

Mining Industry in Canada (Opportunities and Threats)

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Abstract

The article contains a case study focusing on the safety procedures related to the mining industry in Canada. The purpose of the study was to identify the best mining practices in Canada. The paper contains an overview of the laws and procedures regulating the mining industry in Canada as well as the procedures for enforcing environmental and safety regulations. The procedures for changing and constantly updating the safety regulations are also being discussed. This was also done for the purpose of identifying the best practices. The article also addresses the procedure for investigating mining accidents in Canada. The article emphasizes the importance of a three-way partnership (management of the mining company, labor union, and the Ministry of Labor). That three-way partnership is important from the perspective of revising and modifying the mining safety regulations as well as enforcing those regulations. Participation of the labor union as well as the management of the mining company in updating safety regulations makes them more practical and reflective of real safety issues. Unpractical and obsolete mine safety regulations are being eliminated. The labor union and mine management feel the ownership of the mining safety regulations. This fact makes it easier to enforce new regulations. The article also focuses on environmental protection procedures. Environmental risk evaluation is conducted before a mining permit is issued. This is being done by the provincial government. During the mining operation, the Ministry of Labor is handling the environmental protection issues. The Ministry of Labor is constantly checking the compliance with the safety as well as the environmental and sustainability guidelines. Using artificial intelligence and Industry 4.0 technology is also being mentioned.

Keywords

mining industry, safety procedure, environmental protection, mining sustainability, AI in mining



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Introduction

The mining industry in Canada is contributing significantly to the economy of that country. The mining industry generated a revenue of \$43.9B (2017). The mining industry provides employment to 403,000 people. Approximately 50% of the merchandise transported by the railroad system in Canada is a product of the mining industry. A significant amount of the minerals transported from Canada are using ports in that country. Mining companies in Canada are shareholders in mining industries worldwide (100 companies). These companies are mainly in South America, Australia, and the southern part of Africa. The value of these stocks is \$163B. Over 50% of the mining companies in the world are registered on the stock exchange based in Toronto (Canada). The mining industry in Canada produces significant amounts of aluminum, cobalt, diamonds, gold, nickel, platinum, uranium, and titanium. Coal mining has a significant role in the extraction industry in Canada. (<https://nettg.pl/gornictwo/174340/nowa-kopalnia-wegla-kamiennego-w-kanadzie>). Those metals and minerals are significant exports for the country. Ontario, Quebec, and British Columbia (Canada) are the provinces where the mining industry is located.

Literature Review

The extraction of minerals, metals, and ores by the mining industry/companies causes many environmental problems and dangers. Under certain conditions, however, it brings considerable economic profits and positively influences the social aspects of development. This applies to the extraction of all raw materials and minerals, including precious metals, rare earth metals, diamonds, and coal. The implementation of legal regulations and procedures related to environmental protection is one of the important elements of sustainable development. Protocols on biodiversity, waste management, crisis management, safety and health, energy, greenhouse gases, and community involvement for sustainable mining have been developed by the Towards Sustainable Mining (TSM) and have become mandatory for Mining Association of Canada (MAC) members since 2004 (Jarvie-Eggart and Edith, 2013). To avoid economic collapse and ecological risks, the mining industry had to focus on cooperation with various stakeholders (mining companies, regulators, scientists, and other stakeholders from the industry) to develop practical adaptation strategies to climate change (Pearce, 2011). In the extractive industry, economic risks must also be taken into account. The profitability of mineral extraction is related to many different factors - access to capital and foreign investment, conditions in international markets, and changing demand. In addition, mining projects in the Canadian Arctic are burdened with difficult environmental conditions and high operating costs (Têtu et al., 2015). Nevertheless, the mining industry in Canada is growing. In addition, Canadian laws also allow foreign capital to invest. Despite its economic performance, the Canadian mining sector has not been spared the setbacks that have jeopardized its reputation. This prompted the adoption of a new paradigm in sustainable development in this industry (Gueye et al., 2021).

