

# How the US Inflation Reduction Act Transforms Indonesia's Nickel Industry

Santa Laetitia Nusa Putri<sup>1,2</sup>, Daffa Kaditya Tayip<sup>1,2,\*</sup>, Kaihua Xu<sup>1,2</sup>, Nila Armelia Windasari<sup>3</sup>, and Leiting Shen<sup>1</sup>

<sup>1</sup>School of Metallurgy and Environment, Central South University, Changsha 410083, China

<sup>2</sup>Jingmen GEM New Materials Co., Ltd., Jingmen 448000, China

<sup>3</sup>School of Business and Management, Institut Teknologi Bandung, Bandung 40132, Indonesia

Email: 233519009@csu.edu.cn (D.K.T.)

\*Corresponding author

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**Abstract**—Indonesia holds over 42% of the world's nickel reserves and has rapidly become a global production leader. However, the country faces major challenges under the United States' Inflation Reduction Act (IRA), which restricts tax incentives to minerals sourced from non-Free Trade Agreement (FTA) partners. Without such agreement, Indonesian nickel exports are largely excluded from premium markets. This study employs a mixed-method approach, combining stakeholder interviews with quantitative scenario modeling, to assess Indonesia's potential to access IRA-compliant markets. The simulation projects that without reform, compliant exports may remain below USD 500 million annually by 2030. In contrast, coordinated national policy could unlock up to USD 11.4 billion in annual exports, totaling USD 35.6 billion by decade's end. The qualitative approach highlights the disconnection between firm-level adaptation and national readiness to realize said number. The novelty of this study lies in bridging between these two, revealing that coordinated intervention is critical for Indonesia to transition from volume-driven to value-driven exports in global supply chains.

**Keywords**—inflation reduction act, Nickel industry, policy scenario, market simulation

## I. INTRODUCTION

The United States' Inflation Reduction Act (IRA), enacted in August 2022, represents a landmark policy designed to accelerate the transition to clean energy, secure domestic supply chains, and reduce greenhouse gas emissions. With USD 369 billion allocated toward climate and energy programs, the IRA emphasizes traceable and ESG-compliant sourcing of critical minerals from countries with Free Trade Agreements (FTA) with the US (Kim & Yang, 2023; Mirza, Naqvi, Rizvi, & Umar, 2023). While globally positioned to benefit, Indonesia, faces structural limitations: it lacks an FTA with the US while also remains heavily reliant on Chinese capital and coal-based processing. These eventually raise compliance concerns with the IRA.

This evolving policy context reveals a key tension between firm-level adaptation and national readiness. While some Indonesian firms are restructuring operations to meet IRA standards and position themselves for access to premium markets, national-level coordination remains limited. As a result, firms may satisfy technical requirements but still struggle fully adapt or capitalize on strategic opportunities without broader policy support.

Until now, no study has quantified the potential capital value Indonesia could gain from entering IRA-compliant markets, largely because the country's current export value of

nickel-derived products to these markets remains negligible. To explore the gap, this study uses mixed-methods approach. A qualitative case study captures how a leading Indonesian firm interprets and implements IRA-aligned practices on the ground, offering insight into real-time industrial adaptation. At the same time, a quantitative simulation estimates the capital potential of accessing US or premium markets, under various policy and market scenarios. Since Indonesia currently has small exports to these destinations, this model helps assess opportunities that are not yet visible in historical trade data. Together, these methods provide a dual lens on the disconnection between firm readiness and policy inertia, and how alignment could unlock significant value.

## II. THEORETICAL BACKGROUND

### A. Indonesia's Growing Nickel Industry: Struggles and Opportunities

Indonesia has rapidly become the world's top nickel producer, holding 42.3% of global reserves and contributing nearly half of global output in 2023 (Kementerian Energi dan Sumber Daya Mineral, 2024). This growth is driven by abundant laterite deposits and strong national policies aimed at industrializing the nickel sector. Since the 2014 export ban and the 2020 mining law, Indonesia has attracted large-scale investment in smelters and refineries, pushing export gains from under USD 1.0 billion in 2019 to USD 6.8 billion in 2023 (Siahaan, 2024; Sunuhadi *et al.*, 2024).

