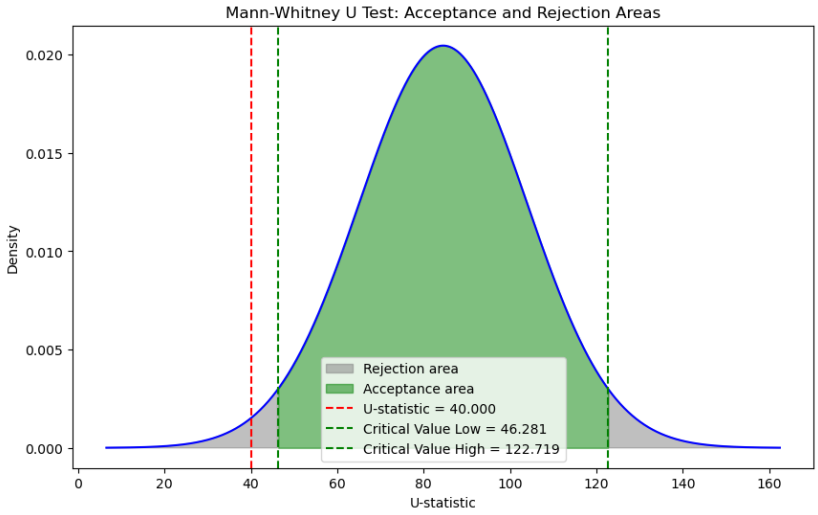

Figure 3. Mann-Whitney U Test

We used linear regression analysis to determine the extent to which electric vehicle sales increased after the subsidy policy was implemented on April 1, 2023. Sales data were separated into two periods: before and after the subsidy. The results of the linear regression analysis show that before the subsidy policy, electric vehicle sales increased by 1187 units per month, as indicated by the regression equation $y = 1187x - 2151$. After the subsidy policy was implemented, electric vehicle sales increased to 1878 units per month, with the regression equation $y = 1878x + 44$. This indicates an increase in sales of 691 units per month, or approximately 58.2 percent. The figure visually shows that sales trends increased after the subsidy was implemented, indicating that the subsidy policy has a significant positive impact on increasing electric vehicle sales in Indonesia.

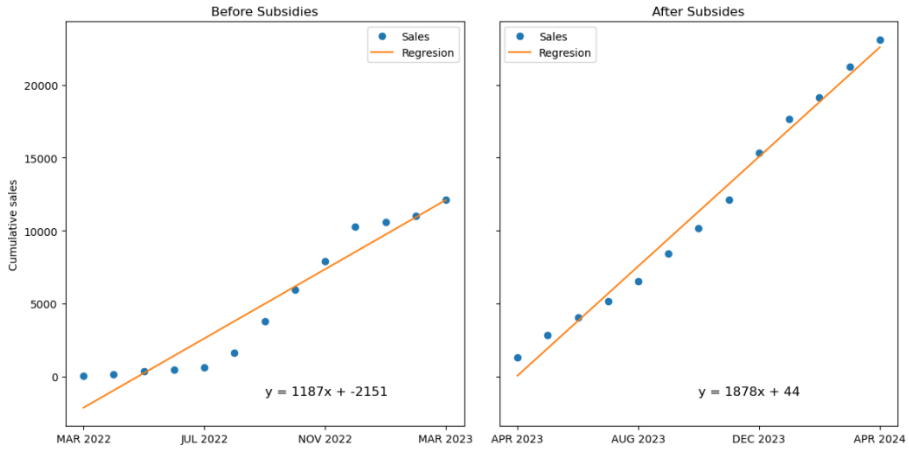

Figure 4. Linear Regression

The subsidy policy has a positive impact on electric vehicle sales in Indonesia. We conducted linear regression on two brands that received subsidies: Wuling and Hyundai.

The analysis results show an increase in sales for both brands after the subsidy policy was implemented. Wuling's sales increased from 903 units per month before the subsidy to 963 units per month after the subsidy, indicating an increase of 60 units per month. Hyundai's sales increased from 251 units per month before the subsidy to 545 units per month after the subsidy, indicating an increase of 294 units per month.