Canadian mining is also becoming more and more innovative, both in terms of the economical and efficient exploitation of deposits, as well as in terms of ecological innovations and safety factors. Mining companies, however, largely benefit from the inventions of third parties providing services to the mining industry, especially in the field of mine operation and mineral processing (Fernandes, 2021). The supportive conditions for innovation (Grebski and Grebski, 2016; Grebski and Grebski, 2018; Grebski and Grebski, 2019) in this industry are also important. From the perspective of sustainable development, innovation is not only an important economic aspect but also an ecological, social and human aspect. Innovative technologies should serve people by using artificial intelligence (AI) and/or robotics in dangerous work. There are many examples of innovative solutions used in the mining industry as well as those that are used in mine rescue operations (Kuzior, 2017; Bołoz and Biały, 2020), e.g., the Canadian Sewer Robot (Kasprzyczak et al., 2013). Artificial intelligence and robotics used in mining, particularly in mine rescue operations, allow for penetrating the endangered zones of mines and assessing the conditions during the excavation and extraction processes. Rescuers receive the information they need to make a decision and can take rescue action in a more safe manner. The use of robots and AI in mine rescue operations improve and provide for rescuers' safety (Kuzior, 2017).

Currently, the mining industry is undergoing a transformation. The global demand for raw materials and stringent environmental regulations are major challenges for the mining industry. Therefore, innovations are moving towards increasing productivity through intelligent mining based on Industry 4.0 solutions (Nanda, 2020). At the same time, the ethical side of innovative solutions should be kept in mind (Fobel et al., 2019), as well as the social (Bijańska et al., 2018) and socio-geological potential of mining regions. Research on Canadian mining projects has clearly confirmed that mining activities are only possible if the social aspects of the territory are also understood and taken into account (Bergeron, 2021).

Mineral and Metal Extraction and Production – Statistics Data in Canada

Table 1 shows the statistical data related to the extraction and/or production of different metals and minerals in Canada between 2014 and 2021 as available.

Table 1. Mineral and metal extraction and/or production – statistical data in Canada

Minerals and Metals	2014	2015	2016	2017	2018	2019	2020	2021
Aluminum ¹ (in 1000 metric tons)	2,858.2	2,800	3,208.7	3,211.9	2,923.8	2,853.8	3,112.8	n/a
Coal ² (million tons)	62	63	64	64	57	57	58	n/a
Cobalt ³ (metric tons)	n/a	n/a	n/a	n/a	148,000	n/a	140,000	n/a
Copper ⁴ (tons)	650,000	697,322	650,000	575,000	527,510	543,609	475,898	n/a
Diamond ⁵ (million carats)	12	11.7	13	23.2	23.2	18.6	15	n/a
Gold ⁶ (metric tons)	151.74	160.75	161.5	168.07	183.05	175	170	170
Nickel ⁷ (tons)	210,000	220,000	230,210	200,000	177,867	193,057	167,243	n/a
Platinum Group Metals (PGM) ^{8/8} (troy ounces)	1.1	903,000	n/a	n/a	n/a	1.1	981,000	n/a
Titanium ^{9/9} (metric tons)	770,000 (2013) 31,000 (2014)	n/a	n/a	n/a	n/a	433,440	504,000	680,000 (Ilmenite)
Uranium ¹⁰	9.134	13,325	14,039	13,116	7,001	6,938	3,885	n/a

n/a – Data was not found.

*PGM – Platinum Group Metals (Include Indium, osmium, rhodium, ruthenium, palladium and platinum)

**Titanium is produced mainly from the minerals ilmenite (iron-titanium oxide/FeTiO₃), rutile (titanium dioxide/TiO₂) and leucocene while smaller quantities are produced from perovskite. Canada produces no rutile.

Sources: own study based on:

¹statista.com/statistics/1039638/canada-aluminum-production.

²nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/coalfacts/20071#L5.

³https://www.statista.com-statistics-global-cobalt-mine-production.

⁴https://www.nrcan>minerals-metal-facts>copper.

⁵statista.com/statistics/585551/Canada-s-diamond-production-in-canada/.

⁶statista.com/statista/947362/gold-production-canada/.

⁷nrcan.gc.ca/nrcan/files/mineralsmetals/factbook/nickel/canadianminingproduction-2010to2019; https://www.nrcan.gc.ca>mineral-metal-facts>nickel.

