INKUBIS: Jurnal Ekonomi dan Bisnis
Volume 8, Issue 1, 442-460
e_ISSN: 2775-3913
https://inkubis.polteksci.ac.id/index.php/ink/index
DOI: doi.org/10.59261/inkubis.v8i1.204

Downstreaming Mineral Resources in Indonesia in Bibliometric Analysis

Brigita Purnawati Manohara[1*]
, Institut Pemerintahan Dalam Negeri, Indonesia

Muhammad Iqbal[2]
Sekolah Tinggi Ilmu Hukum IBLAM, Indonesia

Hyronimus Rowa[3]
Institut Pemerintahan Dalam Negeri, Indonesia

Suhajar Diantoro[4]
Institut Pemerintahan Dalam Negeri, Indonesia

Tjahyo Suprajoyo[5]
Institut Pemerintahan Dalam Negeri, Indonesia

***Corresponding author:**
Brigita Purnawati Manohara, Institut Pemerintahan Dalam Negeri, Indonesia.
✉brigita.purnawati@binus.ac.id

Article Info:
Article history:
Received: Month XX, 2026
Revised: Month XX, 2026
Accepted: Month XX, 2026

Keywords:
bibliometric; indonesia; mineral downstreaming; nickel; public policy.

Abstract

Background: Although research has been shrinking over the last few years, despite growing publications, its recent bibliometric structural development remains relatively underexplored regarding Indonesia's continuing industrial policy after the nickel export ban and Mining Law (2020).
Objective: To map research development, collaboration networks, and trending topics while also identifying gaps in mineral downstreaming research.
Methods: Using Publish or Perish in Google Scholar, 1,000 publications (2005–2025) were obtained and analyzed using VOSviewer for co-authorship and keyword co-occurrence.
Results: Publications increased exponentially after 2020, coinciding with Indonesia's nickel export ban. Co-authorship analysis identified 32 connected authors across 8 clusters, with Chinese-affiliated researchers dominating the network (Wang, Zhang, Chen, Li). Keyword co-occurrence mapping revealed 1,083 interconnected items across 26 thematic clusters, with the discourse evolving from resource nationalism and investment policy toward critical minerals, battery ecosystems, ESG, and sustainability.
Conclusion: The bibliometric map reveals a maturing but fragmented research landscape, with underexplored areas in green governance, mineral circularity, and domestic social impact. This study contributes the first systematic bibliometric overview of mineral downstreaming research in Indonesia, providing a research roadmap for scholars, policymakers, and industry stakeholders navigating Indonesia's role in the global clean energy supply chain.

To cite this article: Manohara, B. P., Iqbal, M., Rowa, H., Diantoro, S., & Suprajoyo, T. (2026). Downstreaming Mineral Resources in Indonesia in Bibliometric Analysis. *INKUBIS: Jurnal Ekonomi dan Bisnis*, *8*(1), 442-460. https://doi.org/10.59261/inkubis.v8i1.204

INTRODUCTION

Indonesia is not only known as an archipelagic country and a maritime country, but it is also rich in natural resources (Rochwulaningsih et al., 2019). Among the many types of resources owned by Indonesia, mineral resources have recently become a subject of significant discussion, given that the government continues to promote efforts to increase the added value of commodities (downstreaming) (Farawansa & Gultom, 2024; Krustiyati & Gea, 2023). This has

been the case because, for decades of Indonesia's independence, the utilization of mineral resources (nickel, copper, tin, bauxite, etc.) focused solely on the export of raw materials, so that the state's revenue from this sector was limited to royalties. Realizing the importance of providing added value for commodities, including minerals, the government, through Law No. 4 of 2009 concerning Mineral and Coal Mining (Minerba), requires mining companies to process their mineral output within Indonesia. In Article 95, letter (c) of Law No. 4 of 2009, it is expressly stated that holders of IUP (Mining Business Permit) and IUPK (Special Mining Business Permit) are obliged to increase the added value of mineral and/or coal resources. This provision is further elaborated in Law No. 3 of 2020, which is a revision of Law No. 4 of 2009. In Article 102, paragraphs (1) and (3), the law reaffirms the obligation to increase the added value of minerals in mining business activities by IUP and IUPK holders. Even in the subsequent revision of the Mineral and Coal Mining Law, passed in 2025, particularly Article 104A, it is stated that the task of increasing added value may be carried out by state research institutions, regional research institutions, state-owned enterprises, regional-owned enterprises, or private business entities to conduct research, investigations, and/or project development in the designated area (Setneg, 2010, 2020, 2025).

Global trends toward resource nationalism and industrial policy-driven value chain development have intensified scholarly attention on commodity-exporting nations (Sovacool et al., 2020). Indonesia, as one of the world's leading producers of nickel, bauxite, copper, and tin, occupies a strategically significant position in global mineral supply chains particularly in the context of the energy transition and the growing demand for critical minerals for electric vehicle batteries (Agency, 2023).

The downstream mineral policy of the government is not only intended to increase revenue—since the selling price of processed mineral products is higher than that of raw materials—but it is also expected to accelerate the growth of the domestic processing industry. Through this policy, mining companies contribute not only through royalty payments, but also through taxes, PNBP (Non-Tax State Revenue), and dividends (if the operating entity is a state-owned enterprise). Based on data released by the Central Statistics Agency (Badan Pusat Statistik/BPS), in the first semester of 2025, investment realization in the mineral sector amounted to Rp193.8 trillion. This has had implications for job creation, with the second quarter recording the recruitment of 665,756 workers.

In addition, this policy is also aligned with the energy transition program, namely Net Zero Emissions (NZE) 2060, or the accelerated target as committed to by the government. Nickel, which is one of the critical minerals, plays a significant role in the battery value chain within the energy transition process (Dugoua et al., 2025; Wang et al., 2026). Therefore, mineral downstreaming has the potential to reduce dependence on imports of clean energy components (Fikru & Kilinc-Ata, 2024; Islam et al., 2022). Although this industry has experienced significant growth and contributes positively to national economic development, it also contributes to carbon emissions, as its primary energy source is fossil fuels.

Mineral downstreaming also presents new challenges for the government, including the utilization of low-grade nickel, environmental and occupational health and safety issues, funding provision, and technological innovation. Also notable is the emergence of what is known as the hollow gap phenomenon. This phenomenon occurs when there is a gap between the upstream and downstream industries. This condition arises when the material processing and manufacturing industry fails to develop in tandem with high-value industries. This phenomenon also results in suboptimal state revenues and continued poverty among communities in downstream industrial centers.

The downstream policy does present challenges for the government; however, the rationale behind this policy is to increase added value by processing raw materials into higher-value products for export, while aligning the interests of economic growth, the environment, and social welfare in its management. Therefore, the implementation of this policy needs to be balanced with the development of downstream industries to encourage mineral-based domestic industries, so that their utilization is optimized in advancing national economic independence. In this way, Indonesia can increase its global competitiveness through improvements in production factors such as infrastructure, technology, and the cultivation of more skilled human resources

(Handika, 2023; Wau et al., 2024).

Bibliometric studies have increasingly been used to map the intellectual landscape of emerging policy fields. Studies such as Donthu (2021) in the Journal of Business Research and Zupic (2015) in Organizational Research Methods have demonstrated the utility of co-authorship and keyword co-occurrence analyses in identifying research frontiers and collaboration patterns. However, despite the strategic prominence of Indonesia's mineral downstreaming policy in global critical mineral supply chains, no systematic bibliometric study has comprehensively mapped this research field. Existing reviews either focus on broader resource governance themes Ploeg (2011) and Ross (2015) or are limited to single-commodity analyses. This gap is particularly significant given the exponential growth of publications since 2020 and the multidisciplinary nature of the discourse—spanning law, economics, environmental science, and engineering. Therefore, this study addresses the following research gap: there is no comprehensive bibliometric mapping of Indonesia's mineral downstreaming literature that captures publication trends, international collaboration networks, and thematic evolution across disciplines.

The development and implementation of downstream policies, especially mineral downstreaming, have attracted the attention of researchers both domestically and internationally. This interest encompasses not only the downstream policy and its implementation but also the government's decision to ban the export of raw materials. Understanding the dynamics of mineral downstream policy implementation can help inform the policy evaluation process.

Therefore, understanding research trends in mineral downstreaming, author networks, and thematic maps can help inform and accelerate mineral downstreaming initiatives. Based on the foregoing, this study aims to present: (1) the development of publication trends concerning the downstreaming of mineral resources in Indonesia; (2) a co-authorship network map among authors discussing mineral resource downstreaming; and (3) a thematic map based on publication keyword analysis. The findings are expected to contribute to the advancement of knowledge, particularly in the field of mineral downstreaming in Indonesia. Furthermore, other scholars may build on this study to conduct follow-up research that can inform the continued implementation of mineral downstreaming in Indonesia.

