# Recent Research in the Malaysian Mining Industry and Its Contribution to Others Sectors: a Systematic Literature Review Approach

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# Abstract

Malaysia is endowed with an abundance of diverse minerals, making the mining sector one of the country's most important industries. However, there is a scarcity of literature devoted to studies of the Malaysian mining sector. Thus, the objective of this systematic research was to (1) to investigate the research trends in the Malaysian mining industries. and (2) to study the contribution of mining industry with others sectors in Malaysia. A systematic literature review (SLR) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) review technique discovered 24 papers linked to current research in the mining sector in Malaysia from 2016 to 2021 from the ScienceDirect and Scopus databases. Using thematic analysis, one primary theme and seven subthemes were produced based on 24 selected articles. The study on tin mining was the most widely circulated article in the preceding six years. Moreover, the research and publication on contribution of mining industry to various industries also were lacking such as in composite, cosmetic, construction industry and many more. In conclusion, the systematic review study may encourage mine owners, mine employees, government officials, and policymakers to write their own research and development (R&D), issues, or related problems in mining activities and publish them in reputable journals, conferences, and other publishing databases that will benefit the Malaysian mining industry.


# 1. Introduction

The National Mineral Industry Transformation Plan (TIM 2021–2030) was launched by Malaysia's National Mineral Council to sustain the mining and mineral industry holistically and assure its long-term viability (https://www.ketsa.gov.my/).The establishment of numerous mining-related acts, laws, and regulations aims to manage mineral extraction responsibly, guarantee that mining activities run smoothly, and minimize mining accidents or disasters. Despite the availability of various mining legislation, policies, and regulations, systematic literature reviews (SLRs) that examine or highlight current research trends in the mining industry in Malaysia are scarce. What are the current research trends have been studied in Malaysian mining studies was the main research question guided the SLR study. The themes and subthemes produced from this study might give new knowledge for future academic effort in order to meet the study's goal. It is critical to comprehend this and offer solutions to enhance this sector, particularly in regard to mining issues or related challenges. Therefore, the study used a SLR and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique (1) to investigate the recent research trends in the Malaysian mining industries. and (2) to study the contribution of mining industry with others sectors in Malaysia

# 2. Methodology

In a well-organized and transparent process, the systematic literature review (SLR) attempts to reveal, search, and summarize literature systematically connected to prior studies or research, using verifiable techniques at each stage. This study employed the Preferred Reporting Items for Systematic Reviews and

Meta-Analyses (PRISMA) to conduct a systematic literature review (SLR) on research trends studies in the Malaysian mining industry. Figure 1 shows the steps of SLR including;

i. TITLE-ABS-KEY ("mining industry AND Malaysia") is a search string that may be used to identify a document.
ii. Articles published in Scopus and Science Direct databases between 2016 and 2021 in English-language publications on the mining sector in Malaysia are included in the screening procedure.
iii. Eligibility is the process of manually including or excluding articles based on the authors' particular criteria.
iv. Data abstraction and analysis involve manually evaluating, reviewing, and analysing the complete text of publications (in-depth).

Based on identified papers, a thematic analysis was conducted to discover themes connected to influencing variables of safety cultures. The 24 papers' main issues, similarities, and differences were found and grouped. Six phases were followed to perform thematic analysis as recommended by Nowell et al (2017). The steps are shown in Fig. 2.

# 3. Results

The review managed to obtain 24 selected articles discussed on recent research studies on mining industry in Malaysia. The studies reported on gold, bauxite, tin, granite, rare earth, iron ore and others. Figure 3 shows the number of published articles for various types of minerals for year 2016 until 2021. The study on tin mining was the most widely circulated article in the preceding six years. Other materials were addressed in this study, including rare earth, gold, bauxite and other minerals. Furthermore, 20 articles were fully quantitative and 4 articles were qualitative articles. By applying thematic analysis, one main theme and 7 sub-themes were created as shown in Table 1. The details for each article on the SLR study also shown in Table 1.