However, Indonesia's role in the global nickel value chain remains largely resource-based. While the down streaming policy, especially Class I nickel for Electric Vehicles (EV), is emphasized, its target market is constrained by environmental and sustainability concerns coupled with dominant foreign ownership, especially China, and low domestic EV adoption (Tritto, 2023). These factors limit access to high-value markets that demand strict ESG compliance, such as the US. Consequently, Indonesia's market becomes saturated and loses its value.

In global terms, Indonesia faces growing competition as EV markets evolve. The rise of Lithium Iron Phosphate (LFP) batteries, which require no nickel, and recent price declines of up to 45% underscore the risks of overproduction and narrowing margins (Olivetti *et al.*, 2017). To stay competitive and move up the value chain, Indonesia must transition from exporting bulk intermediates to securing premium positions in EV and clean energy supply chain.

### B. Development of US Inflation Reduction Act vs. Indonesia's Position

The US Inflation Reduction Act (IRA) introduces strict sourcing and ESG standards for critical minerals, including nickel. While designed to strengthen US supply chains and reduce reliance on geopolitical rivals, its provisions limit imports from countries with a Free Trade Agreement (FTA), such as Indonesia. The IRA also restricts market access for entities tied to Foreign Entities of Concern (FEOC), which poses additional challenges for Indonesia's Chinese-backed nickel sector (John, 2023).

Under US IRA, Indonesian nickel producers must also undertake substantial upgrades, including the traceability and transparency mandate, which requires producers to provide verifiable data on the origin, processing, and transportation of critical minerals (John, 2023). US IRA also promotes stringent ESG requirements and the adaptation of low-carbon technology, which will hit Indonesia's laterite nickel industries that have inadequate environmental, labor, and social regulations.

As of now, Indonesia has responded to the US IRA by accelerating its downstream Class I nickel policy (Lahadalia *et al.*, 2024). In parallel, Indonesia's export to the US or other premium market is still negligible. Theoretically, Indonesia may pursue a limited critical minerals agreement with the US to gain partial eligibility for IRA tax credits, Japan alike. Nonetheless, without stronger enforcement and clearer frameworks, firm-level efforts may fall short of IRA expectations. This poses a risk of being locked out of premium markets, even as Indonesia expands its nickel output.

On the other hand, the IRA faces its own supply dilemma. FTA partners alone cannot meet projected US demand for nickel by 2030 (Wang *et al.*, 2023). Currently, over 40% of US nickel imports come from non-FTA countries, such as Russia (Daniel *et al.*, 2023). This opens a strategic window for Indonesia: with proper reforms and credible alignment, it could fill a major supply gap and upgrade its role in the global EV and clean energy value chains.

### III. RESEARCH METHODOLOGY

This study uses a mixed-methods approach to capture both firm responses and national policy implications under the US IRA. A qualitative interview shows how one Indonesian nickel company adapts in practice, while the quantitative simulation estimates potential export value to the US or premium markets. Since Indonesia lacks direct export data to these markets, scenario modeling helps explore outcomes under different compliance and policy conditions.

#### A. Qualitative Analysis

This study uses a qualitative interview with PT ESG New Energy Material, a company built to meet IRA standards. The interview explores how an Indonesian nickel producer adapts its operations to comply with IRA requirements. Key themes from the interview were analyzed using ATLAS.ti.

#### B. Quantitative Analysis

This study also includes a quantitative analysis to estimate Indonesia's potential export value to the US or other premium market under the IRA from 2025 to 2030. The simulated Eq.

(1) assumes that the Gross Export Potential (GEP) depends on nickel production capacity (Q), the share of Class I nickel over total nickel production (P/P<sub>T</sub>), market access (α) due to compliance, and Class I nickel pricing (π).

$$GEP = Q \cdot \left(\frac{P}{P_T}\right) \cdot \pi \cdot \alpha \quad (1)$$

The evaluation scenarios are structured by categorizing each parameter into two or three cases. Production and price variables are estimated through curve fitting using the polyfit function in MATLAB, calibrated against historical data given in Eq. (2).

$$\hat{y}(x) = \sum_{k=0}^n \beta_k x^{n-k} \quad (2)$$

In contrast, the values for α and P/P<sub>T</sub> are adjusted based on informed assumptions and predefined estimates using Eq. (3). In 2025, the initial value of α is assumed to range from 0.00 to 0.02, reflecting the very limited export of Class I nickel to the US or other premium markets. On the contrary, the Class I nickel production ratio is estimated at around 0.20 in 2025, driven by the ongoing down streaming policy. By 2030, the projected share of α increases to 0.10–0.30, while the share of P/P<sub>T</sub> is expected to rise to 0.35–0.65. The (t) represents the year and (k) represents the growth coefficient.

$$\beta(t) = \beta_{min} + (\beta_{max} - \beta_{min}) \cdot (1 - e^{k(t-t_0)}) \quad (3)$$

The evaluation of all scenarios is calculated by MATLAB. A summary of their parameters, levels, and scenarios is provided in Table 1.

