

# Research on the significance of changes in technology faced by contemporary Indonesian nickel mining organizations

Qianchen Li

University of St Andrews, St Andrews KY16 9AJ, UK

**Abstract:** Indonesia is the world's biggest supplier and exporter of nickel. The mining industry faces uncertainty under regulation changes, technological improvement, and social pressure towards environmental changes. The existence of social medias, computer modelling and EVs owing to changes in the technological trend have impacted the operating environment of mining organizations to various extents. Therefore, identifying these strategic trends on a global basis is essential for Indonesia nickel mining organizations. This research portfolio will focus on exploring the importance of changes in technological trends that influence the external operating environment of nickel mining organizations in Indonesia.

**Keywords:** Nickel mining; Indonesian; Organizations operate; Technological trends

## 1. Introduction

Organizations operate in dynamic business environments. Global strategic trends are the general directions of factors which lead to the emerging power of configurations [1]. The exploration of historical and current trends allows organizations to develop wishful thinking to achieve strategic agenda beyond the business-as-usual view [2]. Managers are not only required to access the weaknesses and strengths of the organization, but also on a larger present scale to create better future outcome thorough present actions [3].

Indonesia is the world's biggest supplier and exporter of nickel. As a developing country, nickel mining takes up 4.70% of Indonesia's total GDP and the world's 30.4% nickel production in 2020 (Figure 1, Statista 2022). The mining industry faces uncertainty under regulation changes, technological improvement, and social pressure towards environmental changes. Therefore, identifying these strategic trends on a global basis is essential for Indonesia nickel mining organizations.

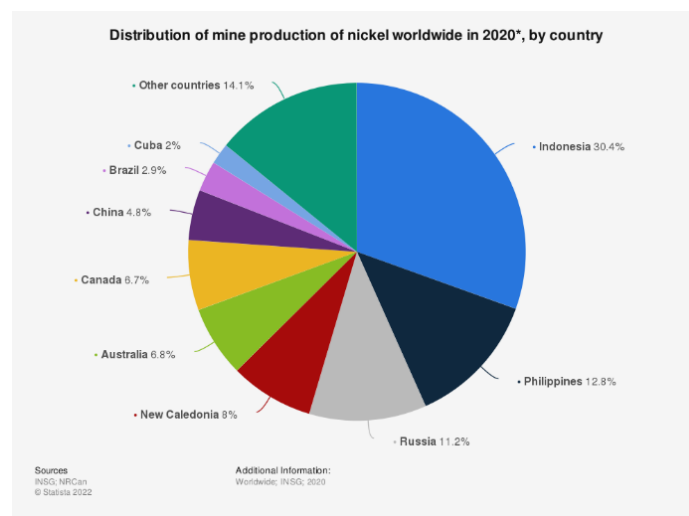


Figure 1: Distribution of mine production of nickel worldwide in 2020

This research portfolio will focus on exploring the importance of changes in technological trends that influence the external operating environment of nickel mining organizations in Indonesia. The following

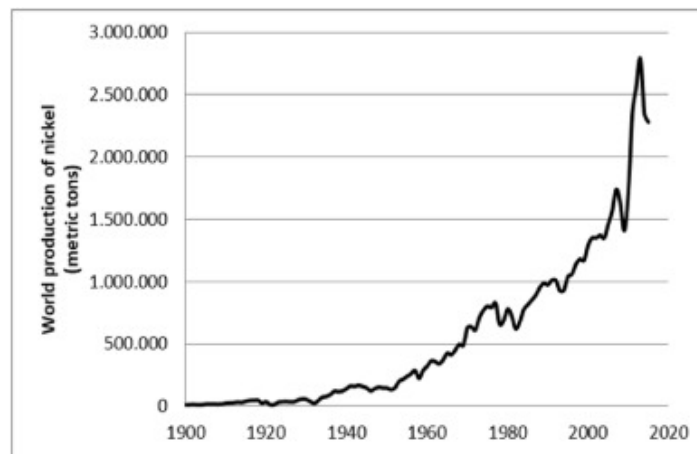
trends will be discussed in depth:

- (1) Evolution of Mining Technology
- (2) The Rise of Electric Vehicles
- (3) Technologies in Social Media
- (4) Development in 3D & Evolutionary Technologies

The intertwining impacts of these strategic trends will be analysed with respective risks and opportunities. An example of PT CNI will be included to illustrate its successful organizational behaviour in response to the dynamic signals.

