ICRRD QUALITY INDEX RESEARCH JOURNAL
INTERNATIONAL CENTER FOR RESEARCH AND RESOURCES DEVELOPMENT
article
ISSN Number: 2773-5958, https://doi.org/10.53272/icrrd, www.icrrd.com

# Impact of Nickel Price, Nickel Export Volume and Production Quantity on Global Electric Car Sales Trends

**Stefany Khairunnisa Aulia Hendrawan[1*], Ni Putu Wiwin Setyari[2]**

[1 2] *Department of Development Economics, Faculty of Economics and Business, Udayana University, Bali, Indonesia*

**Corresponding author; Email: Stefany.hendrawan@gmail.com*

**Received:** 11 March 2025 **Accepted:** 24 June, 2025
**Revision:** 10 May 2025 **Published:** 01 July 2025. **Vol**-6, **Issue**-3

**Cite as:** Hendrawan, SK. & Setyari, NP. (2025). Impact of Nickel Price, Nickel Export Volume, and Production Quantity on Global Electric Car Sales Trends. *ICRRD Journal, 6*(3), 101-112.

**Abstract:** The growth of the global electric car industry is influenced by various economic factors, including nickel prices, nickel export volume, and nickel production quantity. This study aims to quantitatively analyze the impact of these three variables on global electric car sales trends over the period 2014-2023. The method used is a quantitative approach with multiple linear regression, using annual secondary data from national and international sources. The results show that nickel price and nickel export volume have a positive and significant influence on global electric car sales trends. In contrast, the amount of nickel production shows no significant effect. These findings emphasize the importance of maintaining price stability and strengthening nickel exports as strategies to support the growth of the global electric vehicle market. In the future, further research needs to examine the impact of other external factors such as energy transition policies, battery technology development, and mineral supply chain dynamics in more depth using a longitudinal approach or dynamic economic model.

**Keywords:** *Electric car; nickel price; export volume*

## INTRODUCTION

The global transformation towards sustainable mobility has undergone significant acceleration in recent years, with electric vehicles being a manifestation of efforts to decarbonize the transportation sector which contributes around 24% of total global greenhouse gas emissions. In 2018, the amount of carbon dioxide emissions that cause greenhouse gases (GHG) from the energy sector reached 595,000,000 tons of CO2, of which 28% came from the transportation sector (Mantik & Sukadana, 2024). The global electric car market is registering exponential growth with a *compound annual growth* rate (CAGR) of 32% over the period 2018-2023, surpassing initial industry projections and making it one of the segments with the highest rate of expansion in the global economic landscape (International Energy Agency, 2023). This shift is driven by the need to reduce carbon emissions, improve energy efficiency, and meet increasingly stringent consumer demands and environmental regulations. Nickel-bearing lithium-ion battery-powered vehicles do make a positive contribution to

climate change mitigation through reduced greenhouse gas emissions and improved urban air quality indicators. However, the life cycle of this technology presents ecological complexities that should be considered, especially in the *upstream* phase of nickel extraction and refining, which is extractive of natural resources. The process not only consumes energy on a large scale but also has an impact on the degradation of aquifer quality and terrestrial ecosystems in mining areas. In addition, the production of batteries with high nickel content can lead to increased sulfur oxide (SOx) emissions and greater exploitation of water resources. Thus, there is a *trade-off* between the environmental benefits derived from the use of electric vehicles and the negative impacts generated by the supporting stamp supply chain. On the other hand, the main reasons consumers choose electric cars are the desire to contribute to environmental conservation, operational cost savings, government incentives, and the social image and status attached to the use of green technology.