Table 1. Parameters applied for the simulation modelling

Parameter	Symbol	Level	Scenario
Nickel production capacity	Q	1	Constrained
		2	Business-as-usual
Class I nickel price	π	1	Baseline
		2	Premium
		3	High
Class I nickel over total production ratio	P/P <sub>T</sub>	1	Low
		2	Medium
		3	High
Market access due to compliance	α	1	Pessimistic
		2	Baseline
		3	Optimistic

### IV. RESULT AND DISCUSSION

#### A. Key Thematics from the Firm-Level Industrial Practice

PT ESG New Energy Materials is an Indonesian nickel processing company located in Morowali Regency, Central Sulawesi. This company is established to produce battery-grade materials in line with global sustainability standards. Utilizing HPAL technology, the company processes laterite nickel into Mixed Hydroxide Precipitates (MHP), a key input for electric vehicle batteries. Currently, PT ESG is divided into two main sites, 1168 m<sup>3</sup> and 560 m<sup>3</sup> autoclaves, with combined capacity to reach 32,000 tons of MHP. PT ESG now serves as an example, with key thematics obtained from an in-depth interview listed in Table 2.

Table 2. Key thematics from PT ESG New Energy Materials

Theme	Codes Grouped	Description
Strategic alignment with global policy	1. International regulatory measures	PT ESG demonstrates awareness of international frameworks and actively structures its operation to meet US and global standards.
	2. IRA full compliance	
	3. Export market prioritization	
Downstream and value creation	1. Full operational roadmap	PT ESG is committed to Indonesia’s national downstream policy and focuses on creating high-value MHP for EV.
	2. Downstream strategy commitment	
	3. Value addition approach	
ESG and sustainability efforts	1. HPAL Gen-4	PT ESG integrates plans for renewable energy and emissions reductions to improve ESG performance
	2. Green technology development	
	3. ISO 14001 compliance	
	4. Coal power transition	
Innovation and collaboration	1. R&D investment	PT ESG invests in local R&D and seeks partnerships to internalize HPAL technology and reduce foreign technical dependence.
	2. Technology development collaboration	
	3. Public and private sector collaboration	
Governance and institutional gaps	1. Strategic misalignment	PT ESG highlights regulatory uncertainties and disconnects between industrial needs and national policy frameworks.
	2. Policy–industry disconnection	

PT ESG is one of first companies to restructure its operations and equity to comply with the US IRA. In terms of ownership, 55% is owned by Indonesian PT Merdeka Copper Gold Tbk., followed by Korean company SK On and ECOPRO of about 20%, while Chinese ownership is limited to be below 25% to meet IRA FEOC rules.

PT ESG also positions itself at the forefront of traceability and ESG compliance in Indonesia. PT ESG has introduced a full traceability mechanism, including barcoded MHP packaging linked to batch-level production and quality data, enabling transparent tracking throughout the supply chain. To meet environmental standards, PT ESG has pursued ISO 14001 certification and established on-site laboratories for quality control and process optimization. While currently reliant on coal for energy, the company has outlined plans to integrate solar and biomass to reduce its carbon footprint. PT ESG also invests in research and development, partnering with national universities to create the new generation of HPAL technology. These efforts reflect PT ESG’s strategic intent to align with the US IRA mandates, positioning it as a credible supplier to global clean energy markets.

Nonetheless, PT ESG faces key challenges in aligning with US IRA standard. A major struggle lies in the limited regulatory clarity and institutional support within Indonesia, particularly around ESG enforcement. Although PT ESG has taken steps toward sustainability, the transition from coal to renewable energy sources remains difficult due to cost and infrastructure constraints. Additionally, the company faces technological dependence on foreign expertise for their own downstream innovation, which it is trying to address through local R&D initiatives and collaborations. Finally, the absence of a formal critical mineral agreement between Indonesia and the US introduces uncertainty in accessing IRA-compliant markets, despite the company’s effort to meet eligibility criteria.