Table 1
SLR results on recent research in the mining industry in year 2016 to 2021

| Authors | Main study design | Type of Mineral | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gold | Bauxite | Tin | Granite | Rare Earth | Iron ore | Others |
| (Phua et al.,2016) | QL | | | | | / | | |
| (KY et al.,2017) | QN | | / | | | | | |
| (Sanusi et al.,2017) | QN | | | / | | | | |
| (Rendana et al.,2017) | QN | | | | | | | / |
| (Goh et al.,2017) | QL | | | | | | | / |
| (Sakai et al., 2017) | QN | | | / | | | | |
| (Koki et al.,2018) | QN | | | / | | | | |
| (Abidin et al.,2018) | QN | | | | | | | / |
| (Ahmed et al.,2018) | QN | | | / | | | | |
| (Kusin et al., 2018) | QN | | / | | | | | |
| (Sarman et al.,2019) | QN | | | | | | / | |
| (Fauzi et al., 2019) | QN | | | / | | | | |
| (Mohamad et al.,2019) | QN | | | | | | | / |
| (Kusin et al.,2019) | QN | / | | | | | | |
| (Tohar et al.,2020) | QN | | | | | / | | |
| (Hasib et al.,2020) | QN | | | | | | | / |
| (Quintela-Sabaris et al.,2020) | QN | | | | | | | / |
| (Mingyuan et al.,2020) | QN | | / | | | | | |
| (Kuan et al.,2020) | QL | | / | | | | | |
| (Sanusi et al.,2021) | QN | | | / | | | | |
| (Shahbudin et al.,2021) | QN | | | / | | | | |
| (Murlidhar et al.,2021) | QL | | | | / | | | |

| Authors | Main study design | Type of Mineral | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gold | Bauxite | Tin | Granite | Rare Earth | Iron ore | Others |
| (Lehmann et al.,2021) | QN | | | / | | | | |
| (Alaloul et al.,2021) | QN | | | | | | | / |
| *Note: QL = qualitative study, QN = quantitative study* | | | | | | | | |

## 4. Discussion

The main objective of systematic review was to investigate the recent studies on mining industry in Malaysia. The focus of discussion was divided into research on gold, bauxite, tin, rare earth, granite, iron ore and others minerals.

# 4.1 Research on gold mining

The first subtheme was gold mining research in Malaysia. An investigation was undertaken into the distribution of mineral, major, and trace elements in mine wastes from a gold mining location, as well as their relevance to prospective human health dangers, according to Kusin et al., (2019). Mine waste samples consisting of waste rocks, soils, and sediments (including borrow pit, waste dump, stockpile, and tailings) were collected at the Selinsing gold mine region in Pahang, Malaysia. The key elements, such as SiO2, Al2O3, Fe2O3, K2O, and MgO, were acquired primarily from their mineralogical compositions, which were dominated by quartz and muscovite (in waste rocks), kaolinite and illite (in soils), and illite and chlorite-serpentine (in waste rocks), according to the research (in mine tailings). In addition, this study offers a strong indicator or understanding of the potential hazards to human health.

# 4.2 Research on bauxite mining

The second subtheme, bauxite research, has four papers out of a total of twenty-four. KY et al., (2016) investigated the negative effects of bauxite mining in Malaysia and discovered that bauxite contributed to air, water, and soil pollution due to bauxite dust; bauxite leaching into water sources resulting in reduced soil fertility; and affecting agricultural food products and aquatic life. Furthermore, bauxite occupational exposure has negative health consequences for miners and the surrounding community, including increased respiratory symptoms, water contamination, and other potential health risks from bauxite and heavy metal ingestion, such as noise-induced hearing loss and mental stress.