The exponential increase in global demand for electric vehicles has triggered significant growth in the need for nickel as a critical component of lithium-ion batteries. This phenomenon places countries with massive nickel reserves such as Indonesia in a favorable geopolitical position in the global supply network. As the holder of the largest nickel reserves globally, Indonesia has implemented an industrial downstream strategy through restrictions on raw material exports and stimulus for the development of domestic battery and EV industry clusters. This policy move has a double impact: on the one hand, it increases ecological complexity due to the intensification of nickel mining and processing operations that generate harmful pollutants and residues. In this case, the implementation of sustainable policies that include the adoption of clean energy and circular systems becomes imperative to balance industrial growth with environmental preservation. One of the key factors determining the success of this transition is the availability and management of the main raw material for electric vehicle batteries, nickel. Nickel is a vital component in *Lithium-ion* batteries, especially the *lithium nickel cobalt manganese oxide* (NMC) type, which is widely used in electric cars due to its advantages in energy density, durability, and cost efficiency (Popovic et al., 2021). Therefore, the dynamics of nickel prices, export volumes, and the amount of nickel production are strategic issues that greatly affect the sales trend of electric cars globally. In the ecosystem of electric vehicle battery technology, nickel holds a strategic position as a crucial component in the production of high-performance *lithium-ion* batteries. The significance of nickel is particularly prominent in NMC (*Nickel Manganese cobalt*) and NCA (*Nickel Cobalt Aluminum*) cathode technologies that are predominantly used in the long-range electric vehicle segment with a market share reaching 73% by 2023. The evolution of cathode technology shows a trend of consistently increasing nickel content at a ratio of 1:1:1 (NMC111) with 33% nickel in the early generation to 8:1:1 (NMC811) with nickel content reaching 80%, increasing the energy density to 50-80% higher than previous technologies (Chen et al., 2020). Empirical data shows that every additional 10% nickel content in the cathode formulation results in a 20-25Km increase in vehicle range, making nickel a key *enabler* in overcoming "*range anxiety*" which is a major psychological barrier to electric vehicle adoption (Olivetti et al., 2017).

Based on theoretical studies, there is a mutually influential relationship between nickel prices, export volumes, and the amount of nickel production on the development of global electric car sales. The growing demand for nickel, especially for electric vehicle battery needs, has the potential to push up nickel prices on the international market. This increase in nickel prices can ultimately have an impact on increasing the production costs and selling prices of electric cars, thus affecting the competitiveness and adoption of electric vehicles in various countries (Pandyaswargo et al., 2021). In addition, the volume of nickel exports from producing countries, such as Indonesia, is highly

dependent on export restrictions or bans, which will reduce the supply of nickel in the international market and trigger price fluctuations. Meanwhile, domestic nickel production capacity to reflect the industry's ability to meet growing demand, both for domestic needs and exports. Previous studies have generally highlighted the importance of efficient and sustainable nickel supply chain management, the need to diversify raw material sources, and the development of recycling technologies to maintain industry stability and reduce environmental impacts. However, most previous studies have focused on one aspect only, such as recycling analysis, export policies, or environmental impacts, and not many have examined the relationship between nickel prices, export volumes, and production simultaneously and quantitatively on global electric car sales (Alam et al., 2025). Therefore, this study aims to analyze simultaneously the effect of nickel prices, export volumes, and also the amount of nickel production on global electric car sales trends using multiple linear regression methods.

## LITERATURE REVIEW

Previous studies have discussed the link between the growth of electric vehicles and the availability and market dynamics of key minerals, including nickel. Research by Popovic et al. (2021) emphasizes the importance of nickel as a key material in lithium-ion batteries, particularly in the context of energy density and durability. Similarly, Chen et al. (2020) and Olivetti et al. (2017), which showed a correlation between increasing nickel content in cathode formulations and electric vehicle performance and range, making nickel a strategic material in the global energy transition.

In addition, several other studies such as those conducted by Pandyaswargo et al. (2021) and Haryadi et al. (2024) highlighted the policy aspects of nickel down streaming in Indonesia, as well as its impact on battery industry investment and international trade strategies. These studies underline the importance of nickel supply stability and price control in maintaining the growth of electric vehicles globally.

However, most of the previous studies are partial and do not integrate the three main variables simultaneously, namely nickel price, export volume and production quantity, in relation to global electric vehicle sales trends. Some only focus on environmental aspects, technological efficiency, or trade policy, without conducting thorough empirical testing through a quantitative approach.

Therefore, this research is here to fill this gap by quantitatively analyzing the relationship between the three key nickel market variables and the dynamics of global electric car sales. This approach is expected to provide a more holistic and accurate picture of how Indonesia's strategic role as a global nickel producer can affect the electric vehicle industry at a macro level.

## RESEARCH METHODS

This study uses a quantitative approach with multiple linear regression methods, which aims to determine the effect of independent variables on the dependent variable. In this study, there is one dependent variable, namely electric car sales trends, as well as three independent variables, namely nickel prices, nickel export volumes, and nickel production.