## 2. Evolution of Mining Technology

Nickel demand has always been high since it is essential in the production of stainless steel and other metallic products. According to US Geological Survey in 2017, Figure 2 shows the strong increasing trend of world nickel supply relative to its high demand over the past decades.



Source: World nickel production between 1900 and 2017 (US Geological Survey, 2017b)

Figure 2: World Production of Nickel

In the beginning, miners used primitive tools to dig soil, clearing out the mining shafts with bare hand or stone tools [4]. The method for metal extraction was even more straightforward: simply using fire to heat rocks until they cracked. The process of mining was extremely lengthy and dangerous [5]. Before the invention of mechanical drills, people in the Middle Ages used fire powder to clear tunnels and breaking heavy rocks [6]. During the Industrial Revolution, improvements in technology helped miners to replace their mining equipment's with piston-powered mechanical drills and lifts for quicker access through the tunnels. Transportation of mines were accelerated with mining site vehicles. Candles were also changed to gas lamps for better underground vision (GK News, 2019).

In the present mining industry, technologies allow organizations to extract up to 98% purity metallic ores, by applying highly intelligent auto-machines that no longer endanger miner's life. Online conferences could be carried out at a flexible time across the globe through internet. Without being physically present at the site, information and data are transferred at a nearly zero-cost. The introduction of portable ore analysers adds more flexibilities to miners who do not have adequate professional chemistry knowledge, providing workers with more employment opportunities.

However, although technology makes it easier for mining at a faster rate, it also brings several issues to the operational environment. Nickel is the main component for stainless steel production. As the market for stainless steel becomes more competitive and saturated in the recent years, the demand for nickel began to perform diminishing growth rates since there has been excessive supply of nickel relative to the demand for stainless steel (Figures 3 and 4). This supply growth is not matched with proportional demand growth during the same period.