METHOD

The use of bibliometric analysis on certain themes can help in understanding research trends, relationships between authors, and thematic patterns related to the downstream of mineral resources in Indonesia. In addition, a map of the relationship between authors through *co-authoring* can be known so that the network between researchers who contribute to the development of mineral downstream policies, especially in Indonesia. Furthermore, with regard to the use of keywords in research, through bibliometric analysis, it can be known the relationship between focus and issues in the mineral downstream sector. The results of the analysis are possible to help in identifying opportunities for future study development.

This study employed a systematic bibliometric approach conducted in four stages. Stage 1 involved database retrieval using the Publish or Perish (PoP, version 8) application, which queries the Google Scholar database. Google Scholar was selected over Scopus or Web of Science due to its broader coverage of grey literature, book chapters, and non-indexed local journals relevant to Indonesia's policy-heavy discourse. The primary search string applied was: "mineral downstreaming" OR "hilirisasi mineral" OR "nickel downstreaming" OR "mineral downstream Indonesia", with secondary terms including "nickel export ban", "mineral processing Indonesia", and "critical minerals Indonesia".

The search was temporally bounded to 2005–2025, yielding a maximum of 1,000 records per query. Stage 2 applied inclusion and exclusion criteria: included were peer-reviewed articles, book chapters, and working papers in English or Indonesian directly addressing mineral downstreaming policy, economics, or technology in Indonesia; excluded were duplicates, editorials, and unrelated results identified through title and abstract screening. Stage 3 involved data cleaning and storage in CSV/RIS format, with manual removal of non-thematic entries verified through keyword relevance. Stage 4 performed bibliometric analysis using VOSviewer

(version 1.6.20), applying co-authorship network analysis (minimum 2 works per author) and keyword co-occurrence mapping (minimum 2 occurrences, binary counting method). This four-stage process ensures methodological transparency and replicability.

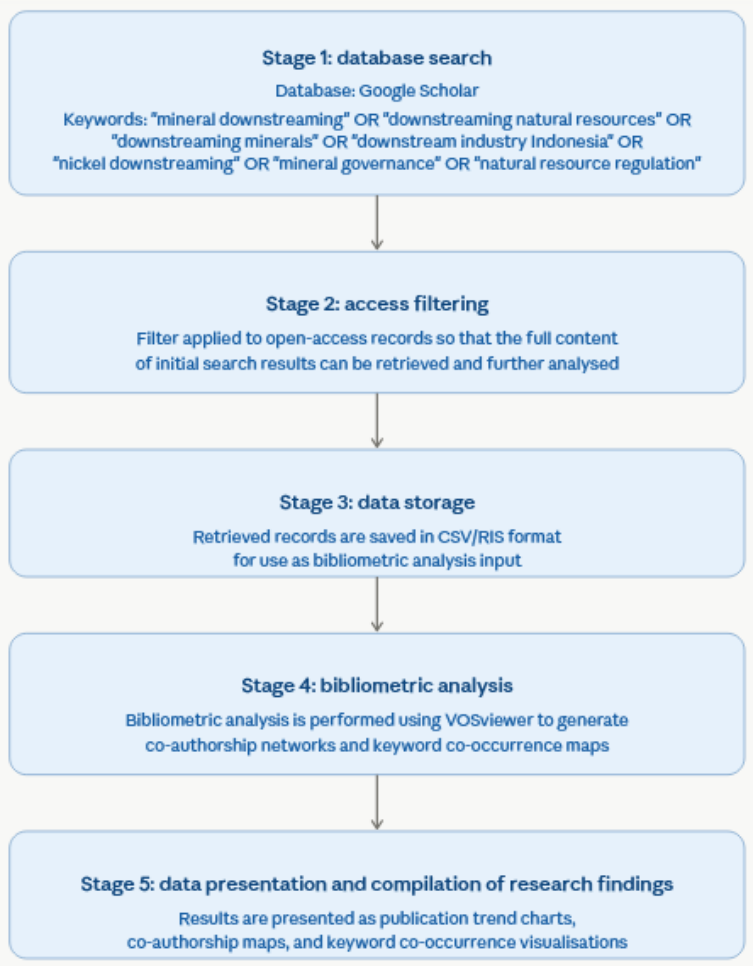

Figure 1. Stages of research
Source: processed (2026)

The diagram/figure above contains Indonesian-language labels. All text within the figure must be translated to English for the final submission. The English labels for each stage are: Stage 1: Database Search (Publish or Perish / Google Scholar) → Stage 2: Access Filtering (Open Access) → Stage 3: Database Storage (CSV/RIS Format) → Stage 4: Bibliometric Analysis (VOSviewer). Please update the figure accordingly. The above research stages are carried out in an effort to answer research questions according to the following table:

Table 1. Research Questions and Techniques of Analysis

No.	Research Questions	Data Analysis
1.	What are the publication trends regarding the downstream of mineral resources in Indonesia?	Bibliometrics
2.	How is the map of the relationship between authors through *co-authorship* in the discussion of downstreaming mineral resources?	Bibliometrics
3.	How is the thematic map generated from the analysis of the publication's keywords?	Bibliometrics

Source: processed (2026)

RESULTS AND DISCUSSION

Results

In accordance with the stages that have been conveyed, the researcher first uses the PoP application with keywords according to the research theme.

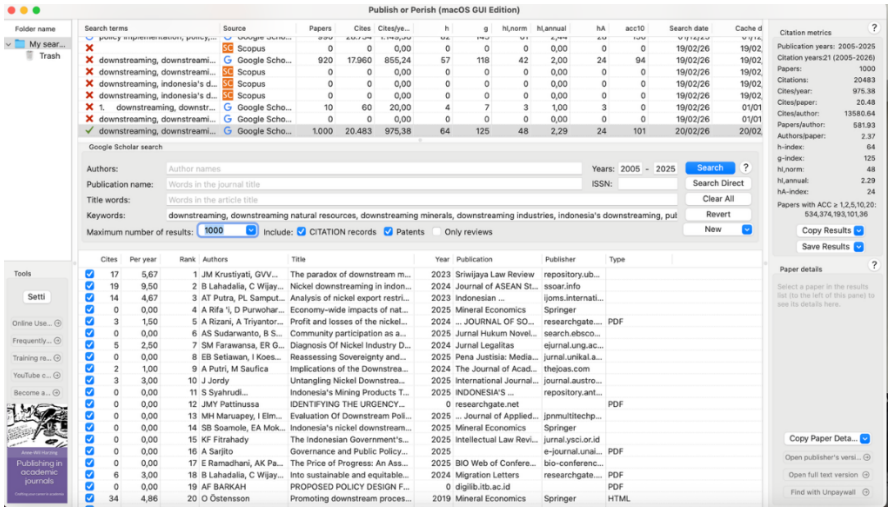

Figure 2. The First Stage of the Database Search Process
Source: processed (2026)

From the search result data that has been determined, which is a maximum of 1000 files, then filtered and stored in CVS/RIS format.

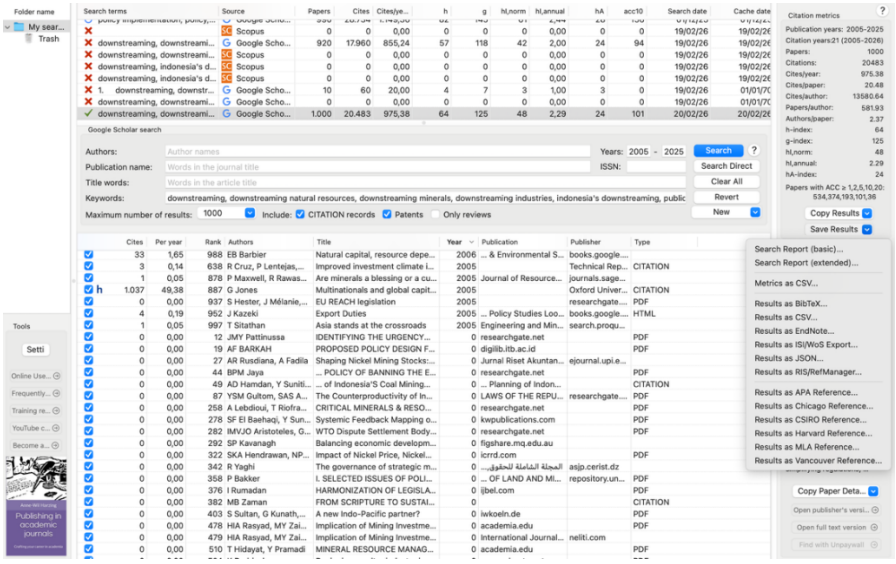

Figure 3. Advanced Stages of the Research Process
Source: processed (2026)

Based on the data from the search results through the PoP, it is known that research on various aspects of mineral resources continues to increase. Even in the last two years (2024-2025), the increase in research with this theme has increased significantly. The development of the research was recorded above 50%, this condition shows an increase in the interest of researchers regarding the theme.