⁸nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/platinum-fact/20520.

⁹https://cubetoronto.com/canada/does-canada-have-titanium/;www.statista.com/statistics/759972/mine-production-titanium-minerals-worldwide-by-country; https://www.steeljrv.com/what-is-titanium.html.

¹⁰statista.com/statistics/568583/uranium-mine-production-in-canada/.

The statistical data (as available) presented in Table 1. are shown graphically in Fig. 1 through Fig. 6 (inclusive).

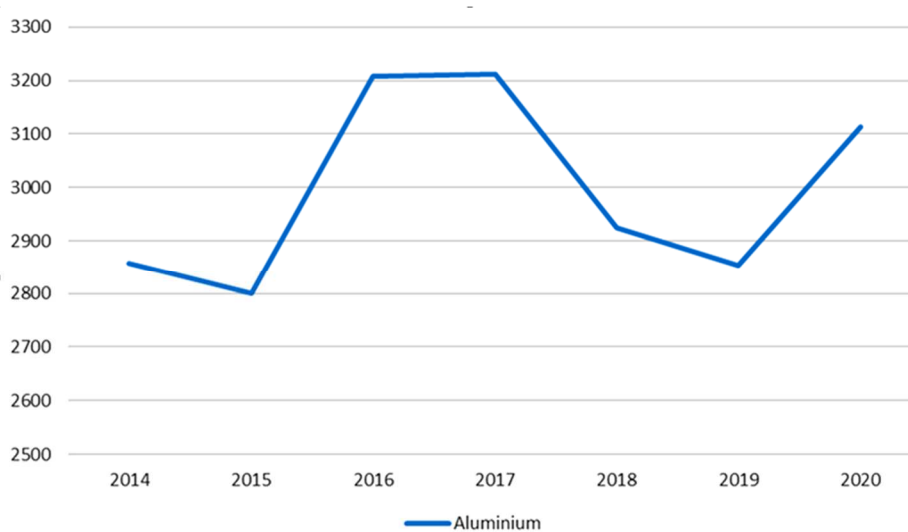


Fig. 1. Aluminium

Source: own study based on: statista.com/statistics/1039638/canada-aluminum-production.

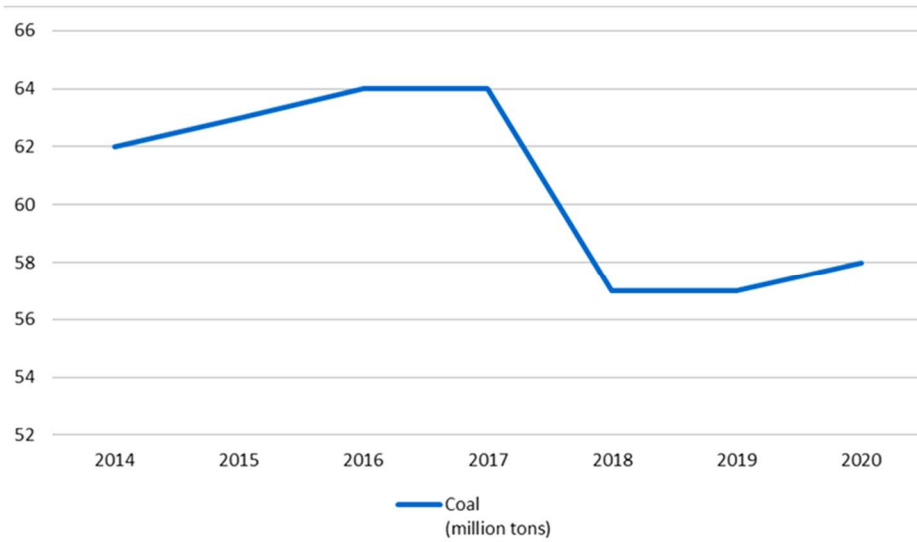


Fig. 2. Coal

Source: Own study based on: nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/coal-facts/20071#L5.