Kusin et al., (2018) on the other hand, examined at the distribution of heavy metals and metalloids in surface sediments of heavily-mined regions for bauxite ore in Pengerang, Johor, Malaysia, as well as the risk assessment that went along with it. He observed that the bulk of heavy metals (Al, Cd, Co, Cr, Cu, Fe, Mn, Pb, Sr, Zn) and metalloids (As) in sediments were Fe and Al, which contributed directly to the negative ecological and human health effects. Kuan et al.,(2020) brought attention to study on bauxite mining in

Malaysia, which focused on the long-term viability of the industry. He discovered a disconnect between local legislation and global best practises, particularly in the area of environmental management and performance. The investigation also uncovers flaws in Malaysia's current Standard Operating Procedure (SOP) and bauxite mining practises..

In addition, Mingyuan et al. (2020) concentrated on land restoration in Bukit Goh, Kuantan, as a result of bauxite mining activities. Jatropha curcas' growth performance in bauxite mine soil was studied for 90 days in a greenhouse setting, and he determined that it has the potential to be cultivated as an alternative crop in bauxite mine soil, with plants growing in the subsurface (46.54%) and topsoil (46.54%).

# 4.3 Research on tin mining

The third subtheme was research on tin mining conducted by Sanusi et al.,(2017), Sakai et al., (2017), Ahmed et al.,(2018), Fauzi et al., (2019), Sanusi et al.,(2021), Shahbudin et al.,(2021), Lehmann et al., (2021). Most of these researchers were conducted the research on ex-tin mining and the impacts on the environmental and social activities. Sanusi et al. (2017) evaluated the impact of new townships and residential areas being developed in old tin mining sites, notably in the heavy mineral- or tin-bearing alluvial soil in Kuala Lumpur, as well as background radiation exposure and human health risk assessment. He realised that the odds of getting diagnosed with cancer and dying from it in Kuala Lumpur were quite slim. As a result of ex-tin mine mining activities, Sakai et al., (2017) investigated the presence of arsenic and heavy metals in the Selangor River basin and detected arsenic and five heavy metals (nickel, copper, zinc, cadmium, and lead). Furthermore, Koki et al., (2018) looked at the occurrence of heavy metals in ex-mining ponds in the Klang Valley and Melaka, concluding that arsenic was the most important risk factor, presumably due to old tin mining activities.

# 4.4 Research on granite mining

The fourth subtheme was research on granite mine activities as reported by (Murlidhar et al.,(2021). He investigated the flyrock distance generated by blasting using artificially intelligent algorithms for three open-pit granite mines in Johor, Malaysia. A total of 152 blasting events were tracked in order to acquire field data. These flyrock can cause damage to neighbouring structures and equipment, as well as danger to individuals, particularly employees on construction projects. As a result, flyrock prediction is critical in mining research.

# 4.5 Research on rare earth mining

The fifth subtheme was rare earth mining with a total of two out of 24 studies were reported in Malaysia. In Malaysia's environmental issue, Phua et al. (2016) investigated the use of influence in the rhetoric of an Australian transnational mining business and its supporters. He observed that Malaysia's underlying political economy, which is replete with corruption and 'crony capitalism,' and public opinion is frequently disregarded or systematically influenced by government-controlled mass media, has a detrimental impact on the country's approval of rare earth mining. Tohar et al.,(2020) studied the major rare earth-bearing

minerals in Johor, Malaysia's southern peninsula, and identified monazite (Ce), apatite, zircon, titanite, allanite (Ce), and bastnaesite (Ce).

## 4.6 Research on iron ore mining

Sarman et al.,(2019) conducted research on iron ore mining, concentrating on the potential of geotourism for ex-iron ore mines in Bukit Besi, Dungun, Terengganu. Geotourism is a responsible and sustainable sort of tourism package creation, similar to ecotourism and other nature-based derivatives of tourist, that takes a deeper look at local landscapes and the geological basis beneath them. The existence of inhabitants and the railway, which is part of the intrinsic information that makes the monuments remaining in Bukit Besi have a higher value in a tourist context, the study showed that Bukit Besi has a significant potential to become a geotourism destination in Malaysia.