The data used is secondary data obtained from several official institutions. Nickel price data for 2014-2023 was taken from the Ministry of Energy and Mineral Resources (ESDM). Meanwhile, data on the volume of nickel exports and the amount of nickel production are sourced from the Central Statistics Agency (BPS) and also Databox which cites BPS data. For global electric car sales trends, data was obtained from International Energy Agency (IEA) reports and publications.

The scope of this study focuses on the relationship between the development of the nickel industry in Indonesia and the global trend of electric car sales. The population in this study is all annual data for the past ten years relating to nickel prices, export volumes, production quantities, and electric car sales. Since this study uses time series data, no individual sampling is done, but rather the entire current year's data is used as the unit of analysis.

Before regression analysis, classical assumption tests were conducted, namely normality test, heteroscedasticity test, and multicollinearity test. The test results show that the residual data is normally distributed. There is no multicollinearity problem because the Variance Inflation Factor (VIF) values of the three variables are below 10. In addition, the model also passes the heteroscedasticity test, with an *Obs*R-squared* probability value of 0.0772 (>0.05). Thus, the regression model used has met the eligibility requirements for further analysis.

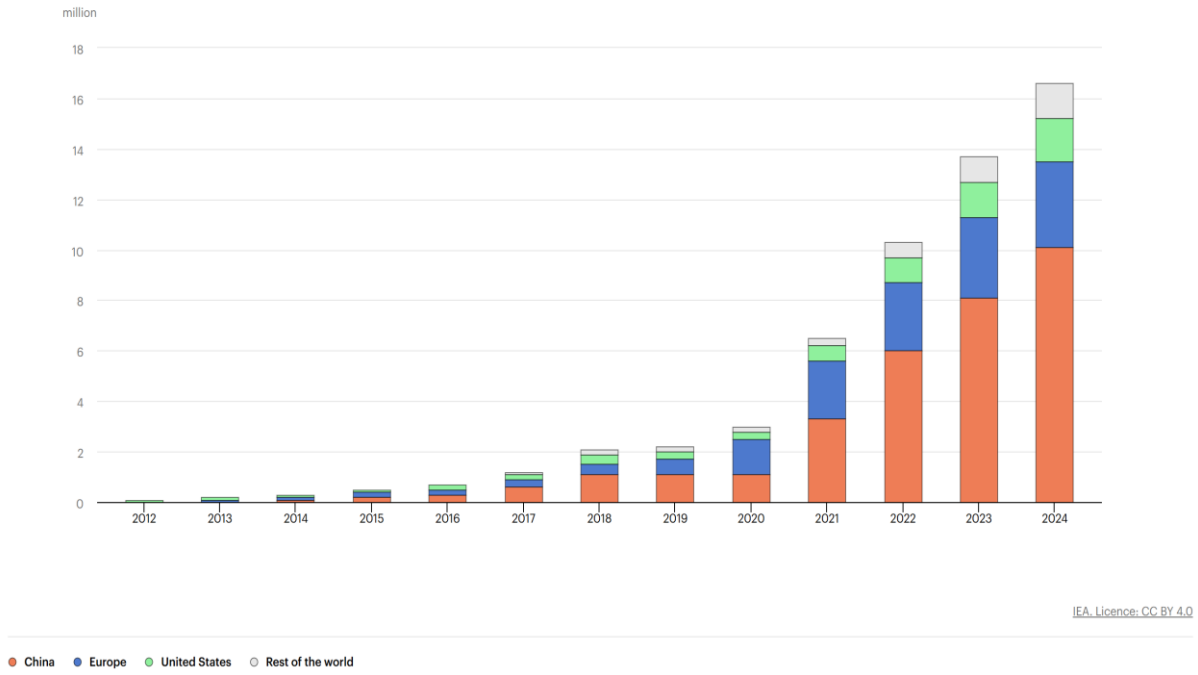
## RESULTS AND DISCUSSION

In the midst of global efforts to reduce carbon emissions, electric cars are now symbolizing major changes in the automotive industry. However, behind these technological advancements, one key commodity is nickel. Nickel is not just another metal, it's an essential raw material for the *lithium-ion* batteries that power modern electric cars. Without nickel, electric cars would not be able to compete in terms of durability, efficiency and price.

Indonesia, as the owner of the world's largest nickel reserves, is now at the forefront of the industrial revolution, in this case electric vehicles. The nickel ore export ban policy implemented since 2020 has not only changed the global trade map, but also encouraged the growth of the domestic battery and electric car industry. The world's battery producers have had to adjust their strategies, as nickel supplies are now mostly absorbed for Indonesia's domestic needs and the development of downstream industries (Pirmana et al., 2023; Pandyaswargo et al., 2021).