**B. Gross Export Potential (GEP) to the US or Premium Market under Various Scenarios**

Based on prior discussions with PT ESG, there is a clear indication of the Indonesian government’s and industry stakeholders’ strong interest in advancing downstream development of Class I nickel production to access higher-value markets. However, specific strategies, infrastructures, and investments to achieve this goal appear to be lacking. In

such absence, there remains a risk of market oversupply and price suppression, particularly due to dependence on a single dominant buyer such as China. To simulate these uncertainties, this study proposes six scenarios, which are detailed in Table 3.

Table 3. Indonesia’s GEP to the US or premium market scenario matrix

Theme	Q	$\pi$	$\alpha$	P/P <sub>T</sub>
Baseline caution	1	1	1	1
Constrained opportunity	1	2	2	2
Strategic volume	2	1	2	2
Industrial momentum	2	1	3	2
Value-leveraged play	1	2	3	3
Strategic convergence	2	2	3	3

To initiate the evaluation, Fig. 1 presents two projected scenarios for Indonesia’s nickel mine production, expressed in primary metal output equivalents, based on data provided from 2019 to 2023 (International Nickel Study Group, 2024). The figure illustrates a clear upward trend in production from 2019 to 2023, reflecting the momentum driven by Indonesian government policies. This growth trajectory suggests that primary metal output could potentially double by 2030. However, the extent of this increase may be constrained by several domestic factors, including market saturation, infrastructure limitations, environmental considerations, and political dynamics.

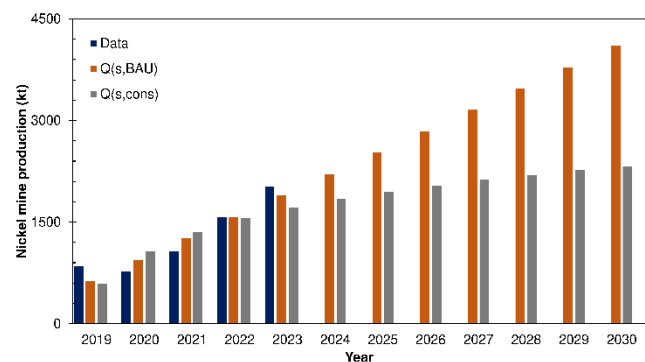


Fig. 1. Indonesia’s nickel mine production based on data provided from 2019 to 2023 (International Nickel Study Group, 2024).

The baseline price for Class I nickel in Fig. 2, represented in this study by MHP, is derived from historical pricing data provided by PT ESG. For confidentiality, the specific

timeline of the data is not disclosed. A clear downward trend in MHP prices is observed, attributed to overproduction and market saturation. These conditions weakened Indonesia's pricing leverage in the market. Monthly price fluctuations ( $\sigma$ ) are estimated at approximately 3.5%, a figure that also serves as the basis for defining the premium price scenario. This premium pricing is representative of conditions during market upswings or when MHP is traded within a premium niche market.

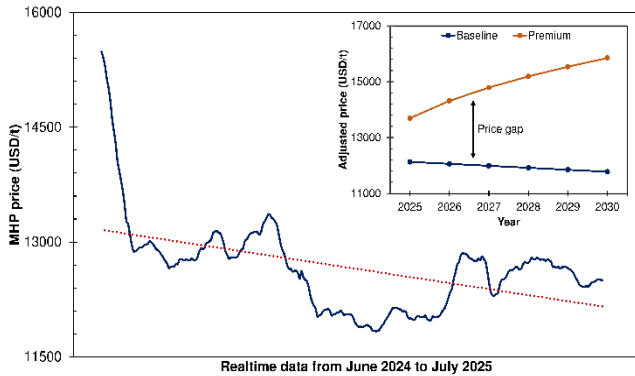


Fig. 2. Indonesia's MHP price forecast based on data provided by PT ESG.

Fig. 3 illustrates the GEP of Indonesia's nickel industry to the US or premium markets under six scenarios. Fig. 3a represents the baseline case, showing linear but limited growth, with export value remaining below USD 500 million annually by 2030. This scenario reflects Indonesia's regulatory inertia, slow ESG reform, and weak investment in sustainability (Scenario 1). Class I nickel production remains constrained, while prices continue to decline due to market saturation.