## 4.7 Research on others mining study

Rendana et al., (2017) investigated land revegetation in Tasih Chini, Pahang, as a consequence of mining operations, whereas Goh et al., (2017) investigated the key elements and regulatory framework of the new National Mineral Policy 2 (NMP2). Abidin et al., (2018) and Hasib et al., (2020) investigated the water quality of Sungai Langat as a result of the influence of various forms of land use, such as mining operations. Meanwhile, according to Mohamad et al.,(2019), ripping production was projected based on production rate and relationships with sandstone and shale rock from three mining locations. Quintela-Sabaris et al., for example, focused their mining research on revegetation on ultramafic soils in Sabah, Malaysia (2020). He observed that perennial plants with lateral spreading capacity and a conservative growth approach are the best choice for restoring ultramafic degraded areas in Sabah. On the other hand, Alaloul et al.,(2021) noted the construction sector's interconnectedness with other sectors through complex connections that contribute considerably to the economy and gross domestic product (GDP), notably in Malaysia's mining industry.

# 5. Potential Research And Contribution Of Mining Industry To Others Sectors

The current study showed no recorded published articles discussed on contribution and interrelation between mining industry with others sectors such as construction, composite, cosmetic and many more industry in Malaysia. Most of articles were mentioned on the problem related to production of the minerals itself. The mining industry is a unique whereby most minerals obtained from mining activities were contributed as a raw material for the production for various products and widely used for various purposes. Figure 4 shows the example contribution of mining industry to others sectors.

It is undeniable whereby mining industry contributes to the construction industry. According to Evdokimov et al.,(2016), he successfully found the potential of the production of Portland cement after removing metal using aerosol jet flotation the old tailings of tungsten-molybdenum from the plant and adding lime into the composition. Another study by Lupo et al.,(2007) revealed the geomembrane liner materials in

mining industry. Linear low-density polyethylene (LLDPE), high density polyethylene (HDPE), polyvinyl chloride (PVC), and polypropylene are all common geomembrane liner materials (PP). In the mining sector, these materials have been employed as liner systems for process solution containment in heap leach pads and tailings impoundments, pond coverings, waste rock encapsulation, and surface water diversion applications. Moreover, cosmetic industry wastewater has undesirable features such as low biodegradability, high levels of suspended solids, fats and oils, and high load of organic matter. According to DeAndrade et al., (2020) the waste from the steel/metallurgical industry can be used as a source of iron, by generating less solid waste (sludge) and involving a more cost-effective technology to treat the wastewater from cosmetic industry. For automotive industries, many of the components required to build a vehicle in such as steel, are provided by the mining industry. The electric vehicles will increase the demand for different minerals such as cobalt; indeed, half of the global demand for cobalt can be attributed to electric vehicles (https://www.azomining.com/Article.aspx?ArticleID=1504).

In contrast, there are some studies show on the contribution of composite materials in mining Industry. For example, in the United States, the coal mining sector makes substantial use of Glass Reinforced Plastic (GRP) composite pipes for fresh water, acid water, and slurries (Kalisz et al., 2022). GRP took the role of mild steel and wood, which were unable to withstand the corrosion caused by sulfuric acid. Eastern Associated Coal, Consolidated Coal, North American Coal, Carbon Fuel, and others have all had successful installations. A coal-burning electric utility in Texas transports bottom ash. The ash is made up of 11% iron oxide, 40% silica, 16% alumina, 22% calcium, 2% magnesium, 1% sodium, and traces of other metals. The piping has a 1–2 year longer usable life than cast iron and was much less expensive to install. In the United States, GRP ducting and pumps are commonly employed in corrosive applications (Kalisz et al., 2022)

Waste materials from coal mining and consumer items can represent substantial environmental problems. Residual coal deposits cause acid drainage and the discharge of pollutants, resulting in detrimental alterations in soil and aquatic systems. Because of their widespread use and slow disintegration in the environment, low density polyethylene (LDPE) polymers are a source of worry for the environment. In Brazil, recycled low-density polyethylene composite is being used to reduce the environmental impact of coal mining waste (Gryczak et al., 2020). As a result, it is critical to investigate the ecotoxicological impacts of leachate generated from these materials. The earthworm Eisenia fetida (avoidance behaviour, feeding activity), the collembole Folsomia candida (mortality, reproduction), and the bacterium Aliivibrio fischeri were tested for ecotoxicological effects in soil and water (inhibition of bioluminescence) (Gryczak et al., 2020).