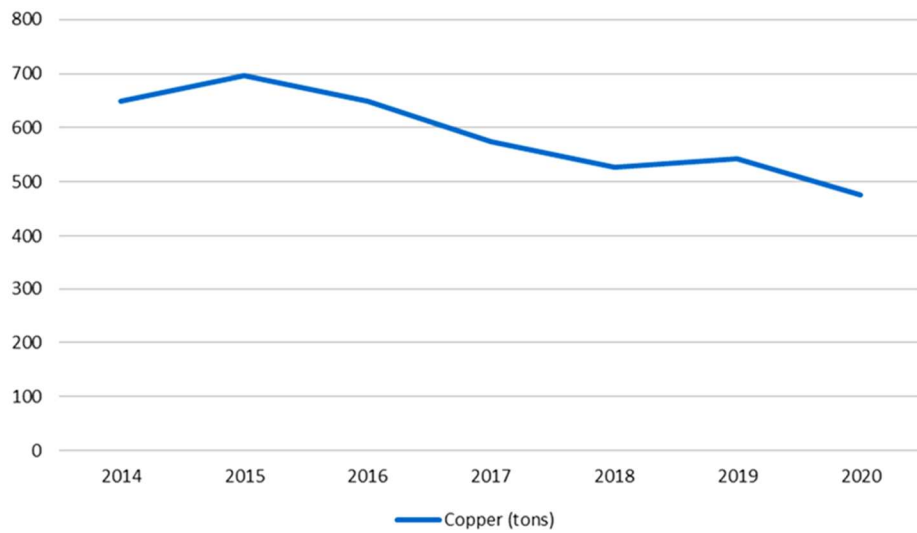


Fig. 3. Copper

Source: Own study based on: <https://www.nrcan.ca/minerals-metal-facts/copper>.

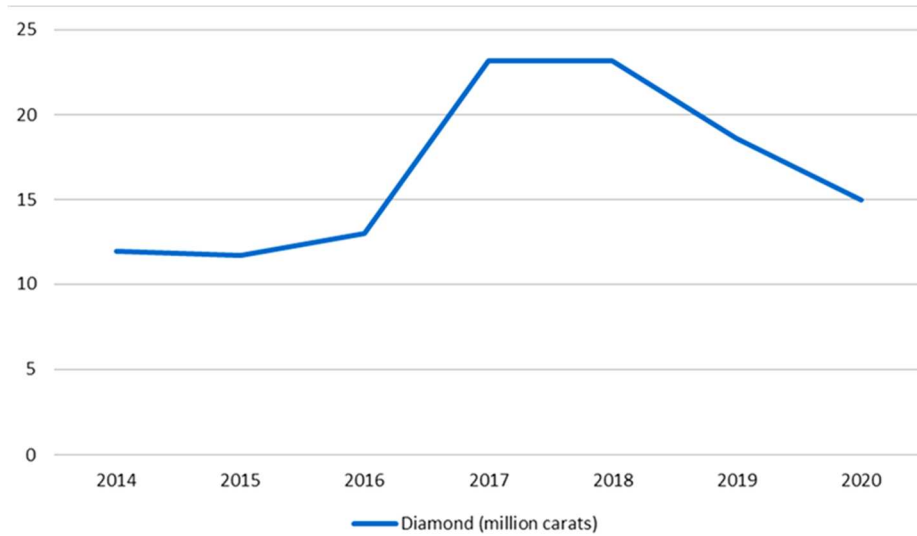


Fig. 4. Diamond

Source: Own study based on: staista.com/statistics/585551/Canada-s-diamond-production-in-canada/.