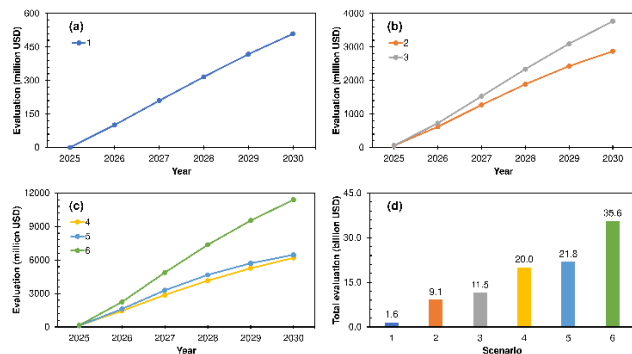


Fig. 3. Simulation results showcasing the evaluated value for (a) baseline model, (b) moderate compliance mode, (c) high compliance model, and (d) total evaluation from 2025 to 2030.

Fig. 3b illustrates the moderate compliance model under two different scenarios. In the constrained opportunity scenario (No. 2), supply and output caps lead to price increases, supported by modest policy alignment. In contrast, the strategic volume scenario (No. 3) assumes business-as-usual output growth with only mild IRA access, resulting in a price drop. Both evaluations reach an annual export value of USD 2.8 to 3.8 billion by 2030.

Fig. 3c illustrates the optimistic compliance model under three different scenarios. In the industrial momentum scenario (No. 4), Indonesia has high IRA alignment, although prices remain soft. This reflects long-term strategic planning, with an intermediate share of Class I nickel output. In the

value-leveraged play scenario (No. 5), a combination of premium Class I nickel production, strong IRA compliance, and limited supply drives a sharp price surge. Lastly, the strategic convergence scenario (No. 6) positions Indonesia as a fully compliant key supplier, unlocking its full potential and representing the most optimistic outcome. The projected annual export values by 2030 for these scenarios are USD 6.2, 6.5, and 11.4 billion, respectively.

A substantial disparity is observed between the pessimistic and optimistic scenarios, with total export evaluations varying by a factor of 10 to 20 in Fig. 3d. Realistically, the optimistic outcomes may emerge through two distinct pathways. First, the Indonesian government aggressively expands overall nickel production, potentially resulting in a modest decline in prices and a reduced share of Class I nickel within the product mix.

Alternatively, a more strategic approach involves capping total output while prioritizing the development of Class I nickel production. The pace at which Indonesia improves its eligibility, whether moderate or rapid, directly influences the export value captured in premium markets within both of these scenarios. Overall, the simulation underscores the critical role of policy action, ESG advancement, and market-focused planning in maximizing Indonesia's strategic value in the global EV supply chain.

### C. Policy Implications to Bridge the Firm-National Adaptation Gap

While the simulation highlights Indonesia's potential, it also underscores a key tension: this value can only be realized if both policy and firm-level conditions are met. The case of PT ESG shows that firms are already taking concrete steps. However, the simulation also assumes national-level reforms, which are currently lacking. This disconnect suggests that even firms with strong adaptation may be unable to access premium markets or maximize export value in the absence of coordinated policy support. Therefore, the full potential modeled in the simulation remains conditional. To address these issues, three national policies are introduced in Fig. 4.

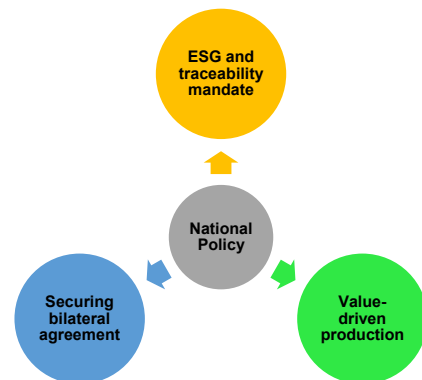


Fig. 4. National policy effort to support firm-level adaptations.

#### 1) Establish a National Framework for ESG and Traceability Compliance

Indonesia must formalize their traceability and ESG compliance at the national level. While firms like PT ESG have taken initiative, these efforts remain voluntary and firm-specific, limiting their broader impact. A national framework mandating traceability, environmental audits, and third-party

verification would provide a consistent standard aligned with IRA expectations. However, enforcing such a framework requires addressing structural gaps in institutional capacity (Cagli *et al.*, 2023).