Based on Figure 1, it can be seen that the demand for electric cars continues to increase globally, this has led to an increase in the need for nickel as the main material for batteries. Projected sales of battery-based electric cars are expected to reach 145 million units by 2025, far surpassing fossil fuel cars. This makes nickel a strategic commodity that many countries are fighting over (Haryadi et al., 2024).

*Image1 . Electric Car Sales 2012-2024*




Source: IEA (2024)

Appropriate nickel policies and management, such as technology development, human resource quality improvement, and battery industry infrastructure development, are key to Indonesia becoming not only a supplier of raw materials, but also a major player in the global electric car and battery market (Pandyaswargo et al., 2021; Haryadi et al., 2024). Thus, nickel and electric cars are closely linked: the advancement of electric cars drives demand for nickel, while good nickel management will strengthen Indonesia's position on the stage of the future automotive industry.

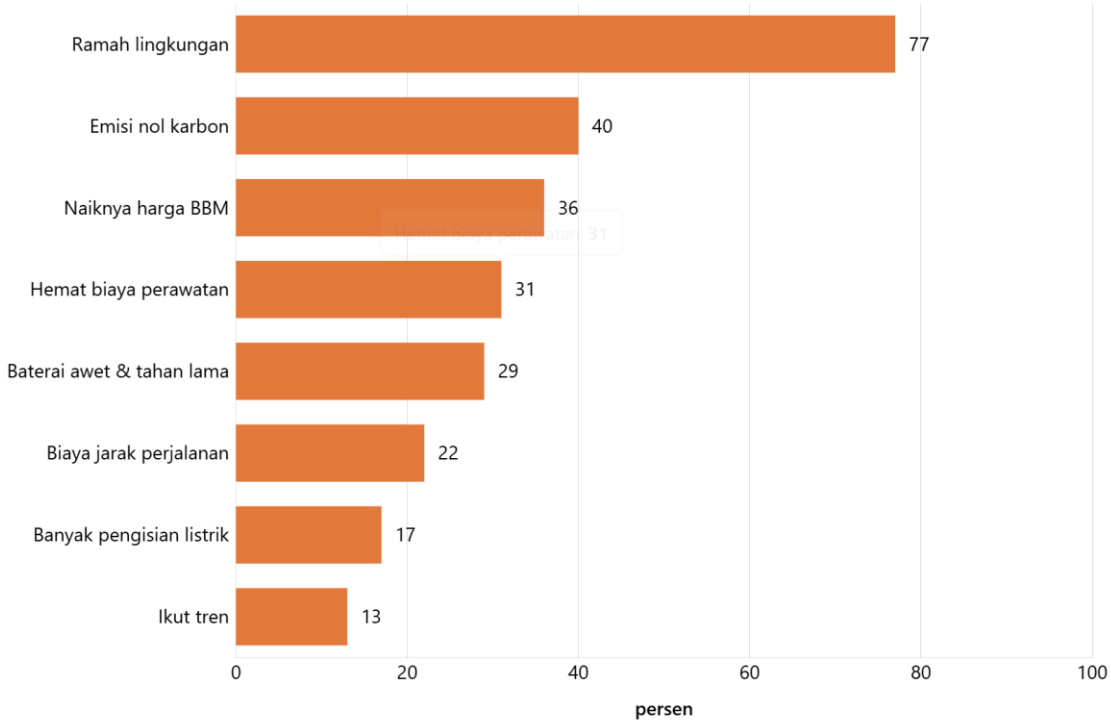
***Nickel Mineral Price***

The main finding of this study is that there is a positive and significant effect of nickel prices (X1) on electric car sales trends (Y), with a regression coefficient of 150.2801. This result shows that if every unit increase in the price of nickel (Rp / ton), it will increase electric car sales by 150.2801 units, assuming other variables remain constant. Economically, the increase in the price of nickel, which is the main ingredient in making electric car batteries, is closely related to the law of supply and demand. The increasing demand for electric cars globally drives the demand for nickel, which causes an increase in the price of nickel. This is in line with the basic concept of economics, where an increase in demand for goods (in this case, electric cars) will increase the *input* (nickel price) of production, which in turn pushes up the price of the *input*.