This difference may be due to the variance in market prices between the two brands. Wuling is relatively cheaper compared to Hyundai, making the 10% VAT tax reduction more significant for Hyundai. Overall, the subsidy positively impacts the sales of both brands, with a larger increase observed for Hyundai.

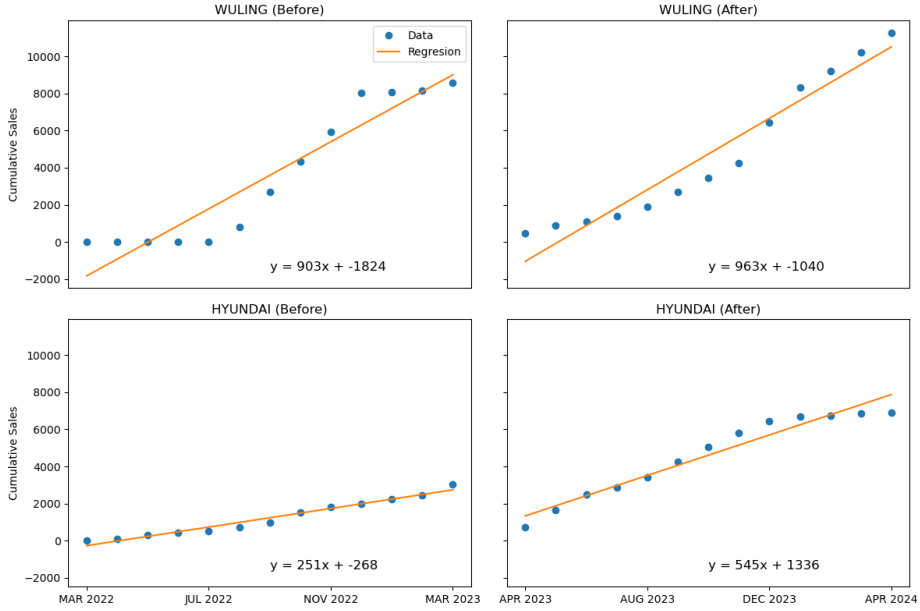

Figure 5. Linear Regression

Furthermore, we calculated the cumulative accumulation of electric vehicle types from year to year to observe the trend of the electric vehicle market in Indonesia (Table 1). From the analysis results, there is a significant development observed, indicating the formation of an electric vehicle atmosphere in Indonesia after the implementation of Presidential Regulation No. 55 of 2019, which regulates the acceleration of battery-based electric vehicles. Since the enactment of this regulation, electric vehicles began to appear for the first time in 2020. Subsequently, the Ministry of Industry also issued Regulation No. 6 of 2023 regarding electric vehicle subsidies. The industry responded positively to this regulation, as evidenced by the surge in the number of electric vehicle types available in Indonesia. As of April 2024, there are already 52 types of electric vehicles available in the Indonesian electric vehicle market.

Table 1. Cumulative Electric Car Type

BRAND	2020	2021	2022	2023	2024
BMW				6	9
CHERY					1
CITROEN					1
DFSK		2	2	2	2
HYUNDAI	4	4	8	10	10
KIA				2	2
LEXUS	1	1	1	3	3
MERCEDES-BENZ PC				5	5
MINI CHOOPER			1	1	1
MITSUBISHI MOTORS	1	1	1	1	1
MORRIS GARAGE				3	4
NETA				1	1
NISSAN		1	1	1	1
SERES				2	2
TOYOTA	1	2	2	2	2
WULING			2	5	7
Total	**7**	**11**	**18**	**44**	**52**

5. Discussion

The increase in electric vehicle sales after the implementation of the subsidy policy demonstrates the positive impact of the policy. However, upon reviewing other data, it appears that sales of hybrid vehicles are higher than subsidized electric vehicles (Figure 6). Our hypothesis is that this is due to the uneven distribution of electric vehicle support facilities in Indonesia, despite the current trend towards green energy. Hybrid cars have become the preferred choice for consumers because they can still use oil-based fuels as an alternative.