# 6. Limitations, Implications And Recommendations For Future Research

Despite the fact that it was done in a thorough manner, this SLR has certain limitations. The search was limited to indexed journals that were peer-reviewed in English and that the author could access through a university library system. As a result, because non-indexed journals did not match the pre-established

inclusion criteria, this SLR cannot claim to include them. This study also serves as a solid indication for understanding current studies in the Malaysian mining sector during the last five years. The findings were also beneficial in revealing a large gap in publishing articles regarding mining sectors or activities in Malaysia in high impact journals, based on the PRISMA technique. Despite the fact that Science Direct and Scopus are renowned established databases, this evaluation makes some recommendations for further research. Various databases or search engines, such as Google Scholar, SpringerLink, bulletin, and others, may be utilised to improve knowledge about research trends studies in the Malaysian mining sector. Furthermore, the SLR reveals that all of the articles chosen were written by academics or researchers from universities, with lack of publications from the mining players or companies. As a result, there is still a lack of awareness of the challenges and concerns that the mining sector is experiencing.

# 7. Conclusion

The SLR study in the Malaysian mining sector has been successfully created for the years 2016 to 2021. ScienceDirect and Scopus, two databases that use the PRISMA technique, have systematic reviews for twenty-four papers. Tin mining research was the most widely published paper in the previous six years. Others, such as rare earth and gold, were also mentioned in this research. Moreover, the research and publication on contribution of mining industry to various industries also were lacking. The systematic review study may encourage mine owners, mine employees, government officials, and policymakers to write their own research and development (R&D), issues, or related problems in mining activities, and publish them in reputable journals, conferences, and other publishing databases that would benefit the Malaysian mining industry.

# Declarations

### Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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### Competing Interests

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### Authors Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Siti Noraishah and Azizul Helmi. The first draft of the manuscript was written by Siti Noraishah and Azizul Helmi and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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# Figures

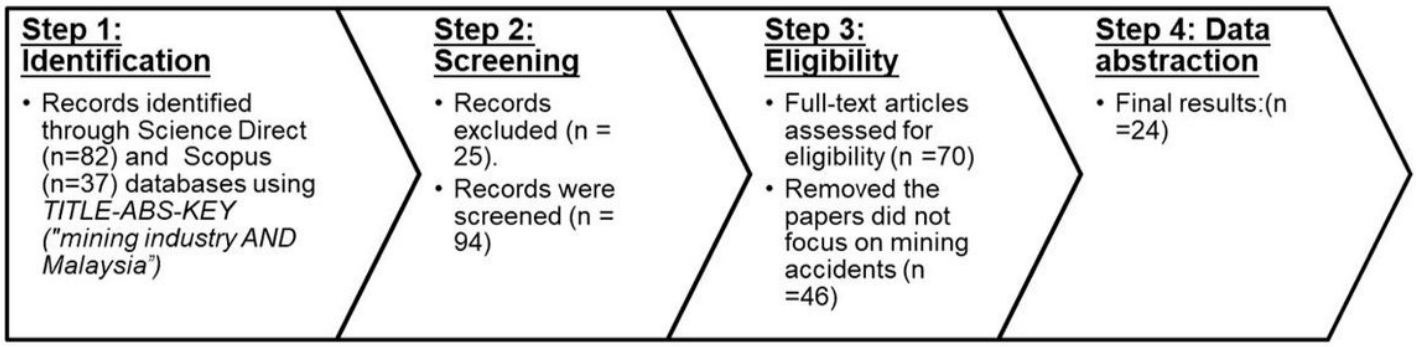


**Figure 1**

The process of SLR study (Adapted from Ismail et al., 2021)