The phenomenon of increasing sales of electric cars is driven by the public perception that electric cars are more environmentally friendly, this is evidenced by the results of a survey conducted by Populix (in 2022) to 1002 respondents. From the study, it was found that as many as 77% of respondents thought they used or planned to use an electric car because it was more environmentally friendly. This rapid growth in global electric car (EV) sales has triggered a surge in demand for critical

minerals such as nickel, which is one of the main ingredients in EV batteries. Data shows that a 1% increase in *lithium* production could drive a 0.58% increase in EV sales, mainly due to a more stable battery supply and declining costs (Du, 2024). In addition, advances in *lithium-ion* battery technology are also improving efficiency and overcoming range-related concerns, so more consumers are switching to electric cars. However, this surge in demand has caused mineral prices to rise. High demand makes the elasticity of demand for minerals very low, even though prices rise, demand remains high due to the huge needs of the battery industry (Shojaeddini et al., 2024). This poses a new challenge, where the supply of minerals, especially nickel, is increasingly critical and vulnerable to global supply chain disruptions. In addition, this phenomenon also raises tensions between the need for a clean energy transition and the socio-environmental impacts of mineral extraction. Electric car consumers are generally less aware of the environmental and social impacts of the mineral mining process, while on the upstream side, there is exploitation of nature, social conflict, and also violation of the rights of local communities in mining areas (Liu et al., 2022).

*Image2 Reasons People Buy Electric Vehicles*




Source: databoks

Research supporting the influence of mineral prices on electric car sales generally emphasizes the importance of the causal relationship and the strong correlation between the variables. One such study shows that demand for minerals such as *lithium*, nickel, cobalt became less elastic after the surge in EV adoption. This means that even if mineral prices rise, demand remains high because the needs of the battery industry are huge. This reinforces the influence of the mineral price relationship on EV sales, especially in the context of the energy transition. However, there is also research that shows the effect of mineral prices on EV sales is not always significant. One modeling study shows that at very high levels of EV production, nickel, lead and zinc prices do not increase significantly because supply from major producing countries is able to meet demand. Only in certain scenarios do mineral

prices increase noticeably. Based on data, research results, and analysis of scientific arguments, the author is on the side that supports the significant influence of mineral prices on the trend of electric car sales. This is based on empirical evidence showing a close relationship between mineral demand and electric car market growth, as well as the importance of minerals as a key component in battery production. However, the authors also acknowledge the need for caution in generalizing the results, as well as the importance of considering other external factors such as policy, innovation, and global market dynamics.

***Export Volume***

The results of the analysis show that mineral export volume (X2) has a positive and significant effect on the trend of electric car sales (Y), with a regression coefficient of 5.0154. This finding indicates that every one unit increase in export volume (tons) will increase electric car sales by 5.0154 units, assuming other variables remain constant. The theory of comparative advantage states that a country will gain an economic advantage if it focuses production and exports on goods or commodities that can be produced at a relatively lower cost compared to other countries. Meanwhile, according to the elasticity theory, if nickel exports fluctuate, it will have an impact on nickel demand (Virgianto & Sukadan, 2023). In the context of minerals for electric car batteries, countries that have large reserves and production capabilities of nickel, *lithium* or cobalt, such as Indonesia, have a comparative advantage in exporting these minerals. This allows the country to become a major player in the global electric vehicle supply chain, support the growth of the global EV industry, and reap the economic benefits of exporting much-needed minerals for the energy transition.

The accelerating adoption of electric vehicles (EVs) globally has driven demand for critical minerals such as lithium, nickel, and cobalt, which are key ingredients in EV batteries. This high demand has caused mineral prices to become more persistent and tend to increase, especially after years of surging EV sales. Empirical studies show that the demand for these minerals has become highly inelastic, meaning that even if prices rise, demand remains high due to the huge needs of the battery industry. Mineral producing countries, especially in the Global South such as South Africa and the Democratic Republic of Congo, have become very important in the global supply chain. The volume of mineral exports from these countries greatly affects the availability of raw materials for EV batteries (Rahman, Hossain, et al., 2025). If export volumes increase, global mineral supply becomes more stable, supporting the growth of the EV industry and the trend of electric car sales globally (Hirlekar et al. 2025; Weiss and Jones 2023). Conversely, if export barriers or supply disruptions occur, battery production and EV sales may be hampered. Increasing mineral export volumes also bring environmental and social impacts, such as environmental damage in mining areas and social conflict in local communities. These issues are gaining increasing attention as new mining projects increase to meet global demand.

