
**INDONESIAN NATIONAL TIN PRODUCTION PLANNING:
CONCEPTUAL FRAMEWORK****Hadi Sahal Fadly Daulay¹, Andri Budhiman Firmanto¹, Yoke Pribadi Kornarius^{3*}**Kementerian Energi dan Sumberdaya Mineral Bandung, Indonesia^{1,2}, UniversitasKatolik Parahyangan Bandung, Indonesia³Email : hadi.sahal@gmail.com¹, andri.budhiman.f@gmail.com²,yoke.pribadi@unpar.ac.id^{3*}

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ABSTRACT**Keywords:** attendance; agile; mobile applications; human error.

Tin mining in Indonesia has been regulated by Indonesia Law Number 3 of 2020. However, it has not been fully utilised in Indonesia despite the country's abundant tin deposit opportunities, its position as one of the significant producers of tin globally, and the impact on both the global tin stock and price. In light of this, a comprehensive literature review has been carried out; an initial conceptual framework and causal loop diagram of Indonesia's national tin production planning have been produced to produce the concept of an instrument for setting national tin production quotas and the concept of formulating the distribution of national tin production levels that could be a reference for future researchers as well as Government of Indonesia in order to find the national tin production planning.



Introduction

Article 3 of Law Number 3 of 2020 ("Mineral and Coal Law") states that to support sustainable national development, the purpose of mineral management (one) is to ensure the availability of minerals as raw materials for domestic production (Hanif & Suherman, 2023). The fact that Indonesia is known as a country that has abundant mineral reserves in the world; Indonesia's contribution to world production also affects London Metal Exchange (LME) stocks and world tin prices and has helped the economy of local communities through infrastructure, foreign trade, government revenue, and direct and indirect employment. However, illegal mining practices will have negative impacts, including environmental damage, land and threatening biodiversity (Rey-Martí et al., 2023). Other problems related to tin mining in Indonesia include miners who become illegal tin collectors and the person in charge of calculating tin reserves not having the necessary competencies, which leads to no optimal state revenue.

Law Number 3 of 2020 in Article 3 states that one of the objectives of mineral management is to ensure the availability of minerals as raw materials for domestic production to support sustainable national development. Indonesia is known as a country with abundant mineral reserves worldwide. This can be seen from the report (U.S. Geological Survey, 2023), which states that Indonesia's tin reserves are ranked 1st in the world or contribute 17.3% of the world's tin reserves. Indonesia is ranked 2nd in the world for tin production and contributes 23.5% of world tin production.

Tin mining permit holders in Indonesia can conduct tin mining up to producing pure tin bars with the condition that the Work Plan and Cost Budget have been approved. As

one of the countries with the most significant tin production, tin production in Indonesia more or less affects the supply-demand principle that affects metal prices, and metal prices are influenced by financial market conditions (Arezki & Matsumoto, 2015). In Indonesia, the benchmark price of tin is calculated using the formula Mineral Benchmark Price (Mineral et al.) as stipulated in the Decree of the Minister of Energy and Mineral Resources Number 2946 K / 30 / MEM / 2017, where the benchmark price of tin bars is the same as the reference price of tin set every month with the stipulation of the Decree of the Minister of Energy and Mineral Resources. In the Decree of the Minister of Energy and Mineral Resources stipulated monthly regarding the mineral reference price, the tin reference price refers to the settlement price on the Indonesia Commodity & Derivatives Exchange (ICDX) and Jakarta Future Exchange (JFX) on the day of sale. (ICDX, 2023) states that one of the tin market's fundamental drivers is price movements in international markets such as LME, KTM, and SHFE. In addition, the USD exchange rate against other major currencies, economic factors in major producing and consuming countries, commodity-specific events, Government trade policies, and geopolitical events are also considered factors affecting the tin market (Indra Ibrahim, 2015).

Mining activities have helped local communities' economies through infrastructure, foreign trade, government revenue, and direct and indirect employment. However, this has negative impacts, including rapid environmental damage, land and crops, and threatening biodiversity (Rey-Martí et al., 2023).

Based on literature studies that have been conducted on the topic of mining, policy, and tin in Indonesia, there has not been much research that discusses tin production planning in Indonesia. Research that has been conducted on the topic of mining in Indonesia includes the environmental impact of mercury utilisation in gold mining (Castilhos et al., 2006; Edinger et al., 2008; Kambey et al., 2001; Tomiyasu et al., 2013), environmental health impacts of mercury utilisation in gold mining (Male et al., 2013; Nakazawa et al., 2016), social or local communities from several mining sites, such as in East Nusa Tenggara (Erb, 2016), in Bogor, West Java (Libassi, 2020), and in general regarding labour wages (Pelzl & Poelhekke, 2021).