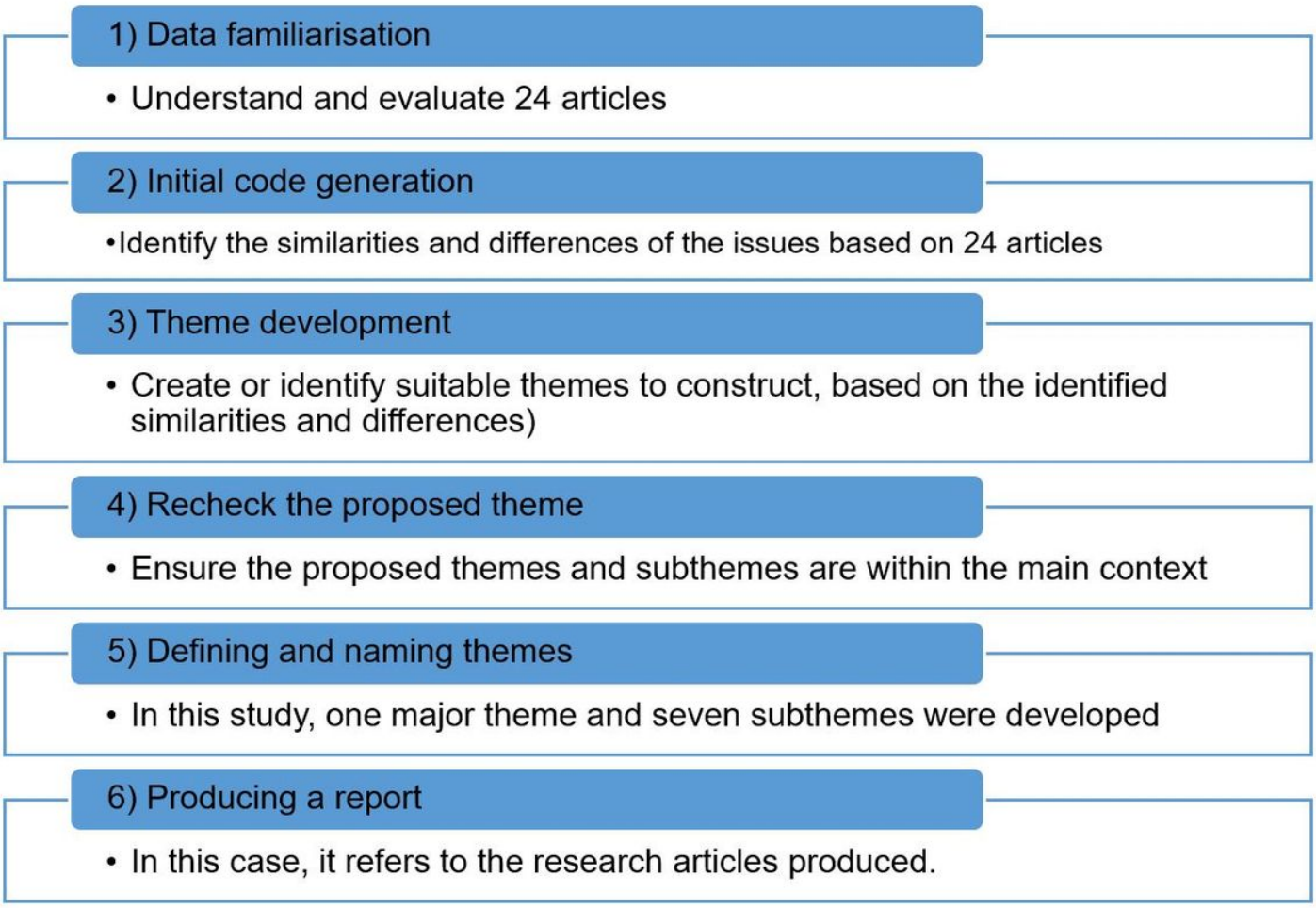


**Figure 2**

The steps for thematic analysis (Adapted from Nowell et al., 2017)