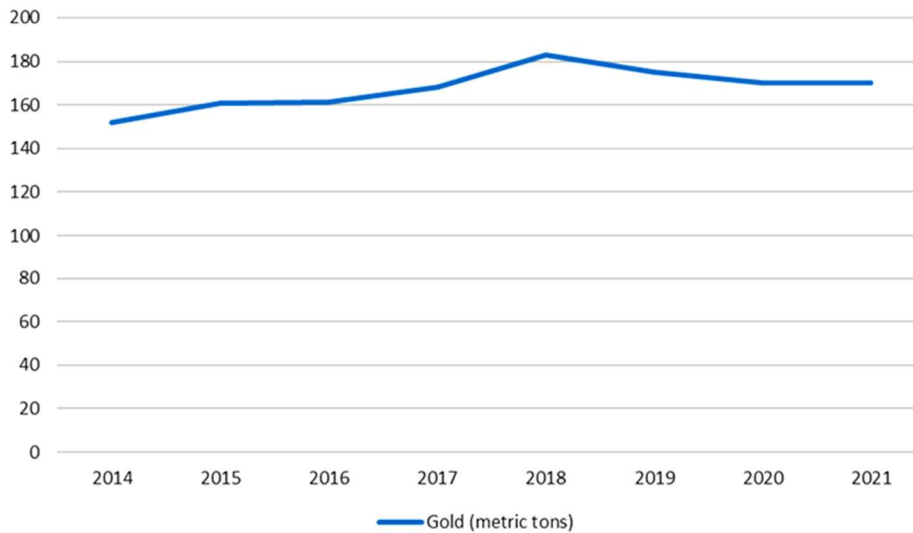


Fig. 5. Gold

Source: Own study based on: [statista.com/statista/947362/gold-production-canada/](https://www.statista.com/statista/947362/gold-production-canada/).

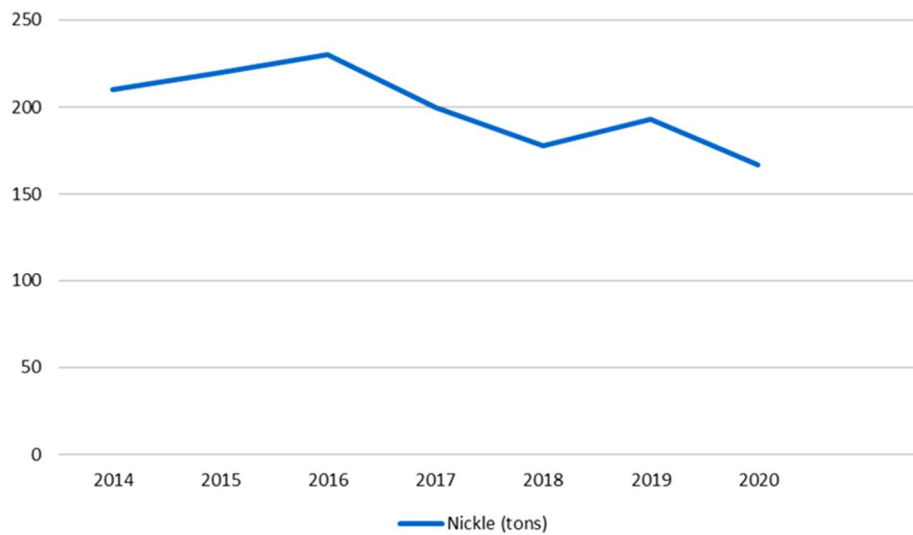


Fig. 6. Nickle

Sources: Own study based on:

[nrcan.gc.ca/nrcan/files/mineralsametals/factbook/nickle/canadianminingproduction-2010to2019/](https://www.nrcan.gc.ca/nrcan/files/mineralsametals/factbook/nickle/canadianminingproduction-2010to2019/);
<https://www.mrcan.gc.ca>mineral-metal-facts>nickle>.

The extraction and production of metals and minerals in Canada from 2014 to 2021 (as available) were affected by market prices as well as environmental restrictions implemented in Canada and other countries worldwide. The extraction of some of these metals and minerals (copper and nickel) had a decreasing tendency. The extraction of coal decreased significantly from 2017 to 2018 (due to environmental concerns) and has then stayed steady. The production of aluminum temporarily decreased between 2017 and 2019. Then this production increased to the previous level. The extraction of gold stayed steady because of high market prices. The mining of diamonds demonstrated a significant increase in 2017 and 2018. In 2020 it decreased to the level of 2016.

The level of extraction and production of metals and minerals in Canada remains high.