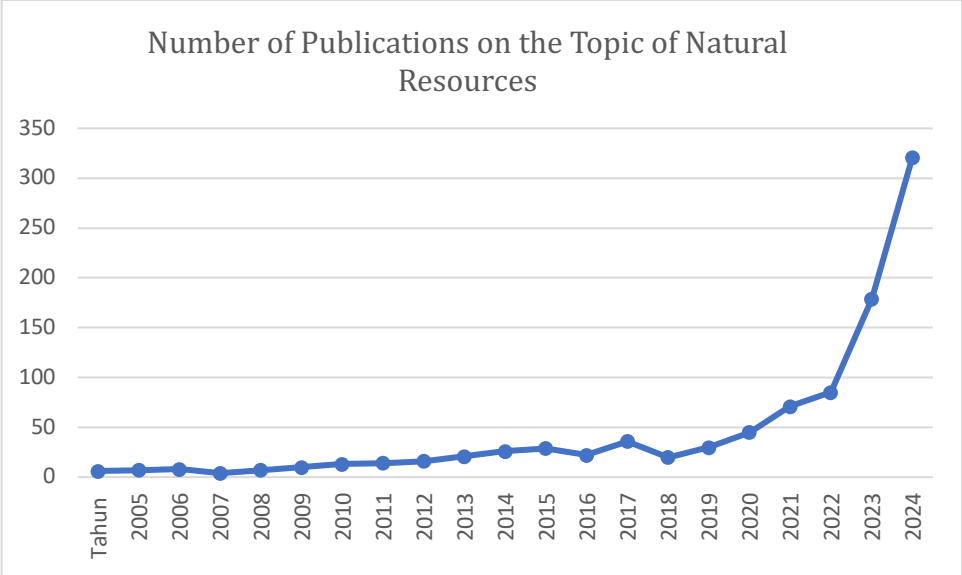

Figure 4. Number of publications on natural resources
Source: processed (2026)

Regarding the number of publication citations on themes that have been identified through the PoP, it is presented through the table below:

Table 2. Publication Database Ranking Results Based on Number of Citations

No.	Title	Year	Publications	Numerous citations
1.	The Natural Resource Curse: A Survey	2010	National Bureau of Economic Research (working paper)	1581
2.	Multinational and Global Capital	2005	Oxford University Press (Book)	1037
3.	Mining Capitalism: The Relationship Between Corporations and Their Critics	2014	University of California Press (Book)	1011
4.	Mineral Resources, Economics and The Environment	2015	Cambridge University Press (Book)	602
5.	Material Worlds: Natural Resources, Resource Geography and the Material Economy	2009	Geography Compas, Volume 3, Issue 3, Pg 1217-1244	527
6.	Mineral, Critical Minerals, and the US Economy	2008	The National Academies Press, Washington DC (Book)	482
7.	Mining and The Freshwater Environment	2012	Elseview Applied Science (Book)	415
8.	Mining Royalties: A global Study of Their Impact on Investors, Government, and Civil Society	2006	The World Bank (Book)	407
9.	Escaping from the Resource Curse: Evidence from Botswana and The Rest of The World	2007	IMF Economic Review, Volume 54, pg 663-699	340
10.	By All Means Necessary: How China's Resource Quest is Changing the World	2014	Oxford University Press (Book)	339
11.	Did Botswana Escape from the Resource Curse?	2006	IMF Working Paper No.6/138	246
12.	Electronic Waste Generation, Regulation and Metal Recovery:	2021	Environmental Chemistry Letters Vol.19, pg. 1347-1368	233

No.	Title	Year	Publications	Numerous citations
	A review		(published by Springer)	
13.	Foreign Direct Investment and Development: Launching a Second Generation of Policy Research	2011	Peterson Institute for International Economics (Book)	220
14.	China's Domestic and Foreugn Influence in the Global Cobalt Supply Chain	2019	Resource Policy, Vol.62, August 2019, pg. 317-323	204
15.	Electric Vehicle Battery Chemistry Affects Supply Chain Disruption Vulnerabilities	2024	Nature Communications Vol.15, Article Number 2143	204

Referring to the table above, it can be seen that research citations in the field of natural resources are dominated by discussions about the impact of natural resource exploitation on the economic and environmental sectors. Some research has begun to focus on electric vehicles whose main raw materials are critical minerals. Research on electric vehicles has recently been carried out due to the energy transition process that was agreed upon by many countries at COP21 in Paris in 2015. Another theme that is also interesting to research is the impact of resource royalties. The use of royalties for the government, the private sector, and the public was researched in 2006; therefore, if other researchers want to study this theme in a different location, it is very possible to do so, considering that the previous research was carried out 20 years ago.

Co-Authorship Pattern in Publications on Mineral Downstream

The relationship between authors regarding the theme of mineral downstreaming, especially in Indonesia, can be found by utilizing the VOSviewer application. The database obtained from PoP is applied to VOSviewer.

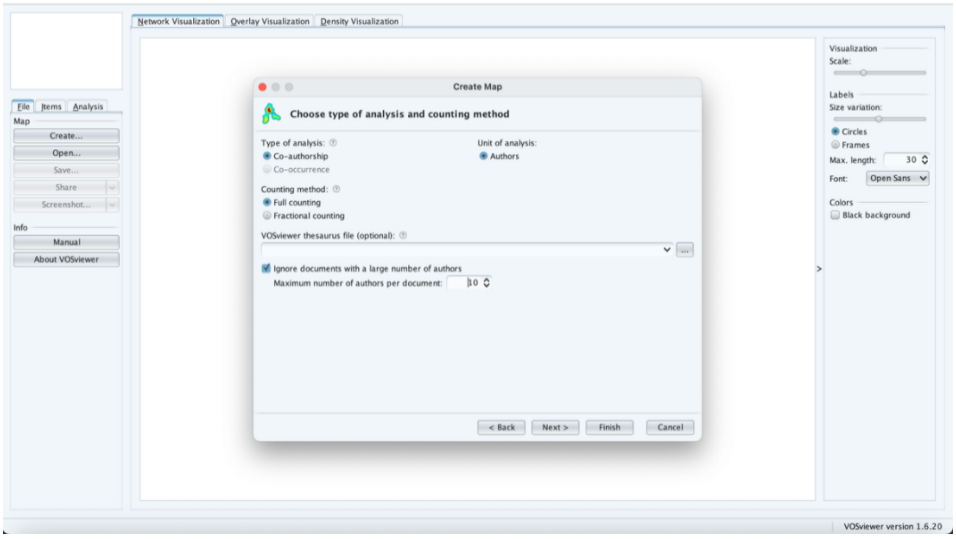

Figure 5. Database Utilization Process with *vos viewer*
Source: processed (2026)

Furthermore, the researcher sets the minimum limit of the work that has been produced by the author according to the theme of 2 (two) writings. This limit is set on the assumption that if the author has produced more than 1 (one) work, then the author has an interest in the theme and is likely to have a relationship with other writers with the same interest. Of the 1858 authors recorded in the database, 202 of them met these criteria.

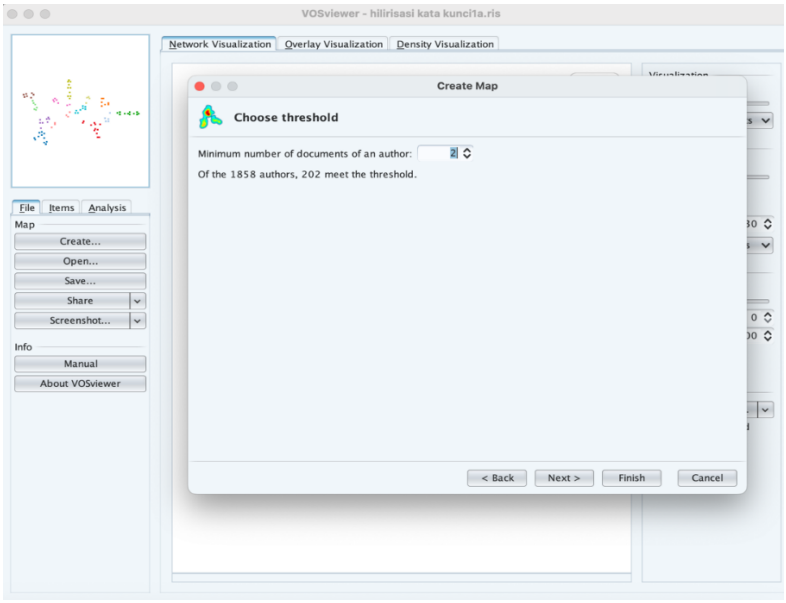

Figure 6. Filtering Process Before Analysis
Source: processed (2026)

From the results of the VOSviewer analysis, it is known that there are 32 authors who are connected, and from this number, they are grouped into 8 (eight) clusters with a minimum of 2 (two) authors and a maximum of 7 (seven) authors per cluster. The majority of the names that appear are Chinese names.