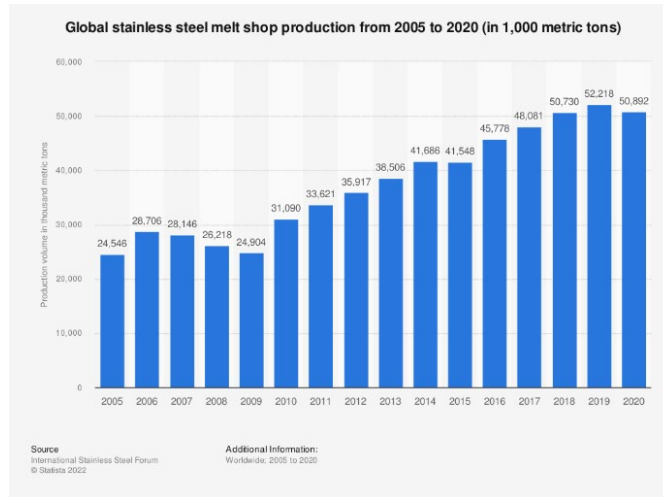


Figure 3: Global stainless steel production

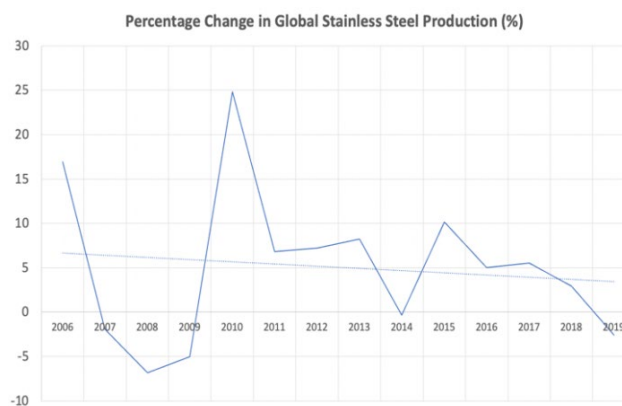


Figure 4: Percentage change in Global Stainless-Steel Production

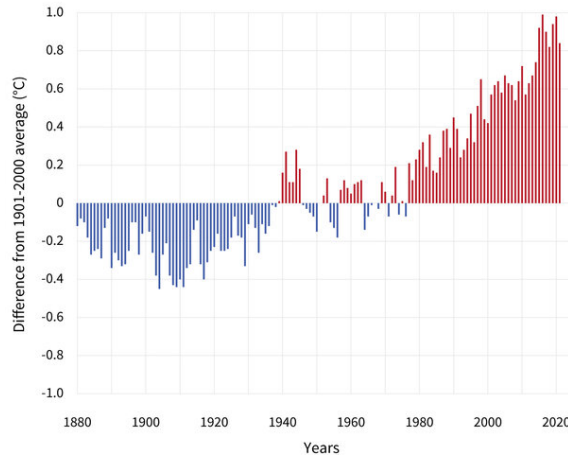
The market for stainless steel experienced a shrink of 1.4% worldwide in 2020 compared to 2019. From the data presented by the International Stainless-Steel Forum published in 2022, we can see a falling trend of stainless-steel production before Financial Crisis period that occurred in 2008. During this period, although technology used in stainless steel production is advanced, the worldwide high inflation affected the steel industry. When the real estate bubble burst, steel price lost half its value [7]. This abrupt turbulence in the economy severely harmed the stainless-steel price and consumers' expectation for the market. As a result, the demand for nickel also fell. Even though steel price began to recover after the 2008 Financial Crisis, its production in general is experiencing a declining percentage over time, with a downward sloping trend line until 2020.

Moreover, technology makes nickel mining process quicker and easily accessible. Higher rate of mining also means that the damage caused to the natural environment is being accelerated [8]. Normally, a mining site takes 10-15 years to recover to its natural conditions under appropriate treatments [9]. The exploitation technologies in the mining activities have brought disruptive damages to Indonesian lands, not to mention illegal mining and failures to rehabilitate the mining sites.

### 3. The Rise of Electric Vehicles

Environmental factor is another driver that influences business operations. The global warming issue has drawn our attention towards the environment. Changes do not happen abruptly without a sign. Rather, slowly rising tropical ocean temperatures starting from the 1930s was a weak signal implying the abnormality of the nature. Over time, people began to realize as the condition exacerbated. This contributed to the go-green lifestyle and the emergence of environment-friendly products in today's culture. (As shown in figure 5)

### GLOBAL AVERAGE SURFACE TEMPERATURE



Source: NOAA Climate.gov graph, based on data from the National Centers for Environmental Information.

Figure 5: Yearly surface temperature compared to the 20th-century average from 1880–2021. (Blue bars indicate cooler-than-average years; red bars show warmer-than-average years)

With technological advancement and increased awareness for environmental protection, Electric Vehicles (EVs) were introduced to replace carbon-emitting vehicles in the international market. Nickel element is found to be a critical ingredient for EV batteries. But as a scarce and non-renewable resource, nickel production will only diminish in the future, eventually leading to shortage. Overmining arose from technology growth has inevitably drawn the industry into a difficult position to supply nickel sustainably. (As shown in figure 6)

### Use in batteries will double global nickel demand by 2040

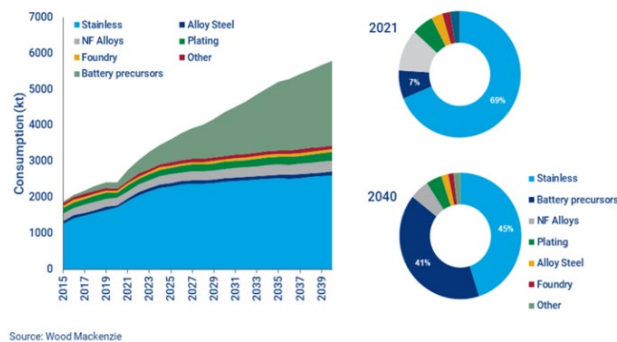


Figure 6: Nickel Demand in Batteries with Expectation

Nickel soars to record high  
 Price of LME benchmark nickel contract (\$/tonne)



Figure 7: LME Nickel Price Record

Before 2021, 69% of nickel were consumed for stainless steel productions, 7% in alloy steels with the rest on plating, batteries or other uses. Nickel organizations depended heavily on the demand for

stainless steels. Yet, with the emergence of EV, the demand for lithium-ion batteries drove the entire market into nickel shortage. On top of this, Indonesia's 2020 export ban added more value to its domestically processed nickel products, lifting the global nickel price to an extreme level (see Figure 7).