Additionally, the high prices of electric cars are also inhibiting factors. In the Indonesian market, the ideal price range for cars that can be affordable for many people is around 300 million rupiahs. Although the price of Wuling electric cars falls within this range, their small capacity makes them less popular among the public. Meanwhile, Hyundai electric cars with larger capacities have prices that are too high, reaching around 800 million rupiahs. These factors contribute to hybrid cars being a more popular choice among Indonesian consumers.

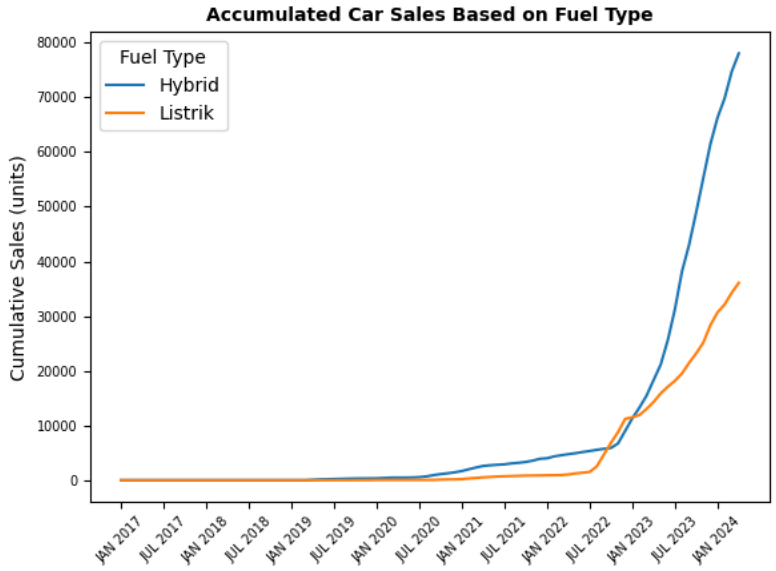

Figure 6. Cumulative hybrid and electric car

6. Conclusion, Implications, and recommendations

Here are the conclusions from this research:

1. Electric vehicle sales in Indonesia have been increasing annually, although they are still significantly lower than non-electric vehicle sales.
2. The most popular electric vehicle brands are Wuling and Hyundai, which receive subsidies for meeting the minimum 40 percent TKDN requirement.
3. Based on statistical tests, there is a significant increase in electric vehicle sales after the implementation of subsidies at a 95 percent confidence interval.
4. Regression analysis indicates an increase from 1,187 units per month to 1,877 units per month after the subsidy implementation, or an increase of 58.1 percent.

The research findings indicate that government subsidy policies have a significant positive impact on electric vehicle sales in Indonesia, reflecting consumers' positive response to the incentives provided. This supports the government's efforts to achieve carbon emission reduction targets. However, hybrid vehicles are still more preferred, possibly due to infrastructure limitations and the relatively high prices of electric vehicles.

Here are the recommendations from this research:

1. Conduct research to identify factors that can attract consumer interest in electric vehicles, including preferences, constraints, and aspects that can enhance electric vehicle adoption in various market segments.
2. Investigate the reasons why consumers prefer hybrid vehicles over electric vehicles, focusing on usability, infrastructure, technology perception, and operational costs.
3. Explore strategies to reduce the price of electric vehicles, including cost production analysis, subsidies, tax incentives, technological innovations, and case studies from other countries that have successfully lowered electric vehicle prices.

7. Acknowledgements

We would like to express our gratitude to GAIKINDO (Association of Indonesian Automotive Manufacturers) for providing comprehensive sales data for all car brands. This data support is invaluable to our research, and we appreciate GAIKINDO's efforts in collecting and providing comprehensive information about motor vehicle sales in Indonesia.

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