Research related to tin in Indonesia, among others, discusses local communities (Rosyida & Sasaoka, 2018), the socioeconomic impact of tin mining on Singkep Island (Syahrir, Wall, & Diallo, 2020), the inequality of resource distribution and tin profits on the coast of Bangka Island (Ibrahim Ibrahim, Sulista, & Pratama, 2022), and the economic impact of tin mining in Babel Province in 2001–2015 (Sulista & Rosyid, 2022).

Most of the research that has been done has not proposed better mining management solutions in Indonesia, especially in mining management. Therefore, this study is the first to present the conceptual framework for planning Indonesia's national tin production quota.

One study on production quotas comes from (Yi et al., 2021), who studied critical mineral quota policies in China and their implications for sustainable supply capacity. Their study analysed several parameters affecting production quota policy: reserve-

production ratio, reserves, output, employees, output value, sales revenue, consumption, net profit, return on assets, and net interest rate on assets.

We analysed the relatedness of specific search strings from the ScienceDirect database to analyse the research gap. The results of the analysis using the VOSViewer application (Figure 1) show that the relationship between the keyword "Mining & Policy & Indonesia" in the majority of journals related to COAL with the year of publication of journals related to the topic of Coal from 2021 onwards (bright yellow). In other words, there are still research opportunities related to mining, policy, and Indonesia for mineral commodities, especially tin.

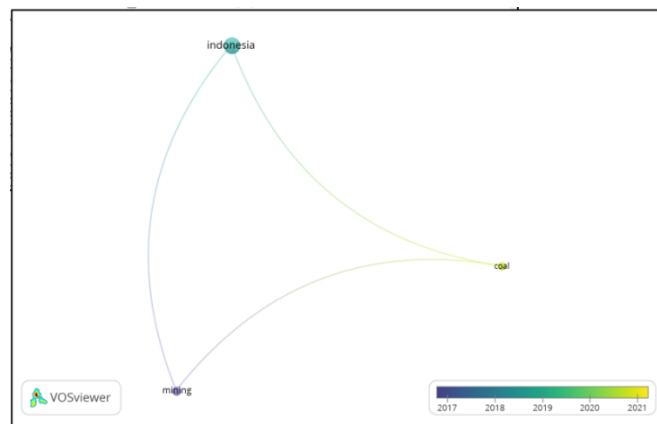


Figure 1. Results of Research Gap Analysis with VOSViewer

Reflecting on these facts, several problems, such as Indonesia's national tin production level, need to be solved, which can create world tin price stability. What variables need to be considered in formulating the distribution of production quotas? What is the formula for determining production based on prioritising alternatives to determine the ranking?

To answer the above questions, we created a conceptual framework for Indonesia's national tin production planning, which aims to produce the concept of instruments for determining national tin production quotas and the concept of formulating the distribution of national tin production levels to prevent overexploitation of tin commodities in order to maintain environmental management, eradicate illegal miners, and optimise state revenue.

Research Methods

The method of conducting research is illustrated in Figure 2. The first step to formulate the conceptual framework of Indonesia's tin national production quota is to obtain state-of-the-art research using the comprehensive literature review method, which is obtained by utilising searches using several keywords in the bibliographic database of scientific publications ScienceDirect, with the keywords used are:

1. Mining AND Indonesia
2. Mining AND Policy AND Indonesia

3. Tin AND Mining AND Indonesia

Then, I will do an abstract and quick reading of the journal's contents (body skim reading). After conducting a literature review, we analysed the research gap by running VOSviewer software. A conceptual framework is proposed from a thorough literature review of the results and the research gap.

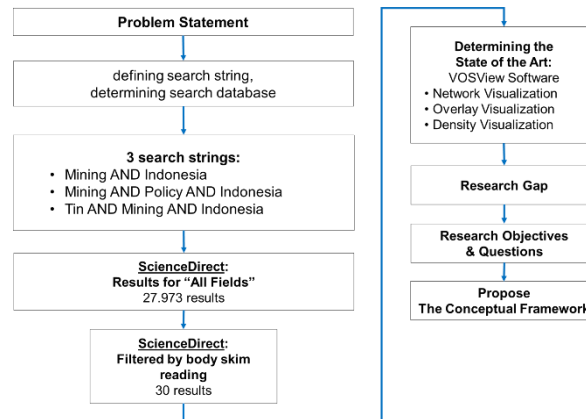


Figure 2. Research Methodology

The literature study results and subsequent research gaps are used to determine research objectives and questions. Based on these matters, a conceptual framework for planning Indonesian national tin production was proposed.