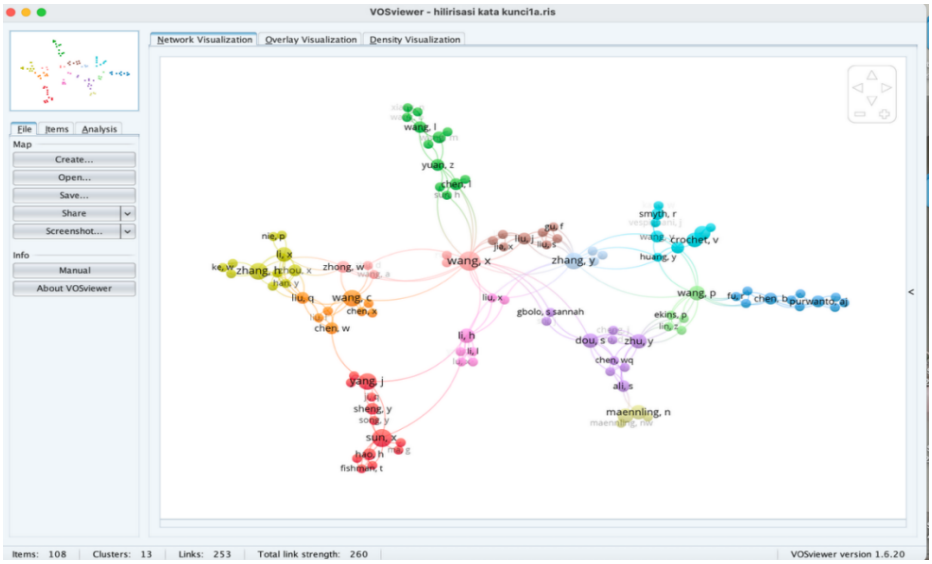

Figure 7. Co-authorship *pattern* of *VOS viewer analysis results*
Source: processed (2026)

From the figure above, researcher Wang, X. is positioned at the center with a large node size. In network analysis, the author possibly serves as a key opinion leader who connects groups of researchers from different fields or institutions. The emergence of foreign names reflects significant international collaboration, particularly the research interdependence between researchers who focus on Indonesian resources and extraction technology experts from other countries, such as China.

Local researchers such as Purwanti, A.J. began to appear in the 2024–2025 period, albeit with more specific research themes, as indicated by the smaller node sizes compared to others. Furthermore, several nodes located in the peripheral area, such as Fishman, T., at the bottom with fewer connections, indicate that their research is more specialized or less integrated with the mainstream. Based on the publication year overlay, it can be observed that the connectivity among

authors has increased since 2023. The results of the analysis also show that the work of earlier authors has been updated and has developed overlap with that of other authors.

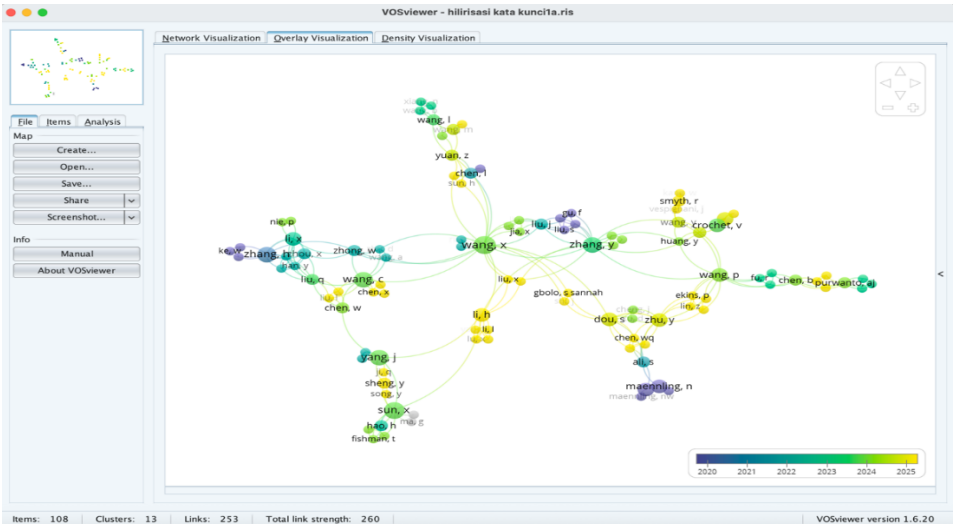

Figure 8. Novelty-based co-authoring pattern
Source: processed (2026)

The figure above shows that researchers in clusters with blue/purple nodes, namely in the 2020–2021 period, such as Maennling, N. and Zhang, H., were the early pioneers who discussed the basis of downstream policies. If one refers to the timeline, it is likely that their research is closely related to the ban on Indonesian nickel exports, which prompted international lawsuits. Furthermore, the 2022–2023 period, represented by green nodes, indicates the peak of publication, as evidenced by the greater number of green nodes that are beginning to spread. The distribution of green nodes, which then form new clusters, shows the development of research moving toward implementation and specificity regarding mineral downstreaming. The period 2024–2025, represented by yellow nodes, signifies the expansion of research on current issues and new yet still related material on mineral downstreaming in Indonesia.

Co-occurrence pattern of mineral downstream theme in Indonesia

Furthermore, to identify the thematic map produced from the analysis of publication keywords, the author again imported the database into the VOSviewer system.

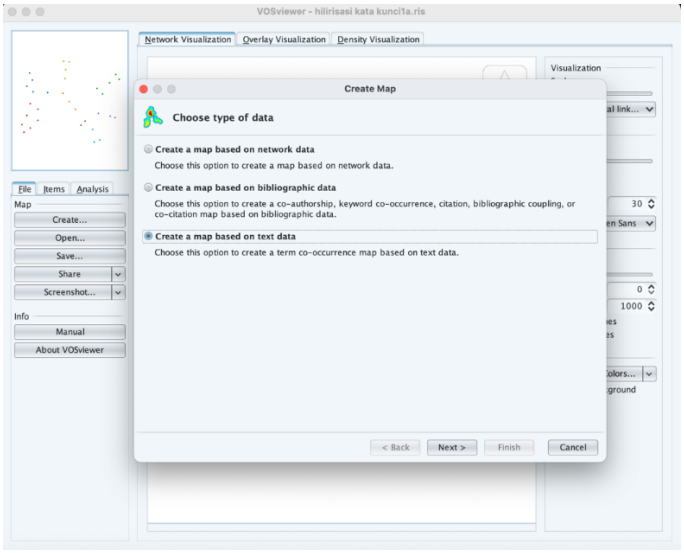

Figure 9. Early stages of *the co-occurrenceance analysis process*
Source: processed (2026)

The linkages analyzed are not only from the title but also from the abstract. The researcher configures the VOSviewer application using binary counting and a minimum occurrence of 2 (two). From the settings applied, there are 1,083 interconnected items from a total of 4,939 items from the initial data. Subsequently, the researcher re-verified the words that were not relevant to the theme of mineral downstreaming in Indonesia.