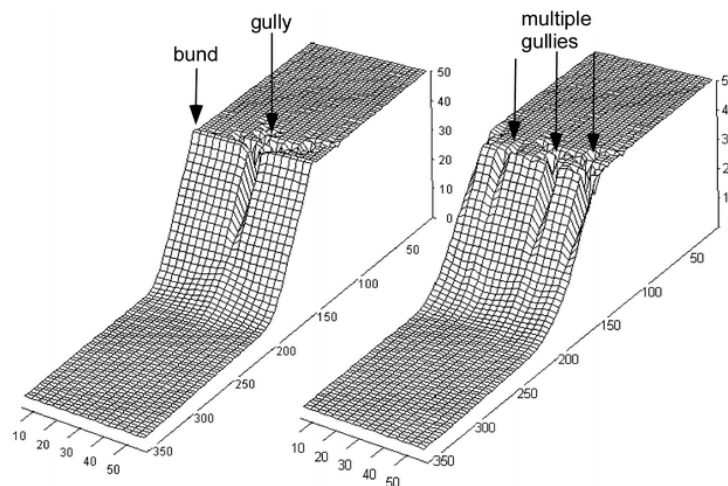
#### 4. Technologies in Social Media

Technological changes established a cultural trend for environmental protection with the development of social medias<sup>[10]</sup>. Analysis from Kepios discovered that 59.3% of the total global population used social media in 2022, significantly differing from 5% in 2005. Technology forms online communities in the society. Along with easier accesses to internet (e.g: WiFi, cellular data, personal hotspot...), social medias allowed people to share ideas more conveniently and raise awareness for environmental problems around the world. Authorities were able to advertise their environmental propaganda online. Mining victims across different countries were able to voice their unfortunate experiences due to inappropriate organizational conducts. The newest Economist Intelligence Unit (EIU) discovered a 71% increase in popularity of "sustainability" related searches on Twitter from 2017-2022. The Indonesian mining organizations, too, were socially pressured to implement their responsibilities and comply with their sustainable organizational commitments under the global trend. Many companies participated in technological innovations such as hydroseeding to accelerate mining pits recovery through erosion control and long-term vegetation.

#### 5. Development in 3D & Evolutionary Technologies

Another trend from 3D technological improvement portrayed the application of virtual models in the nickel mining sector. The existence of 3D Graphical Simulation software enabled site engineers to examine conditions of the mining pit through CS modelling, thus is often used by the mining organizations to efficiently design and evaluate the restoring process. 3D printing technologies are engrafted in the mining sector to physically illustrate the geological site at lower costs and is effective in model robustness testing<sup>[11]</sup>(As shown in Figure 8).

Extended from the "Reduce, Reuse and Recycle" (RRR) concept, evolutionary technologies used in the manufacturing industries for glass refining were also implemented by firms to recycle nickel-containing products<sup>[12]</sup>. This increases the utilization of scarce natural resources, while reducing the need of over-mining to satisfy global nickel demand. The process for machines to purify nickel from wastes and MnCrNi/MnCr containing alloys is highly efficient. Due to the expected future trends in Figure 9, recycled nickels will take up a major portion in nickel supplies in the next 200 years.



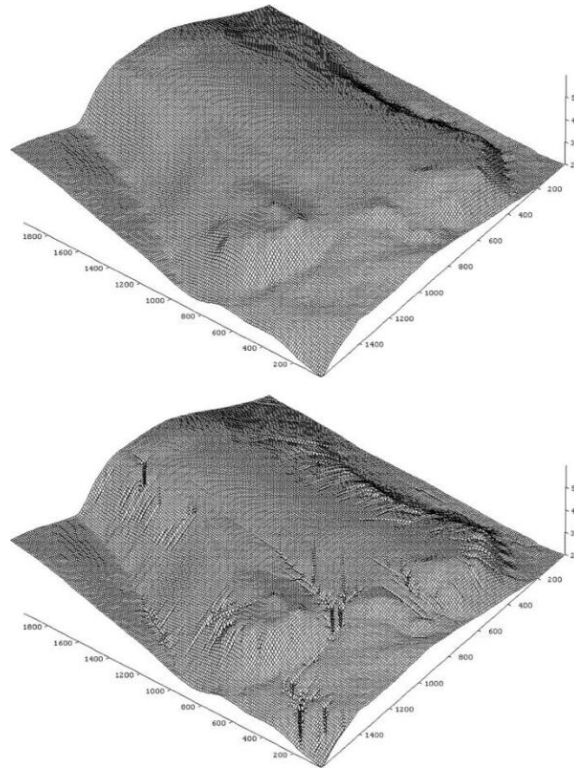
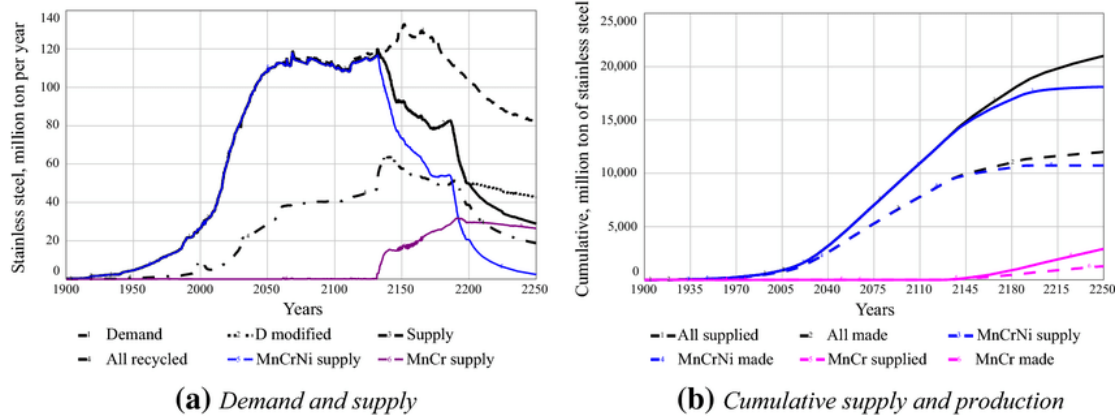