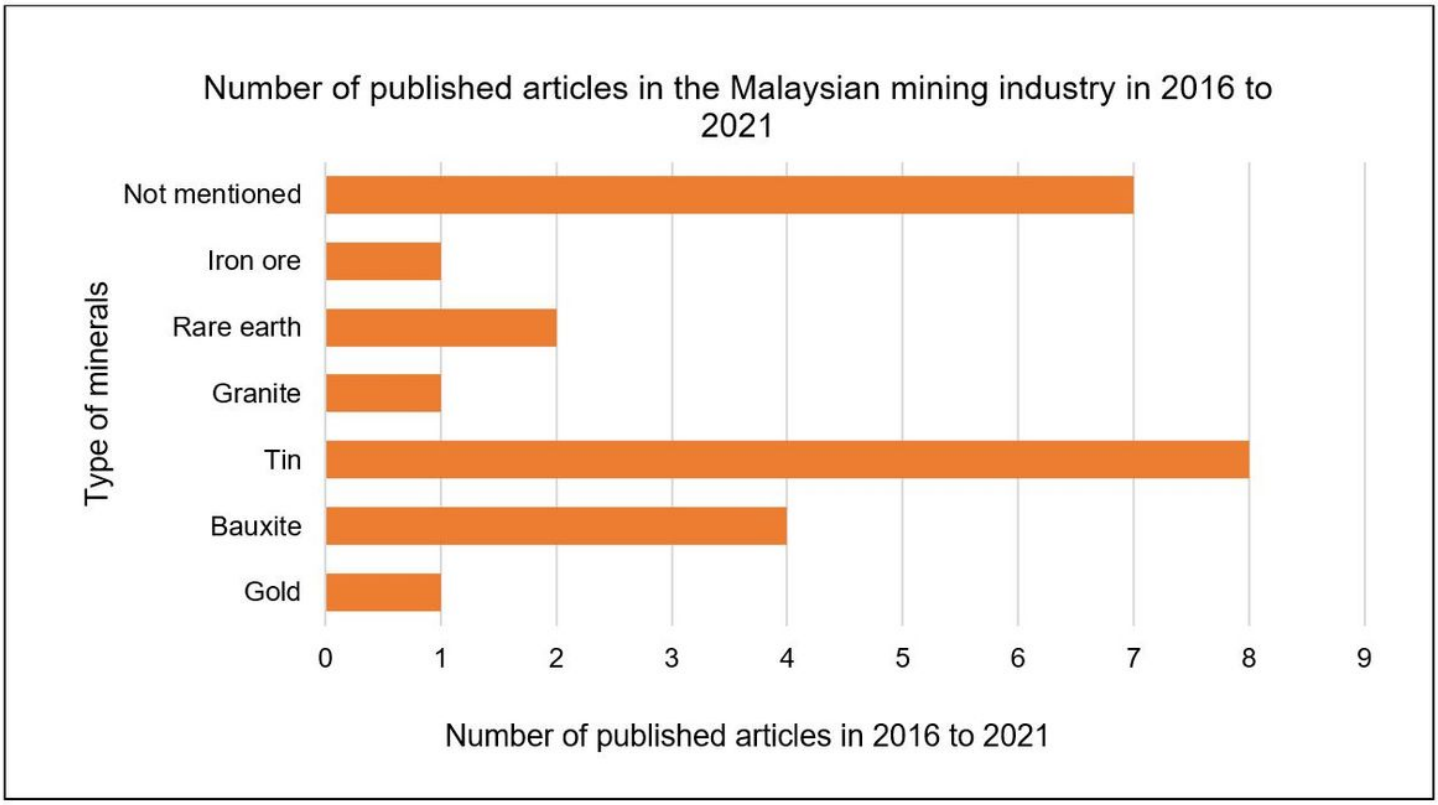


**Figure 3**

The number of published articles for various types of minerals in Malaysia for year 2016 until 2021.