Results and Discussion

Based on a literature review and research gap analysis by running VOSviewer software, a conceptual framework and causal loop diagram of the beginning of Indonesia's national tin production planning were produced.

1. Conceptual Framework of Indonesian National Tin Production Planning

By adopting standards from the Initiative for Responsible Mining Assurance (IRMA) related to mining issues in the form of positive legacy planning (Initiative for Responsible Mining Assurance (IRMA), 2021) and parameters affecting production quota policies conducted in research in China (Yi et al., 2021), the conceptual framework of Indonesia's national tin production planning is illustrated in Figure 3.

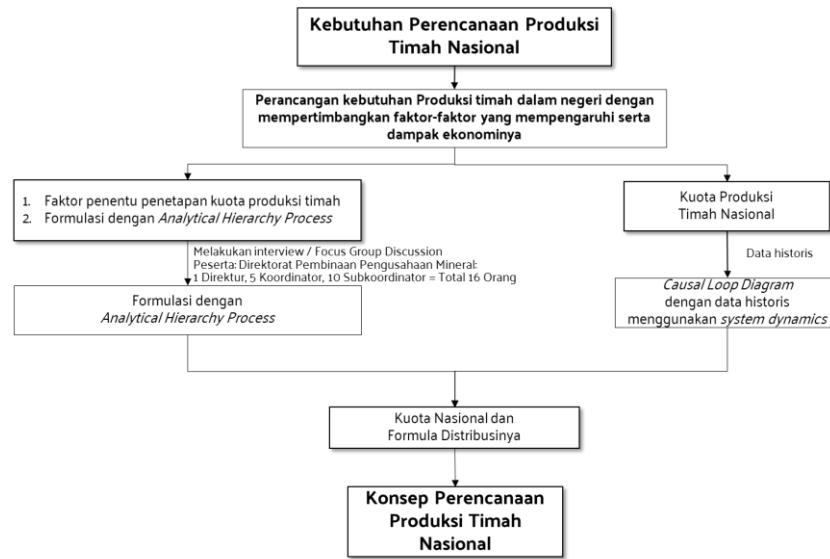


Figure 3. Conceptual Framework of Indonesian National Tin Production Planning

After obtaining the planning needs of national tin production, it is necessary to design the needs of national tin production by considering the influencing factors and economic impacts. In considering the factors affecting national tin production, it is necessary to conduct an interview or Focus Group Discussion with participants of the Directorate of Mineral Exploitation Development of the Ministry of Energy and Mineral Resources. Interviews or Focus Group Discussions can enrich factors in determining tin production quotas. From the results obtained, formulations will be carried out with prioritisation methods for alternatives to determine the ranking, for example, the Analytical Hierarchy Process with IRMA priority ranking. Positive legacy planning standards within the Indonesian context (Initiative for Responsible Mining Assurance (IRMA), 2021) and parameters affecting production quota policies (Yi et al., 2021). Later, national tin production quotas can be obtained by conducting a dynamic system using Vensim software and producing causal loop diagrams.

2. Preliminary Causal Loop Diagram for Indonesian National Tin Production Planning

The initial causal loop diagram proposal for Indonesia's national tin production planning is shown in Figure 6 by taking into account IRMA's planning standards for positive inheritance with the Indonesian context (Initiative for Responsible Mining Assurance (IRMA), 2021) and parameters that have an impact on production quota policies (Yi et al., 2021).