Figure 8: Landscape Evolution Models in Mining Rehabilitation Design

Source: Environmental Geology



Source: Biophysical Economics and Resource Quality

Figure 9: total stainless steel recycled and the supply for MnCrNi and MnCr steel is shown in 9(a). The cumulative amount supplied and produced from 1900 to 2250 of the two qualities of stainless steel are shown in 9(b).

## 6. Implications for the industry

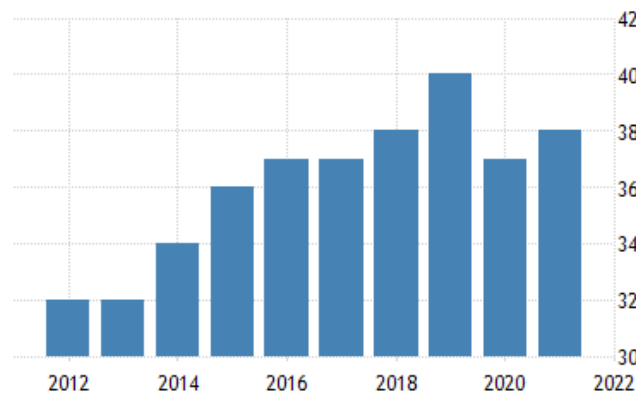
Throughout the sections, we observe that trends never work independently. Rather to say, they form an integrated system that intertwiningly affect each other within a society. It is necessary for organizations to recognize the importance to capture signals of change in these trends.

To addressing the implication of technological change in the mining industry, we will take a look at the leader of Indonesian nickel market, PT Ceria Nugraha Indotama (PT CNI). It has acutely captured signals of change in global trends in the 1990s. As a start-up company, PT CNI discovered disruptive environmental damage and high global fatality rate during mining activities. The rapid growth of the technology sector was a signal indicating that the nickel industry would soon face the impact of technological advancement as well. Thus, PT CNI established early corporations with high-tech equipment producers including Niton and CAT to align its business with the growing technological trend.

The import of high-tech machineries led to increased efficiency in PT CNI's production and fewer worker injuries. It gained profit from reduced mining costs. Also, adopting a systematically controlled mining process helped PT CNI to achieve zero work-related accident and echo the global trend of sustainability in the recent business world. This laid a solid foundation for its organizational power and reputation in the industry. As more organizations adopted PT CNI's sustainable business ideology, pro-environmental trend was established in the society. The 2009 Indonesian Government Law further promoted the use of eco-friendly technologies in sustainable nickel mining.

Lastly, trends do not always interact in harmony. Bartos believed that growing trends in the technological industry does not mean equal necessity for the nickel mining industry to adopt the advanced technology. Global regulations on low carbon emission and the change in consumer's lifestyle for greener products have expanded EV consumptions <sup>[13]</sup>. Bartos argues that, to produce more EV batteries, the rising demand of nickel eventually results in over-mining, deteriorating the environmental conditions. People's well-being, especially in developing countries such as Indonesia, are negatively impacted by pollutions and mining-related sickness/deaths if organizations failed to introduce costly technologies. Hence, the trend of advanced mining technologies is incompatible with the trend of technological rise in EV batteries. This counters the intention of sustainable human life through technological changes.