Environmental oversight in Indonesia remains fragmented across multiple ministries, and local enforcement bodies often lack the technical capacity to monitor ESG metrics effectively. The implementation of Class I nickel production and renewable energy policy (*Kebijakan Energi Terbarukan*) is centrally managed by the Ministry of Energy and Mineral Resources (Kementerian ESDM), which holds partial responsibility for environmental and ESG-related functions. However, these responsibilities are shared with other key institutions, including the Ministry of Environment and Forestry (KLHK), the Ministry of Industry (Kemenperin), and local governments. Without effective coordination and adequate investment in monitoring infrastructure, even well-designed compliance systems risk remaining unenforced and purely administrative.

### 2) *Restructure Industry Strategy Toward Value-Based Production*

Indonesia must shift from a volume-driven to a value-driven production strategy, prioritizing Class I nickel output over bulk Class II products. As highlighted in the simulation, the highest export value scenarios (up to USD 11.4 billion annually by 2030) are not achieved through uncontrolled growth, but through a selective increase in Class I output combined with policy alignment. PT ESG's operations show this shift, using a new HPAL technology to produce MHP. However, to maintain strategic leverage, national policy must reorient: capping low-value production, supporting R&D to lessen Chinese dependency, while also ensuring trade-offs in the environment are managed. This is because, the nickel price in premium markets is related to its environmental pathway (Basuhi *et al.*, 2024). Without this shift, Indonesia risks high output with low strategic value, as firms producing technically compliant products remain structurally excluded from markets that prioritize ESG and product quality.

### 3) *Secure Formal Access to IRA-Compliant and Premium Markets*

To translate firm-level compliance into real market access, Indonesia must secure formal trade recognition under the US IRA. PT ESG, for example, has already limited Chinese ownership below 25% and implemented traceability and ESG measures in anticipation of IRA compliance. Nevertheless, in the absence of a bilateral agreement, these efforts may not qualify for IRA incentives. Meanwhile, more than 40% of current US nickel imports come from non-FTA countries, highlighting both the risk of exclusion and the opportunity gap (Daniel *et al.*, 2023; Wang *et al.*, 2023). A formalized critical mineral deals is essential not only to enable compliant firms to enter IRA-aligned markets, but also to ensure Indonesia captures strategic value from its resource advantage rather than remaining a high-volume supplier to non-premium markets.

## V. CONCLUSION

This study showcases that Indonesia's ability to capitalize on the US Inflation Reduction Act (IRA) is not a matter of mineral abundance alone, but of strategic alignment between

firm-level innovation and national policy reform. Through a mixed-method approach, combining qualitative insights from PT ESG New Energy Materials and quantitative scenario simulations, we identify both the opportunities and systemic barriers Indonesia faces in accessing premium markets.

Our simulation results show that under baseline conditions, characterized by weak ESG and IRA compliance, Indonesia's nickel exports to US or other premium markets may remain below USD 500 million annually by 2030. In contrast, a high-alignment strategy involving Class I nickel prioritization, robust ESG compliance, and formal market agreements could unlock up to USD 11.4 billion annually, totaling USD 35.6 billion in cumulative export value by the end of the decade.

PT ESG's case exemplifies the industrial capacity already emerging within Indonesia. The firm's proactive compliance highlights the private sector's willingness to adapt. However, these efforts are currently hindered by fragmented national frameworks, regulatory inertia, and the absence of a formal agreement with the US. Therefore, the pathway to realizing Indonesia's full strategic potential lies in bridging the gap between firm readiness and policy support. This requires: (1) the institutionalization of ESG and traceability standards; (2) a deliberate shift from volume-based to value-based nickel production; and (3) diplomatic efforts to secure agreement under the IRA. These integrated measures are essential not only for maximizing economic returns but also for securing Indonesia's place in the evolving global EV chain.

Future research should further investigate the techno-economic viability of renewable energy integration into HPAL operations and assess the geopolitical risks tied to critical mineral diplomacy. Such work can support Indonesia in navigating its industrial transformation amid increasingly protectionist and ESG-driven global markets.

### CONFLICT OF INTEREST

The author declares no conflict of interest.

### AUTHOR CONTRIBUTIONS

Both Santa Laetitia Nusa Putri and Daffa Kaditya Tayip conducted the investigation, formal analysis and writing of the original draft; Kaihua Xu lead and administrated the project; Nila Armelia Windasari and Leiting Shen reviewed and supervised the research; all authors had approved the final version.

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