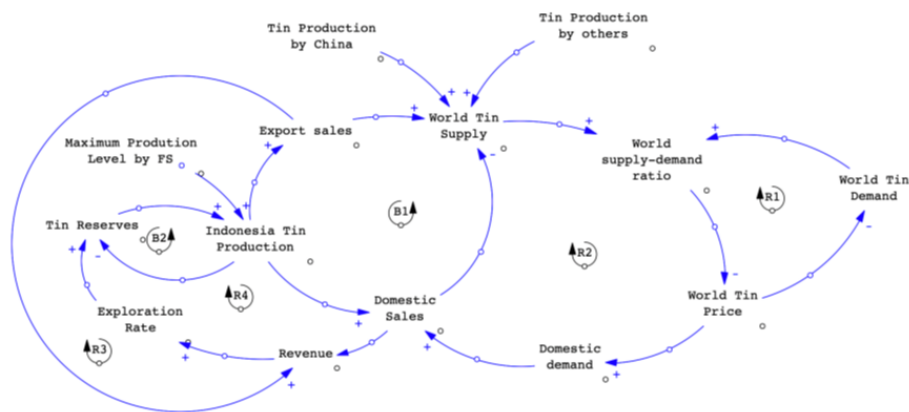


Figure 4. Preliminary Causal Loop Diagram for Indonesian National Tin Production Planning

The initial Causal Loop Diagram shows that Indonesia's national tin production planning is divided into three subsystems (Indonesia's tin production, world tin demand, and world tin supply) consisting of 20 variables, and the details are described in Table 1.

Table 1.
Variables in the Early Causal Loop Diagram of Indonesia's National Tin Production Planning

Remain	Variable	Korelasi
1. Indonesia's tin production	Recommendations / Reserves	Increasing Indonesia's reserves and maximum production level based on a feasibility study will increase Indonesia's tin production and decrease Indonesia's total reserves, but conversely, increasing Indonesia's tin production can reduce the amount of reserves. Increasing Indonesia's tin production will also increase export and domestic sales, increasing revenue. With the increase in income, the rate of exploration will increase, thus increasing the amount of tin reserves.
	Maximum production level by a feasibility study	
	Indonesia's tin production	
	Domestic sales	
	Export sales	
	Income/revenue	
2. World in demand	World Tin Demand	Increasing the world's demand will increase the world's supply-demand ratio. However, the world tin price will decrease along with the increase in the world supply and demand ratio. The decline in world tin prices will reduce world tin demand.
	World supply-demand ratio	
	World Tin Price	
3. World in supply	Indonesia's export sales	Increasing sales of tin exports from Indonesia, tin production from China, and tin production from other countries will increase the world's tin supply. The
	Produksi Timah China/tin production by China	
	Tin production by others	
	World in supply	

Remain	Variable	Korelasi
	World supply-demand ratio	supply-demand ratio will also increase as the world's tin supply increases.

Subsystem 1 (Indonesia's tin production) explains that increasing Indonesia's reserves and maximum production levels based on feasibility studies will increase Indonesia's tin production, but on the contrary, increasing Indonesia's tin production can reduce the number of reserves. Increasing Indonesia's tin production will also increase export and domestic sales, increasing revenue. With the increase in income, the rate of exploration will increase, thus increasing the amount of tin reserves.

Subsystem 2 (global tin demand) explains that increasing world tin demand will increase the supply-demand ratio. However, the world tin price will decrease along with the increase in the world supply and demand ratio. The decline in world tin prices will reduce world tin demand.

Subsystem 3 (global tin supply) explains that increasing tin export sales from Indonesia, Chinese tin production, and other countries' tin production will increase world tin supply. The supply-demand ratio will also increase as the world's tin supply increases.

Conclusion

Article 3 of Law Number 3 of 2020 ("Mineral and Coal Law") states that to support sustainable national development, the purpose of mineral management (one) is to ensure the availability of minerals as raw materials for domestic needs. Regarding the availability of minerals in Indonesia, it is famous as a country with abundant mineral reserves worldwide. Indonesia's contribution to world production also affects tin metal stocks on the London Metal Exchange (LME) and world tin prices. Although mining has helped the economy of local communities, there is still environmental damage caused by rampant illegal mining in Indonesia, such as illegal tin mining. Other problems in tin mining in Indonesia include miners who become illegal tin collectors and competent people who calculate tin reserves not according to their competence. Although Indonesia has large tin reserves, it is one of the largest tin producers. Indonesia's tin production impacts global tin stocks and prices, so tin mining management in Indonesia can be more optimal. Based on this and based on literature studies, a conceptual framework and causal loop diagram were produced in Indonesia's national tin production planning to produce the concept of an instrument for determining national tin production quotas and the concept of formulating national tin distribution to prevent overexploitation of tin commodities in order to maintain environmental management, eradicate illegal miners, and optimise state revenue, which is expected to be a reference for further studies and the Indonesian government in order to identify national tin production planning.

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