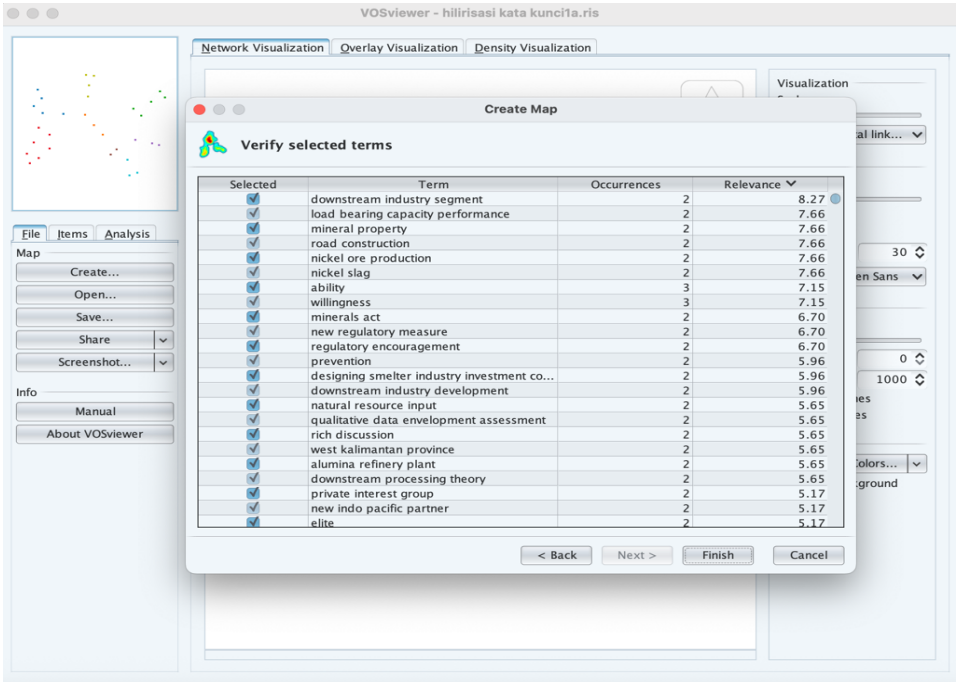

Figure 10. Final verification of relevant 'words'
Source: processed (2026)

The results of the analysis of VOSviewer in co-occurrence mapping can be seen in the image below:

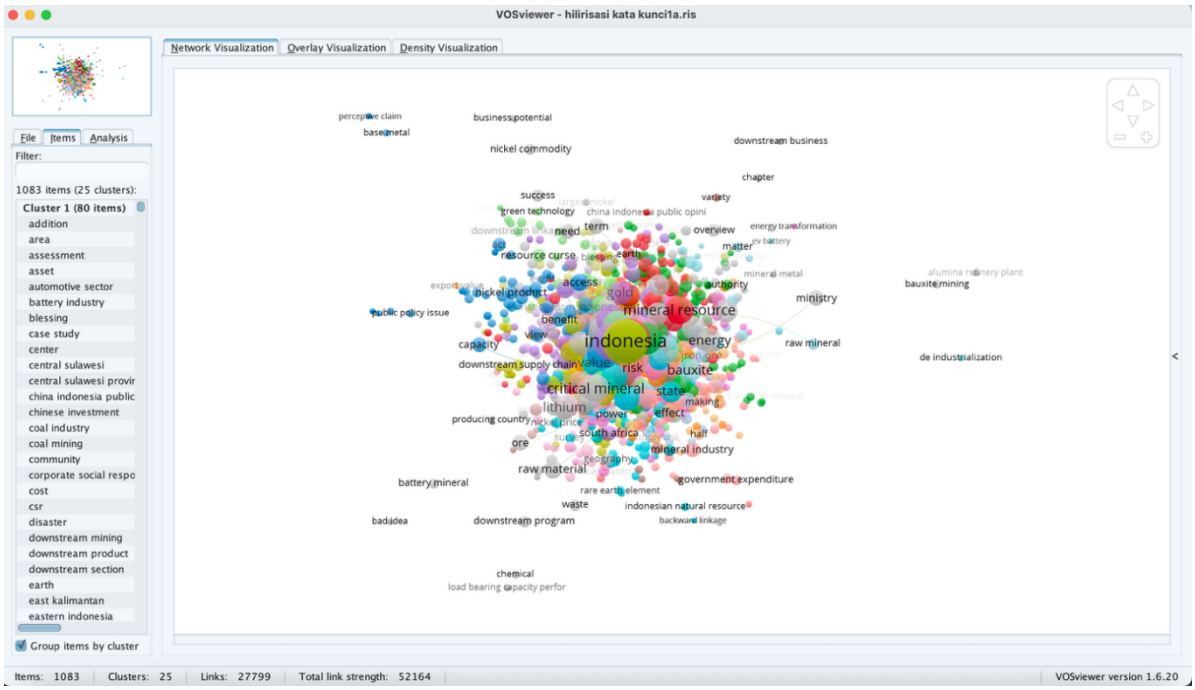

Figure 11. Co-occurrence pattern on mineral downstreaming in Indonesia
Source: processed (2026)

Referring to the image above, it can be seen that there are 27799 relationships out of 1083 items that have been filtered. All items are grouped into 26 clusters with the following details:

Table 2. Results of Grouping to Database

Cluster	Item
Cluster 1 (80 items)	*Addition, area, assessment, asset, automotive sector, battery industry, blessing, case study, center, central Sulawesi, central Sulawesi province, China Indonesia public opinion, Chinese investment, coal industry, coal mining, community, corporate social responsibility, cost, csr, disaster, downstream mining, downstream product, downstream section, earth, East Kalimantan, eastern Indonesia, environment, environmental damage, environmental impact, ESDM, esg, exclusion, extraction, extractive industries, Ghana, governance, health, Indonesian government, initial stage pertain, integrated nickel, integrating environmental social, key mineral, massive exploitation, mining area, mining industry, Morowali, Morowali district, Morowali regency, natural resource, nickel downstream, nickel mine, nickel mine exploitation, nickel mineral, nickel mining, nickel mining industry, nickel raw manetrial, number, obi island, potential, priority, production chain, pt freeport Indonesia, quality, region, river, Samarinda, significant deposit, silver, social affair, social conflict, southeast Asian energy, special economic zone, stainless steel, sustainability, target, type, water quality*
Cluster 2 (73 items)	*Added value, advantage, anxiety, authority, belt, bri, change, climate, coal law, complexity, context, cooperation, corruption, dilemma, dispute, distribution, downstream policy, endowment, energy transition mineral, European union, exploitation, gpns, home, Indonesian government, industrial development, industrial downstreaming, industry chain, innovation, institutional change, international law, interplay, landscape, largest exporter, license, lot, market position, metal mineral, mineral ore export, mineral resources, mineral resources regulation no, mineral resources regulation number, minister, national interest, national law, national policy, natural resource management, natural resources management, nickel, outcome, outlook, palm oil, party, pathways, place, policy, polycrisis, product, realization, recent year, regulatory framework, republic, resilience, road initiative, scenario analysis, section, service, system dynamic, time, transformation, transformation towards green Economy, Vision, Welfare*
Cluster 3 (72 items)	*Ability, access, act, Africa, base metal, benefit, capacity, Carnegie, Chinese capital, class, designing smelter industry, detail, downstreaing industry development, downstream industry segment, downstream manufacturing, downstream process, downstream production, downstream value, economic, electric vehicle revolution, elite, event, financing, graphite, increase, Indonesian economy, Indonesian government policy, Indonesia nickel industry, Indonesian nickel processing, Indonesias export, Indonesias measure, Indonesias nickel industry, Indonesias policy, industrialization, industry, input, institute, institutional position, interest, life cycle assessment, local content, loss, nationalism, natural resource exporter, nature, new Caledonia, new indo pacific partner, nickel downstream program, nickel export ban, nickel product, nickel smelter industry, nonrenewable natural resources, perceptive claim, policy implication, prevention, private interest group, prohibition, public affairs, public policy issue, public policy support, restriction, revenue, rise, smelter industry, social construct, stage, strategic mineral, structure, transition mineral, view, willingness*
Cluster 4 (71 items)	*Amount, attainment, competitive advantage, concept, critical mineral resources, deal, dependency, discourse, down, downstream industrial sector, downstream supply chain, dualism, economic analysis, element, enactment,*