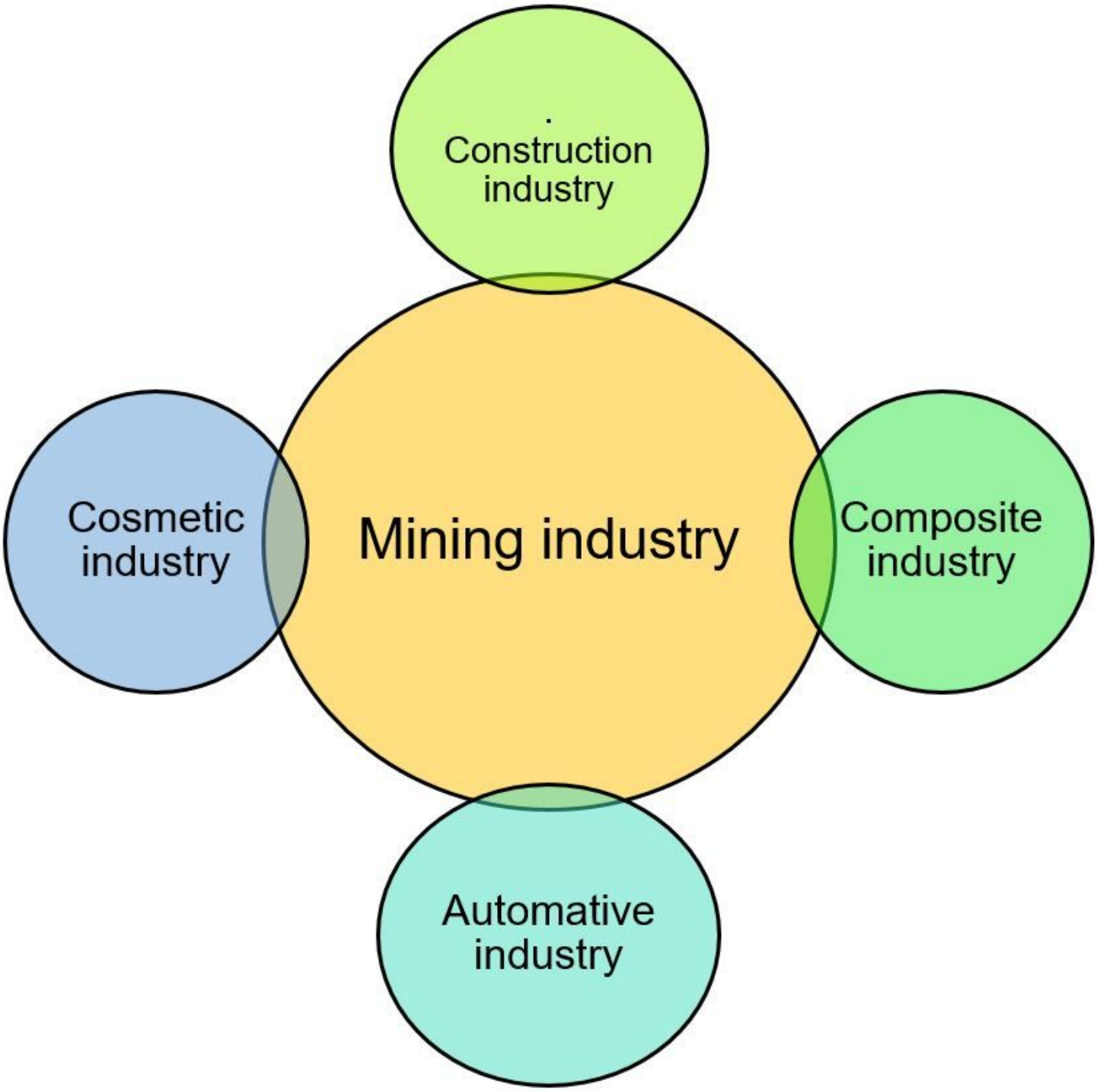


**Figure 4**

Example of contribution of mining industry to others sectors.