Material and Methods

The article is a case study of the mining procedures as well as the rules and regulations in Canada. The methodology used in the article was based on a detailed analysis of Canada's mining laws and regulations (Baldwin and Fipke, 2009). An interview with the Ministry of Labor mining safety inspector in Canada was also conducted (Wedzicha, 2020). Canadian mining laws allow any foreign company to start and conduct mining activities in Canada. Foreign mining companies and Canadian mining companies must follow the same rules and regulations. Foreign companies are equal to Canadian companies. The main goal of the case study described in the article was

to identify the best practices as well as to encourage foreign mining companies to investigate and invest in mining opportunities in Canada.

Results

1. Government Agencies Regulating the Mining Industry in Canada

Canada is comprised of ten provinces and three northern territories. Canada's legal and administrative systems are similar to those in Australia and the United States. The provincial and federal governments in Canada jointly oversee the mining industry. The federal government oversees environmental protection, collecting taxes, and exporting certain minerals and ores (e.g., uranium). Each province in Canada has its own agency regulating its mining operations. Some provinces also have environmental protection agencies. The federal government also oversees environmental protection in all provinces and northern territories. The mining industry in Canada is being regulated from three perspectives.

- Mining safety
- Labor laws
- Environmental protection

The federal government in Canada and, in some cases, the provincial government own the mineral rights. The mining company is paying a fee for the rights to mine the minerals or ores. This fee is being paid to either the federal or provincial government. The federal government or provincial government owns the minerals and ores underneath the ground. After they are brought to the surface, they are owned by the mining company and can be sold on the market. Any domestic or foreign companies, as well as any individual(s), can apply for the right to mine minerals or ores in Canada. The federal or provincial government will assist the company or individual(s) by providing geological maps related to the location of minerals, metals, or ores. Based on the application for mining rights, the permit is being granted, and the amount of the annual fee is being determined. The mining permit is being registered for an indefinite time and can be suspended only because of a lack of payment for leasing the mineral rights. Mining rights can be traded or sold between mining companies. Either the federal or provincial government needs to be made aware of this trade or sale. These governments need to give their approval of the transaction. If the mining continues, the mining permit cannot be revoked. Foreign mining companies have the same rights and privileges as Canadian companies. Those companies have to pay corporate taxes according to Canadian tax laws. Foreign companies must also comply with labor laws and mining safety regulations. The company can be registered as a corporation, partnership, or limited liability partnership (LLP). Neither the federal government nor provincial government in Canada owns any stock or has any financial interest in the mining industry.

2. Regulations Related to Environmental Protections

All mining projects require an assessment of the environmental risks. This assessment is being done by a federal government agency or sometimes a provincial agency in Canada based on the description of the mining activities being planned by the mining company. The mining company does not have to pay any fee associated with the environmental assessment (Kent, 2011). This assessment is being conducted at the expense of the federal or provincial government. Often the environmental assessment is conducted in consultation with the local residents and will determine the influence of the mining activities on the quality of life in the region. The environmental assessment combined with the consultation of the local community can take up to two years (Mines Act, 2018). Therefore, the waiting period for obtaining mining rights is approximately two years. The mining company needs to provide the necessary documentation for the following activities.

- Opening the mine while maintaining safety procedures.
- Closing the mine and land reclamation after the closure of the mine.
- Proof of funds or bank credits needed to open and close the mine operations.

3. Regulations Related to Mining Safety

Mining safety, as well as enforcement of the labor laws in Canada, is in the provincial government's jurisdiction. (There are some exemptions.) The labor laws are similar in all provinces and include the minimum wage, number of work hours in a week, overtime wages and work hours, lunch breaks, holidays, etc. The labor laws also regulate the procedures for the establishment of labor unions and the involvement of these unions in contract negotiations. There are no restrictions related to foreign investment in the mining industry or foreign companies conducting mining operations in Canada. The labor laws and mining safety laws in Canada are strictly enforced with zero tolerance for corruption. The "Mining Health and Safety Program" is under the jurisdiction of

the Ministry of Labor (MOL). In the province of Ontario, the Ministry of Labor has a staff of thirty mining safety inspectors. Those inspectors in Ontario oversee forty deep mines and seven hundred quarries. In the province of Ontario, the mining industry employs 27,400 people. (16,000 of those people work in deep mines.)