Cluster	Item
	export policy, export restriction, facility, form, global impact, global south, green industrial policy, hope, importance, Indonesia Indonesia mineral, Indonesian mineral industry, Indonesian nickel production, infrastructure development, intersection, investment policy, legal mimicry, lesson, literature, metal, mineral product, mineral raw material, molybdenum, moratorium, natural capital, natural resource endowment, natural resource export, natural resource governance, neoliberalism, nickel downstreaming policy, nickel export, nickel industry, nickel production, order, paper, partner, permanent sovereignty, politic, political economy, poverty, problem, project, prosperity, public policy onjective, rare earth, raw nickel ore, regional ev battery chain, Roadmap, Smelter, Strategy, Sustainable Development, Technology, Tesla, Word, WTO Dispute Settlement
Cluster 5 (71 items)	*Afghanistan, approach, asean country, basis, book, copper, decade, development state, diamond, domestic downstream consumption, downstream community, downstream issue, downstream market, economic benefit, economic nationalism, economu, efficiency, end, etc, evidence, expenditure, free trade, gas, gold, high value natural resource, history, illegal mining, industry code, international trade rule, investor, Japan, law, leader, livelihood, local content requirement, local government, measure, mineral, mineral asset, mining areas, mining company, Myanmar, natural gas, natural resource advantage, oil, optimum level, papua new guineam part, peti, petroleum, pgms, post conflict peacebuilding, practice, psnr, resource abundant country, rest, royalty, rule, society, something, South Africa, South Korea, sustainable natural resource, territory, threat, timber, trade cooperation, upstream, Vietnam, way, world*
Cluster 6 (65 items)	*Action, administration, art, backward linkage, battery technology, Canada, capital, China, Chromium, contributor, critical raw material, criticality, criticality assessment, data, depletion, downstream material, downstream policy, dynamic, economic effect, economic sector, Europe, first, formulation, future perspective, global cobalt supply chain, government legislation, green energy transition, identification, implications, Indonesian mining industry, Indonesian natural resource, Indonesian policymaker, influence, insight, Iran, Kazakhstan, law number, list, Makassar strait area development, methodology, mineral sector trade, minerals industry, month, natural resource curse, nickel downstream policy, nickel ore export restriction, nickel price, North Maluku, patterns, rare earth element, recent development, recommendation, regional governance, review, revision, sector, state, strategic autonomy, strategic mineral resource, suggestion, supply, survey, taxation, value, year*
Cluster 7 (57 items)	*Action, administration, art, backward linkage, battery technology, Canada, capital, chronium, cobalt, contributor, critical raw material, criticality, criticality assessment, data, dependenct, downstream material, dynamic, economic effect, economic sector, first, formulation, future perspective, global cobalt supply chain, government legislation, green energy transition, identification, implications, Indonesia mining insutry, indonesian policymaker, insight, Iran, law number, list Makassar strait area development, methodology, minerals industry, month, natural resource curse, nickel price, North Maluku, patterns, rare earth element, recent development, recommendation, regional governance, review, revision, sector, strategic autonomy, strategic mineral resource, suggestion, supply, survey, taxation, titanium, year*
Cluster 8 (51 items)	*Ability, access, act, base metal, class, detail, downstream industry segment, downstream process, downstream production, downstream value, economic, electric vehicle revolution, elite, event, export value, indonesia economy,*

Cluster	Item
	indonesian government policy, indonesian nickel industry, indonesian nickel processing, Indonesias measure, industrialization, input, life cycle assessment, local content, loss, measure, nationalism, natural resource exporter, nature, New Caledonia, new indo pacific partner, nickel downstreaming program, nickel export ban, nickel product nonrenewable natural resource, perceptive claim, policy implication, pricem principle, private interest group, prohibition, public affair, public policy support, restriction, rise, cosial construct, Southest Asia, stage, structure, willingness
Cluster 9 (51 items)	*African battery value chain, age, analysis, Argentina, Asean, Australia, battery, battery supply chain, chain, Chile, coin, concern, conflict mineral, Congo, critical mineral supply, crucial role, democratic republic, developmental state, downstream activity, downstream capacity, downstream company, downstream mineral, economic policy, ev industry, extraction, global nickel price, global nickel resource, green industrialization, green transition, Indonesias nickel, Indonesias Nnickel resource, industrial chain, industrial development, Jokowi, manufacturing, natural resource commodity, natural resource industry, natural resource endowment, nickel diplomacy, opportunity, Prabowo, public poicy challenge, resource, resource nationalism, return, role, use, value addition, Zambia*
Cluster 10 (49 items)	*Aluminium, automotive industry, Chinese capital, community centric justice, de industrialization, downstream firm, downstream industry, downstream processing, downstream processing industry, electric vehicle, ev battery, higher value, Indonesias natural resource, Indonesias nickel sector, industrial park, industry specific, law no, line, Malaysia, market, matter, mineral deposit, mineral ore, natiral resource extraction, natural resource sector, nickel downstreaming, nickel sector, only natural resource, own natural resource, palm oil, Papua new, political economy analysis, Presidential regulation number, raw material case, raw mineral, raw mineral export, re industrialization, regulation, resurgence, safeguarding sovereignty, scarcity, colution, state, state capitalism, successful nickel downstreaming, support, systematic literature review, transition, wto*
Cluster 11 (48 items)	*Aluminium, Brazil, challenges, Chinese firm, coal resource, contrast, control, critical material, downstream nickel industry, downstream policy, downstreaming policy, drc, employment, energy source, enterprise, exploration, figure, foreign direct investment, France, gap, geopolitics, Germany, global market, global value chains, high pressure acid leaching, important natural resource, infrastructure development, lack, lead, limit, limited natural resource, mineral downstreaming, mining resource, Mozambique, natural resource export, natural resource production, nickel ore export ban policy, nickel processing, nickel, non renewable natural resource, rate, raw mineral material, relationship, reserve, system, tension, urgency, Vietnam*
Cluster 12 (47 items)	*Abundance, assessment, biggest nickel, China, comparative prespective, creation, decentralization, department, downstream linkage, downstream section, extractive, gas industry, Ghana, goodm indigenous people, Indonesia, Indonesian archipelago, industrial sector, land, Latin America, major mineral, majority, memr, metals industry, mine, minerals act, mining activity, natural resource abundance, natural resource deposit, new regulatory measurem oecd, open pit nickel mining activity, policy reform, poverty, producer, quality, region, regulatory encouragement, reliance, resource curse, rich natural resource, Russia, South, Sulawesi, tim mining, water quality, zinc*
Cluster 13 (39 items)	*Abundant mineral resource, central government, clean energy transition, coal mining activity, critical mineral market, critical mineral stickpile, critical*

Cluster	Item
	minerals strategy, domestic insutry, downstream, downstream area, economic diversification, effectiveness, energy security, environmental governance, half, downstreaming, indonesian nickel, Indonesias position, industry, institution, iron, largest nickel, law enforcement, mine tailing, nickel ore export ban, nickel reserve, Philippines, point, prospect, public, public policy, response, security, share, steel, subsidy, supply risk, unprocessed nickel, worlds nickel
Cluster 14 (38 items)	*Asean country, attention, blessing, boom, chromite, comparative stucy, copper, crude oil, curse, downstream issue, elimination, European Union, example, exhaustible natural resource, expenditure, export duties, export taxis, extractive insutries, fdi, financing, government, Indonesias government, leader, legality, legislation, Mexico, Myanmar, natural gas, permanent sovereignty, Philippines, relation, report, revenue, rich country, significant deposit, Thailand, timber, world trade organization*
Cluster 15 (38 items)	*Availability, decarbonization, dependence, development, downstream mining policy, effect, environmental sustainability, evaluation, export ban, focus, government expenditure, government revenue, growth, implication, industrial policy, Kalimantan, linkage development, making, mechanism, metal ore, mineral, mineral industry, mineral industry policy, mineral resource input, mining investment improvement, nation, natural resources policy, nickel downstream industry, nickel extraction, percent, process, resource rich country, strategic policy, structural transformation, sustainable resource management, year, ton*
Cluster 16 (37 items)	*Cent, company, custodian, downstream operation, economic development, ecosystem, environmental protection, extractive industry, failure, government regulation, indonesian person, industrial mineral, knowledge, largest natural resource, laws, legal framework, linkage, midstream, mineral export, minerals sector, mining practice, mining regulation, natural resource wealth, nickel ore export, petroleum industry, png, position, precious mineral, range science, right, social equity, soil, study, tool, Trend*
Cluster 17 (37 items)	*Addition, Africa, asset, benefit, capacity, Carnegie, certainty, cost, designing smelter industry, downstream investment, downstream manufacturing, downstream mining, economic diplomacy, esg, governance, graphite, increase, Indonesia governments, Indonesias export, influence, institute, key mineral, nickel smelter industry, nickel smelters, prevention, pr freeport Indonesia, public policy issue, smelter industry, strategic mineral, target, transformation, transition mineral, view*
Cluster 18 (35 items)	*Advantage, anxiety, bauxite, beneficiation, beneficiation law, Botswana, coal law, critical minerals industry, diamond cutting, diamond mining insutry, diversification, domestic natural resource, downstream benefication, downstream player, economy, foreign investment, formation, future, human capital, imperative, industrial downstreaming, innovation, license, local content requirement, metal mineral, natural resource advantage, politic, processing, reality, resource sector, South Africa, upstream, vision, way, welfare*
Cluster 19 (33 items)	*America, business potential, coal mining company, corporate strategy, country, dominance, environmental degradation, era, governance challenge, green technology, hand, hydrometallurgical method, incentive, lithium ion battery, mineral extraction, mineral mining, mineral processing, mineral supply chain, monitoring, need, nickel commodity, nickel resource, pure natural resource, renewable energy, significance, source, success, techno economic analysis, term, trade off, uncertainty, United States, Weda Bay*
Cluster 20 (25 items)	*Abundant natural resource, activity, artisanal, cadmium, construction, content, deposit, downstream consumer, driver, efficiency, firm, frontier, gas*