Aside from the EV batteries, high corruption rate in the Indonesian society and legal system is another obstacle that prevents the mining organizations from joining the trend in technological innovations (see Figure 10). Lacking central supervisions, regional governments are prone to corruptions. The Corruption Eradication Commission (KPK) in Indonesia has found a total of more than USD\$402 million embezzled organizational funds that were originally assigned for R&D and high-tech equipment purchasing purposes. Organizations could simply bribe their local governors for abandoning mining pits or having inadequate formalities, and still being able to mine illegally <sup>[14]</sup>. Corruption limits organizational obligations and minimizes their incentive to care for the environment through RD&I. Whilst this has already become a trend in the Indonesian society, the Indonesian government faces an urgent need to rectify the business environment for nickel mining with deliberate actions.



Source: Trading Economics 2022 Historical Chart

Figure 10: Indonesian corruption index from 2012 to 2022 (points)

## 7. Conclusion

In conclusion, advanced technologies push the nickel mining industry forward with higher efficiencies in cost, supply and environmental protection measures in general. The existence of social medias, computer modelling and EVs owing to changes in the technological trend have impacted the operating environment of mining organizations to various extents. Yet, trends are interrelated. Sometimes technological trends may have influences on other external PESTEL trends, resulting in unexpected or incompatible outcomes for organizations in the business environment. To better understand the complex nature of rapid changes and coming up with actions targeting entrepreneurial success under uncertainty, entrepreneurs should pay attention to the trivial signs of change that could trigger strategic reorientations. Addressing the case of contemporary Indonesian nickel industry, extensive and thoughtful plannings are necessary for business continuity in response to the interconnectedness of technological trends.

**References**

- [1] Carlson, B. G. (2021). *Startseite-CSS*. <https://css.ethz.ch/>
- [2] Wilkinson, A., & Kupers, R. (2020). *Living in the Futures*. <https://hbr.org/2013/05/living-in-the-futures>
- [3] Kaplan, S., & Orlikowski, W. J. (2013). *Temporal work in strategy making*. *Organization science*, 24(4), 965-995.
- [4] General Kinematics. (2019). *Brief History of Mining & Advancement of Mining Technology*. <https://www.generalkinematics.com/blog/a-brief-history-of-mining-and-the-advancement-of-mining-technology/#:~:text=In%20the%20beginning%2C%20miners%20used,depths%20at%20a%20faster%20rate>
- [5] Coulson, M. (2012). *The history of mining: The events, technology and people involved in the industry that forged the modern world*. Harriman House Limited.
- [6] Wilburn, D., Goonan, T., Bleiwas, D., & Rodenburg, E. (2023). *Technological Advancement – A Factor in Increasing Resource Use*. <http://webharvest.gov/peth04/20041113144421/pubs.usgs.gov/of/of01-197/of01-197.pdf>
- [7] Packard, J., & Triplett, T. (2020). *A brief history lesson on steel prices during crises*. <https://www.thefabricator.com/thefabricator/blog/metalsmaterials/a-brief-history-lesson-on-steel-prices-during-crises>
- [8] Henckens, M., & Worrell, E. (2020). *Reviewing the availability of copper and nickel for future generations. The balance between production growth, sustainability and recycling rates*. *Journal of Cleaner Production*, 264, 121460.
- [9] Stephens, T. (2021). *Long-term monitoring shows successful restoration of mining-polluted streams*. <https://news.ucsc.edu/2021/05/mine-remediation.html#:~:text=Even%20with%20differing%20mixes%20of,within%2010%20to%2015%20years>
- [10] Hirsheimer, B. (2021). *Search for Sustainable Goods Grows by 71% as 'Eco-Wakening' Grips the Globe*. <https://www.worldwildlife.org/press-releases/search-for-sustainable-goods-grows-by-71-as-eco-wakening-grips-the-globe>
- [11] Abbasi, I. (2022). *Mining Articles*. <https://www.azomining.com/articles.aspx>
- [12] Bartos, P. J. (2007). *Is mining a high-tech industry?: Investigations into innovation and productivity advance*. *Resources Policy*, 32(4), 149-158.
- [13] Morse, I. (2021). *Indonesia has a long way to go to produce nickel sustainably*. <https://chinadialogue.net/en/pollution/indonesia-has-a-long-way-to-go-to-produce-nickel-sustainably/>
- [14] Jong, H. N. (2020). *With New Law, Indonesia Gives Miners More Power and Fewer Obligations*. <https://news.mongabay.com/2020/05/indonesia-mining-law-minerba-environment-pollution-coal/>