Indonesia has the world's largest reserves of nickel, which is the main raw material for EV batteries. Studies show that if nickel that is usually exported is diverted to domestic battery and EV production, it will increase economic value-added, job creation and national productivity. This is also reinforced by Indonesia's position in the global EV supply chain, so the volume of nickel exports and its management policies greatly affect the growth of the industry and trends in electric car sales, both domestically and globally. Meanwhile, several studies highlight that the surge in nickel consumption in the EV sector does occur, but so far it has been driven mainly by the stainless-steel industry, not

directly by the EV industry. This means that the volume of nickel exports is not entirely driven by EV demand, and the trend of electric car sales is also strongly influenced by other factors such as technology, policies, investment, and the competitiveness of the battery industry. Based on data, research results, and analysis of scientific arguments, the author is on the side of supporting that proper management of nickel export volumes can be a major driver of the growth of the battery and electric vehicle industries, thus having a positive impact on the trend of electric car sales.

***Production Quantity***

The regression results show that the variable amount of nickel production (X3) has a t-statistic value of 0.028 with a probability (significance) of 0.97 (>0.05). This means that there is no significant influence between nickel production and electric car sales trend (Y). The positive regression coefficient (+0.0003) indicates a unidirectional relationship, but it is very weak and not statistically significant. According to supply chain theory, the smooth flow of raw materials is very important to maintain the stability of production and final product prices Rahman, Ismail, et al., 2025). In the context of the electric car industry, an efficient and integrated nickel supply chain will support sustainable battery production. However, research shows that even if nickel production increases, if it is not followed by good supply chain management, technological mastery, and supporting infrastructure, its impact on electric car sales remains limited (Choi et al. 2024).

Global electric car (EV) demand is increasing rapidly, driven by the need for environmentally friendly vehicles and government policies supporting the clean energy transition. This has caused demand for high-energy batteries, particularly nickel-based batteries, to surge. Countries with large nickel reserves, such as Indonesia, China, as well as South Korea, are vying to strengthen their battery and electric vehicle industries. In China, as the world's largest electric car market, there is a gap between demand and supply of nickel for *lithium-ion* batteries. To address this, China has begun to optimize the recycling of nickel from used batteries. It is estimated that by 2030, if all used batteries are recycled, about one-third of the nickel demand for batteries can be met from recycled products, thus reducing the pressure on primary nickel production. So, nickel production (both primary and secondary) remains an important factor in supporting the growth of electric car sales, especially in countries with large EV markets such as China (Yao et al. 2021). However, there are also studies that reject that nickel production is not the only factor determining electric car sales. In South Korea, although nickel demand for batteries is increasing, electric car sales are also strongly influenced by other factors such as government policies, technological innovation, and the paradigm shift of the automotive industry from combustion engines to electricity (Choi et al. 2024). Based on empirical data and literature, the authors are of the view that nickel production is important as a prerequisite for the development of the battery and EV industries, but not as a major factor directly affecting electric car sales. Thus, while nickel production is important, its impact on EV sales is highly dependent on other broader and more complex factors.

## CONCLUSION

Based on the data analysis conducted, it can be argued that the development of global electric vehicle sales in the period 2014 to 2023 is strongly influenced by the dynamics of nickel prices in the international market as well as the large volume of nickel exports, each of which contributes positively to the increasing demand for electric cars in the world. The stability of nickel prices as well as the

expansion of export volumes proved to be key determinants in strengthening the growth of the electric vehicle industry, especially considering the role of nickel as an essential component in the *lithium-ion* batteries used in these vehicles. However, the results also show that the level of nickel production does not statistically significantly influence the trend of electric car sales, indicating that increasing production capacity alone, without effective supply chain management, technological mastery, and targeted export policies, is not enough to directly drive the growth of the electric vehicle market. This finding confirms the urgency of implementing a nickel management strategy that is oriented towards creating added value and sustainability, so that Indonesia as one of the world's largest nickel producers can optimize its role in the global electric vehicle industry supply chain while obtaining optimal economic and environmental benefits.

## LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study has several limitations that need to be observed for a wiser interpretation of the results. First, the scope of the data used is limited to the period 2014-2023, so it does not fully illustrate the long-term dynamics and impact of new policies implemented after that year. Secondly, the multiple linear regression model used in this study only reflects linear relationships between variables, whereas in the context of global markets and energy transition, relationships between variables can be non-linear and complex.