Cluster	Item
	sector, geopolitic, infrastructure, justice, level, location, middle income trap, mineral sector, notion, perspective, raja Ampat, scale, social policy, tourism, transport, unprocessed minerals, work, Zimbabwe
Cluster 21 (20 items)	*Aspect, challenge, community participation, developmental opportunity, disruption, downstream segment, energy transition, exception, geography, global supply, indonesian, Indonesias ban, industrial catch, non, producing country, protection, raw nickel, raw nickel export, strategic raw material, value chain*
Cluster 22 (18 items)	*Attention, comparative study, crude oil, curse, downstream insutry, elimination, example, exhaustiveible natural resource, export duties, export taxis, fdi, Indonesias government, legality, Mexico, relation, rich country, Thailand, world trade organization*
Cluster 23 (13 items)	*Alumina refinery plant, bauxite mining, case, downstream processing, energy, investment, major mineral, ministry, natural resource input, power, qualitative data envelopment, rich discussion, West Kalimantan Province*
Cluster 24 (13 items)	*Coal mining law, critical review, downstreaming, energy resilience, framework, industrialization, mineral metal, mining governance, mining resource, national security, nickel downstream sector, principle, urgency*
Cluster 25 (10 items)	*Chemical, downstream program, export, load bearing capacity perform, mineral property, nickel ore production, nickel slag, raw material, road construction, waste*
Cluster 26 (1 item)	*Variety*

Source: processed (2026)

Based on the clusters and items that have been compiled above, and in accordance with the VOSviewer analysis, Indonesia is the topic of discussion in many articles because it is connected to 993 out of 1,000 articles and an occurrence value of 636. Meanwhile, nickel is connected to 876 articles and has an occurrence level of 425. The discussion of natural resources has an occurrence rate of 388 and is related to 814 articles. Furthermore, minerals have a linkage of 696 and an occurrence number of 255. Downstream has as many as 527 linkages and an occurrence rate of 152. Several regions in Indonesia are also the focus of research, such as Morowali, North Maluku, East Kalimantan, and Sulawesi; however, specifically North Sulawesi and Kolaka Regency have not received much attention from researchers.

If one looks at the timeline of publications carried out, it can be seen that the majority of research was conducted after 2020, as seen in the following figure:

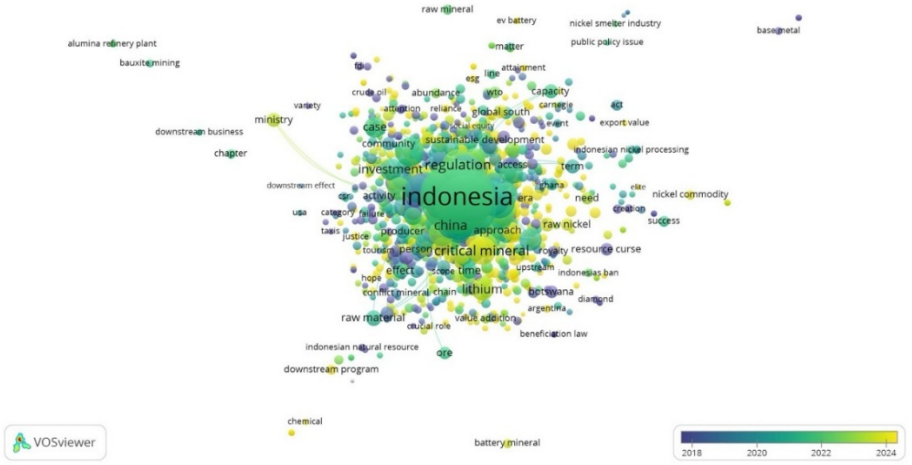

Figure 12. Co-occurrence pattern based on timeline

Source: processed (2026)

Based on the image above, there has been a shift in research locations that, before 2020, were still widely carried out in African regions such as Botswana and South Africa; now they have shifted to Asian regions such as Indonesia, China, Vietnam, and the Philippines. The largest nodes are Indonesia and then China, with adjacent positions. This confirms that Indonesia's downstream narrative is academically strongly associated with investment and economic cooperation with China. The discussion of regulation and investment, according to the image above, is a bridge between government policies and economic aspects. The discussion of regulation is interesting because it is closely linked to the investment climate—such as the policy on the export ban of raw materials (nickel ore).

According to the timeline shown by the yellow and green color nodes, research on the broader theme of mineral downstreaming is increasingly diverse. The research theme has now begun to expand to the electric vehicle industry, including its ecosystem. In addition, the keywords *sustainable development*, ESG, *social equity*, and *justice* are growing stronger in the 2023–2024 period. This condition shows that there is a strong and growing trend of research that is increasingly critical of social and environmental aspects. The commodities being studied are now increasingly diverse; whereas they were previously focused on oil and gas and diamonds, they are now shifting to critical minerals such as nickel and coal.

Discussion

Trend of Mineral Downstream Research Publications in Indonesia

From the results of the bibliometric analysis, a continuous increase in the number of studies since 2020 can be observed. This is likely due to an increase in downstream activities in Indonesia following the second revision of the Mineral and Coal Mining Law in February 2020, which requires business actors to add value to exploited minerals. In addition, the energy transition process taking place in various countries following the signing of the Paris Agreement in 2015 has also expanded the discussion on mineral downstreaming. Along with the increase in clean energy, Indonesia is leveraging its nickel reserves to become part of the electric vehicle ecosystem and stainless steel production to optimize its economic growth (Malik, 2024). It is therefore natural that Indonesia generates significant academic discussion, given that its supply chain plays an important role in the global energy transition. The massive exploitation of critical minerals such as nickel in Indonesia should certainly not disregard its environmental impact (Naryono, 2023).

Discussion on ESG (Environmental, Social, and Governance) has also grown alongside the awareness among mineral-producing countries of the possibility of a 'resource curse'. Therefore, strengthening the development and diversification of the value chain, optimizing cooperation through strategic partnerships, and formulating fiscal, trade, industrial, and regional cooperation policies are also discussed as factors that affect the success of mineral downstream programs—not only in Indonesia but also in various other countries. From a policy analysis perspective, this publication surge is not merely a reflection of academic interest but signals the global recognition of Indonesia as a critical case study in resource nationalism and industrial policy.

Kaplan (2018) have noted that developing countries' export restriction policies—particularly in the critical minerals sector—constitute a new form of structural economic governance that challenges the liberal trade order embedded in WTO frameworks. The dominant presence of China-affiliated researchers in the co-authorship network warrants critical scrutiny: it reflects not only China's central role as the primary investor in Indonesian nickel smelting (through RKEF and HPAL technologies in Morowali and Weda Bay Industrial Parks), but also raises questions about research agenda-setting and the extent to which Indonesian institutional perspectives are centered in the academic discourse. This represents both a finding and a strategic implication—Indonesian universities and research institutions should invest in building domestic bibliometric leadership to shape the narrative of their own resource governance.

Map of Relationships Between Authors

The results of the VOSviewer mapping show that there are 13 author clusters with 108 items. Furthermore, of this number, it is known that there are 253 total links with a link strength

of 260. Based on the visuals of the bibliometric results, the names of Wang, Zhang, Chen, and Li dominate the network. This condition shows the dominance of global researchers in research on the theme of mineral downstreaming. Examining the names of authors with a high level of linkage, it is possible that these authors are from China. This is highly logical, considering that China is the primary investor in smelter technology through either the High-Pressure Acid Leaching (HPAL) or the Rotary Kiln Electric Furnace (RKEF) scheme in Indonesia (such as in Morowali and Weda Bay).

Based on the timeline, the peak of publications with high collaboration intensity is seen in the 2022–2023 range. This phenomenon occurred because, during that period, mineral downstreaming became a topic of significant discussion at the global level. The frequency of research on mineral downstreaming during that period is likely closely related to the ban on nickel ore exports by the Indonesian government. The high intensity of discussions on mineral downstreaming at that time also reflected a high level of collaboration among the authors. This was observed even as the theme began to shift toward discussions of other, more specific topics, such as electric vehicles and their ecosystems.