Third, this study has not included other external factors that influence the trend of electric car sales, such as tax incentives, emission regulations, developments in solid-state battery technology, and price fluctuations of other raw materials such as lithium and cobalt. Fourth, the data used are annual aggregates, so seasonal analysis or short-term economic shocks are not accommodated in the model.

In the future, the research direction can be expanded with a panel data or vector autoregression (VAR) approach to capture the dynamics of the relationship between variables in more depth and temporally. In addition, the integration of environmental, social and governance (ESG) aspects into nickel economic analysis also needs to be developed, in order to create a more sustainable predictive model that is relevant to the current challenges of global energy transition.

**Funding:** The research did not receive financial assistance from any funding entity.

**Conflicts of Interest:** The author has no conflicts of interest to disclose concerning this study.

**Declarations:** This manuscript has not been published to any other journal or online sources.

**Data Availability:** The author has all the data employed in this research and is open to sharing it upon reasonable request.

## References

Donitus Dicky Marchandry. "Analysis of the Effect of International Prices, Production Volume, and the US Dollar Exchange Rate on Nickel Exports in East Luwu Regency." *International Journal of Social Science and Human Research* (2023). https://doi.org/10.47191/ijsshr/v6-i9-27.

Peifan Yao, Xihua Zhang, Zhaolong Wang, Lifen Long, Yebin Han, Zhi Sun and Jingwei Wang. "The role of nickel recycling from nickel-bearing batteries on alleviating the demand-supply gap in China's industry of new energy vehicles." *Resources, Conservation and Recycling* (2021). https://doi.org/10.1016/J.RESCONREC.2021.105612.

Pirmana, V., Alisjahbana, A., Yusuf, A., Hoekstra, R., & Tukker, A. (2023). Economic and environmental impact of electric vehicles production in Indonesia. Clean Technologies and Environmental Policy, 25, 1871 - 1885. https://doi.org/10.1007/s10098-023-02475-6

Pandyaswargo, A., Wibowo, A., Maghfiroh, M., Rezqita, A., & Onoda, H. (2021). The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis. Batteries. https://doi.org/10.3390/batteries7040080

Haryadi, H., Suseno, T., Herlina, U., Nurjaman, F., Prasetyo, E., Handoko, A., Okfarina, S., Susanti, D., & Bahfie, F. (2024). SWOT analysis (strengths, weaknesses, opportunities, threats) of nickel to reach global electric battery market in Indonesia. Mineral Processing and Extractive Metallurgy, 133, 21 - 32. https://doi.org/10.1177/08827508231225025

IEA (2024), Electric car sales, 2012-2024, IEA, Paris https://www.iea.org/data-and-statistics/charts/electric-car-sales-2012-2024, License: CC BY 4.0

Dihni, Vika Azkiya. "Many People Want to Buy Electric Vehicles Because of Environmental Issues: Databoks." Indonesia Economic and Business Data Center, March 22, 2022. https://databoks.katadata.co.id/mobil/statistik/5f7d46d20b5f867/banyak-orang-ingin-beli-kendaraan-listrik-karena-isu-lingkungan.

Alam et al., (2025). *Online Corrective Feedback and Self-Regulated Writing: Exploring Student Perceptions and Challenges in Higher Education*. *15*(06), 139–150. https://doi.org/https://doi.org/10.5430/wjel.v15n6p139

Ruoyao Du. "Assessment of impacts of critical mineral resources on sustainable transport sector." *Resources Policy* (2024). https://doi.org/10.1016/j.resourpol.2024.105335.

Ensieh Shojaeddini, Elisa Alonso and N. Nassar. "Estimating price elasticity of demand for mineral commodities used in Lithium-ion batteries in the face of surging demand." *Resources, Conservation and Recycling* (2024). https://doi.org/10.1016/j.resconrec.2024.107664.

Wenjuan Liu, D. B. Agusdinata, H. Eakin and H. Romero. "Sustainable minerals extraction for electric vehicles: A pilot study of consumers' perceptions of impacts." *Resources Policy* (2022). https://doi.org/10.1016/j.resourpol.2021.102523.

Ensieh Shojaeddini, Elisa Alonso and N. Nassar. "Estimating price elasticity of demand for mineral commodities used in Lithium-ion batteries in the face of surging demand." *Resources, Conservation and Recycling* (2024). https://doi.org/10.1016/j.resconrec.2024.107664.

Luis de la Torre Palacios, Eloy Álvarez Pelegry and José Antonio Piqueras Rodríguez. "The Interest of Mineral Raw Materials in the Development of Electric Vehicles." (2020): 133-156. https://doi.org/10.1007/978-3-030-50633-9_8.

Rahman, M. K., Hossain, M. A., Ismail, N. A., Hossen, M. S., & Sultana, M. (2025). Determinants of students' adoption of AI chatbots in higher education: the moderating role of tech readiness. *Interactive Technology and Smart Education*.

Rahman, M. K., Ismail, N. A., Hossain, M. A., & Hossen, M. S. (2025). Students' mindset to adopt AI chatbots for effectiveness of online learning in higher education. *Future Business Journal*, *11*(1), 30.

Md. Monirul Islam, K. Sohag, S. Hammoudeh, O. Mariev and Nahla Samargandi. "Minerals import demands and clean energy transitions: A disaggregated analysis." *Energy Economics* (2022). https://doi.org/10.1016/j.eneco.2022.106205.

Ensieh Shojaeddini, Elisa Alonso and N. Nassar. "Estimating price elasticity of demand for mineral commodities used in Lithium-ion batteries in the face of surging demand." *Resources, Conservation and Recycling* (2024). https://doi.org/10.1016/j.resconrec.2024.107664.

Omkar Hirlekar, Ashutosh Kolte and László Vasa. "Transition in the mining industry with green energy: Economic dynamics in mining demand." *Resources Policy* (2025). https://doi.org/10.1016/j.resourpol.2024.105409.

C. Weiss and Alan G. Jones. "Introduction to this special section: Critical minerals exploration." *The Leading Edge* (2023). https://doi.org/10.1190/tle42040236.1.

Simon Sneddon. "Paradise lost? The red right hand of green technology." *Journal of Human Rights and the Environment* (2023). https://doi.org/10.4337/jhre.2023.02.03.

Viktor Pirmana, A. Alisjahbana, A. Yusuf, R. Hoekstra and A. Tukker. "Economic and environmental impact of electric vehicles production in Indonesia." *Clean Technologies and Environmental Policy*, 25 (2023): 1871 - 1885. https://doi.org/10.1007/s10098-023-02475-6.

A. H. Pandyaswargo, Alan Dwi Wibowo, M. Maghfiroh, Arlavinda Rezqita and H. Onoda. "The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis." *Batteries* (2021). https://doi.org/10.3390/batteries7040080.

Peifan Yao, Xihua Zhang, Zhaolong Wang, Lifen Long, Yebin Han, Zhi Sun and Jingwei Wang. "The role of nickel recycling from nickel-bearing batteries on alleviating the demand-supply gap in China's industry of new energy vehicles." *Resources, Conservation and Recycling* (2021). https://doi.org/10.1016/J.RESCONREC.2021.105612.

Hwan Ho Choi, Y. Hwang, Junbeum Kim, Hong-Yoon Kang and Doo Hwan Kim. "Material flow and domestic demand analysis for nickel in South Korea." *Journal of Cleaner Production* (2024). https://doi.org/10.1016/j.jclepro.2024.141711.

A.H. Pandyaswargo, Alan Dwi Wibowo, M. Maghfiroh, Arlavinda Rezqita and H. Onoda. "The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis." *Batteries* (2021). https://doi.org/10.3390/batteries7040080.

Mantik, Ki Bagus, and I Wayan Sukadana. "Comparative Analysis of Costs and Selling Carbon Emissions, Maintenance Costs of Purchasing Electric Cars, Operating Costs of Electric Cars and Transitions with Conventional Cars." *E-Journal of Development Economics, Udayana University* 13, no. 7 (October 28, 2024). https://doi.org/10.24843/eep.2024.v13.i07.p01.

Setiawan, I. K. D., & Setiawina, N. D. (2019). Analysis of competitiveness and factors affecting nickel ore exports in Indonesia. *E-Journal of Development Economics*, *Udayana University*, *8*(4).

Virgianto, Jurliem, and I Wayan Sukadana. "Elasticity of Nickel Exports on HDI, Income Distribution, and Poverty Level in East Luwu Regency." *E-Journal of Economics and Business*, *Udayana University*, May 31, 2023, 861. https://doi.org/10.24843/eeb.2023.v12.i05.p07.