Thematic Relevance of Keyword Analysis Results

Across many studies on mineral downstreaming, the keyword 'Indonesia' appears in the center and dominates the chart. It is connected to all issues ranging from economics and engineering to social concerns and politics. In addition, discussions centered on the keywords 'mineral resources' and 'energy' are also closely connected to the main theme. This shows that downstream development in Indonesia is intrinsically related to energy security and the global energy transition. This topic is also a marker of the 'future' cluster connected to the battery industry supply chain. Other keywords that appear at the margins of the graph indicate specific topics that are separated into sub-disciplines of research. Keywords such as 'bauxite mining' and 'alumina refinery' indicate that the Indonesian bauxite research community follows a distinct trajectory and is not as extensive as research on nickel. Furthermore, the keywords 'public policy issue,' 'base metal,' 'chemical,' 'waste,' and 'load-bearing capacity' indicate specific research groups related to public policy, the comparison of base metals in general, and civil or chemical engineering techniques in the development of smelter infrastructure or waste management (tailings). The high strength of the relationship, which reached 52,164, shows that the issue of downstreaming is not discussed in isolation. There is an academic discourse in Indonesia that seeks to weigh the potential economic benefits against investment and environmental risks. In addition, the proximity of the keywords 'resource curse' and 'blessing' indicates a strong theoretical debate about whether downstreaming will prove to be a blessing or will instead repeat the patterns of failure seen in past mineral resource management. An interesting finding from the bibliometric analysis is the emergence of the keywords 'de-industrialization,' 'public opinion,' and 'corporate social responsibility (CSR)' in the periphery of the graph. This phenomenon indicates a research gap that invites further investigation. To date, several studies have questioned the impact of downstreaming on industry, as there are concerns that downstreaming may trigger de-industrialization in other sectors.

Meanwhile, the massive downstream activities have also given rise to new research on public perception of this national strategic project. Another notable keyword is CSR, as several researchers have begun to explore the role of companies—particularly smelter companies—in the community through their CSR allocations and programs. The proximity of 'resource curse' and 'blessing' keywords in the co-occurrence map is analytically significant. It reflects an unresolved theoretical debate in the literature: whether Indonesia's downstreaming policy will overcome the classic resource curse trap documented in African and Latin American commodity exporters Ploeg (2011), or whether it will reproduce new forms of enclave industrialization and environmental externalization. The emergence of 'de-industrialization' as a peripheral keyword also merits policy attention—it signals a concern among economists that intensive mineral processing, dominated by foreign capital and imported technology, may crowd out domestic manufacturing development rather than catalyze it (Auty, 2001; Wenar, 2015). Future research should empirically test whether Indonesia's downstream industrial zones generate genuine backward

and forward linkages, or whether they constitute technology-dependent enclaves with limited domestic value diffusion.

CONCLUSION

Research on mineral downstreaming in Indonesia has grown rapidly over the past five years, with the focus shifting from macroeconomic discussions and the resource curse toward the technical aspects of mineral extraction, the electric vehicle battery ecosystem, and sustainability (ESG). This development was triggered by the nickel ore export ban policy as a case study of natural resource nationalism. Bibliometric analysis indicates that this research is international in nature, featuring strong collaboration with Chinese institutions, as well as a thematic map encompassing 25 clusters centered on regulation, investment, and critical minerals—reflecting the multidisciplinary nature of mineral governance.

Nevertheless, several strategic challenges remain to be addressed, including over-reliance on China-based research networks, interdisciplinary fragmentation that hinders the formation of an integrated framework, and persistent academic concerns regarding the resource curse and deindustrialization. Therefore, future research should include longitudinal studies of policy impacts, comparisons with other countries such as Chile and Botswana, assessments of social impacts in industrial areas like Morowali and Weda Bay, the transition of smelters toward renewable energy, and the strengthening of domestic capital to reduce reliance on foreign technology.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to Universitas Bina Nusantara, Sekolah Tinggi Ilmu Hukum IBLAM, and Institut Pemerintahan Dalam Negeri for their institutional support. Appreciation is also extended to all contributors, experts, and parties involved in the data collection, validation, and analysis processes that enabled the successful completion of this research.

AUTHOR CONTRIBUTION STATEMENT

This study was collaboratively conducted, where Brigita Purnawati Manohara led the conceptualization, data collection, and manuscript drafting; Muhammad Iqbal and Hyronimus Rowa contributed to methodology development and data analysis; while Suhajar Diantoro and Tjahyo Suprajoyo provided supervision, critical review, and validation of the findings. All authors have reviewed and approved the final version of the manuscript.

REFERENCES

Agency, I. E. (2023). *Critical minerals market review 2023*. OECD Publishing.

Auty, R. M. (2001). The political economy of resource-driven growth. *European Economic Review*, *45*(4–6), 839–846. https://doi.org/10.1016/S0014-2921(01)00107-7

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j. jbusres.2021.04.070

Dugoua, E., Noailly, J., & Bystrom, O. (2025). *Critical minerals and the clean energy transition: the role of innovation across the supply chain*. London School of Economics and Political Science.

Farawansa, S. M., & Gultom, E. R. (2024). Diagnosis Of Nickel Industry Downstreaming Policy In Export Restriction Towards Increasing Economic Added Value In Indonesia. *Jurnal Legalitas*, *17*(1), 1–16. https://doi.org/10.33756/jelta.v17i1.19688

Fikru, M. G., & Kilinc-Ata, N. (2024). Do mineral imports increase in response to decarbonization indicators other than renewable energy? *Journal of Cleaner Production*, *435*, 140468. https://doi.org/10.1016/j.jclepro.2023.140468

Handika, I. (2023). Tata Kelola Hilirisasi Mineral Dalam Sistem Hukum Nasional. *Konferensi Nasional Asosiasi Pengajar Hukum Tata Negara Dan Hukum Administrasi Negara*, *1*(1), 143–158.

Islam, M. M., Sohag, K., & Alam, M. M. (2022). Mineral import demand and clean energy transitions in the top mineral-importing countries. *Resources Policy*, *78*, 102893.

https://doi.org/10.1016/j.resourpol.2022.102893
Kaplan, S. B. (2018). The rise of patient capital: The political economy of Chinese global finance. *Institute for International Economic Policy Working Paper Series, Elliott School of International Affairs and the George Washington University*.
Krustiyati, J. M., & Gea, G. V. V. (2023). The paradox of downstream mining industry development in indonesia: analysis and challenges. *Sriwijaya Law Review*, *7*(2), 335–349.
Malik, R. H. (2024). *Stakeholder views on the uptake of sustainable and responsible nickel mining and processing supply chains for electric vehicles in Indonesia*. Massachusetts Institute of Technology.
Naryono, E. (2023). Nickel mine exploitation in Indonesia, between a blessing and a disaster of environmental damage. *Center for Open Science*, 1–22.
Ploeg, F. van der. (2011). Natural resources: curse or blessing? *Journal of Economic Literature*, *49*(2), 366–420. https://doi.org/10.1257/jel.49.2.366
Rochwulaningsih, Y., Sulistiyono, S. T., Masruroh, N. N., & Maulany, N. N. (2019). Marine policy basis of Indonesia as a maritime state: The importance of integrated economy. *Marine Policy*, *108*, 103602. https://doi.org/10.1016/j.marpol.2019.103602
Ross, M. L. (2015). What have we learned about the resource curse? *Annual Review of Political Science*, *18*(1), 239–259. https://doi.org/10.1146/annurev-polisci-052213-040359
Sovacool, B. K., Ali, S. H., Bazilian, M., Radley, B., Nemery, B., Okatz, J., & Mulvaney, D. (2020). Sustainable minerals and metals for a low-carbon future. *Science*, *367*(6473), 30–33. https://doi.org/10.1126/science.aaz6003
Wang, J., Wang, K., & Phoumin, H. (2026). Critical Minerals, Supply Chain, and Energy Transition Analysis: A Systematic Review. *Critical Minerals Supply Chains Security and Resiliency in the ASEAN, Vol. 2: Policy and Technology*, 31–53. https://doi.org/10.1007/978-981-96-9354-2_2
Wau, F. T., Kiton, M. A., Wau, M., & Fau, J. F. (2024). Analisis strategis kebijakan hilirisasi mineral: Implikasi ekonomi dan pengaruhnya terhadap perekonomian Indonesia. *Journal Publicuho*, *7*(3), 1215–1224. https://doi.org/10.35817/publicuho.v7i3.481
Wenar, L. (2015). *Blood oil: Tyrants, violence, and the rules that run the world*. Oxford University Press.
Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629