4. Enforcement of Mining Regulations

Every new project being implemented in the mining industry requires a permit which is granted by the Ministry of Labor. The application for the permit needs to include full documentation, including structural analysis as well as an analysis of the mining safety. The documentation describing the project needs to be prepared by a professional engineer with a valid license in the province where the project will be implemented. The engineer preparing the documentation is fully responsible for the project and the compliance with mining safety regulations. The Ministry of Labor is issuing the permit based on calculations and documentation prepared by the professional engineer. The professional engineer takes full legal and financial responsibility for any potential problems associated with the project. The mining inspector has a right to inspect any mining facility at any time. The inspection focuses on compliance with mining safety regulations (Provincial Coordinator, 2011; Burduk et al., 2021). During the inspection process, the mining inspector is accompanied by two individuals from the mining company. One of them represents management, and the other represents the miners' labor union. The mining safety inspector prepares a written report within seven days from the inspection day. This report includes the following:

- Reason and location of inspection
- Violations of safety procedures
- Recommended corrective action

In the event of major safety violations creating a risk to the miners' safety, the inspector can do the following:

- Stop the mining process until the problem(s) are corrected.
- Close the entire mine until the problem(s) are corrected.

After receiving the inspector's report, the mining company prepares a response by providing the timetable for correcting any safety violations. A copy of the mining company's reply needs to be sent to the miners' labor union as well as the Health and Safety Committee. Every mine is required to have a Health and Safety Committee to safeguard mining safety procedures. The mining safety inspector is not liable for any financial losses on behalf of the mining company as a result of their actions. Another role of the mining inspector is to make sure that the mining procedures do not interfere with pipelines, powerlines, railroads, highways, etc. Every mine needs to have one person designated as a manager responsible for mining operations and for following mining safety procedures. The manager or a designated by him properly trained person needs to be onsite during the mining operation. The manager's responsibility is to enforce mining safety procedures and ongoing safety training. Every report prepared by the mining inspector must be made available to all employees of the mining company. If either the mining company or any of the employees resist following the inspector's recommendations, the inspector can take the following actions.

- Explain what safety procedure(s) have been violated.
- Explain in writing the resistance and the lack of compliance with the safety procedures.
- Impose a monetary fine from \$500 - \$5000 payable by the manager or any other person resisting safety recommendations.

The employee being fined may appeal to the provincial court. After both sides present their case, the provincial court makes the final decision. Obstructing the work of the mining inspector is considered a serious crime and may result in up to three years imprisonment. Continuous ongoing violations of the safety procedure(s) may lead to the closing of the mine by the Ministry of Labor.

5. Procedure for Changing Mining Regulations

The procedure for the mining safety program is published under "Regulations for Mines and Mining Plants," which is part of the "Health and Safety Act". The safety regulations need to provide for the safety and health of the miners, but also they need to be practical, easy to understand, and simple to enforce. The Ministry of Labor works with the mining companies and labor unions in a three-way partnership to secure and achieve mining safety (R.R.O., 2022).

The Mining Legislative Review Committee (MLRC), comprised of nine members, is updating the mining safety procedures. The Ministry of Labor appoints the Chair of the MLRC. The association of mining companies appoints four members. The other four members represent the mineworkers' union. The nine members of MLRC are comprised of mining engineers as well as lower-level mineworkers. The representation from different levels is needed to represent different points of view. The changes in the mining safety procedure suggested by MLRC

need to be unanimously approved by the member of the MLRC. The activities of the MLRC are funded through the budget of the Ministry of Labor. The individual members of the MLRC do not receive compensation. Their travel and hotel expenses are being paid by the Ministry of Labor. The recommendations of the MLRC need to be approved by the Ministry of Labor. After the approval, the recommendations are forwarded to the "Office of Legislative Council" (OLC) to be included in the Mining Safety Procedure. After approval by the governor of the province, the recommendations are strictly enforced by law.

6. Investigations Following Mining Accidents

Any mining accident is followed by an investigation conducted by a mining safety inspector. During the investigation, the safety inspector interviews all the witnesses and reviews the documentation related to the accident. If the mining safety inspector feels that the mining company or any individual is obstructing or interfering with the investigation, the case is being forwarded to the provincial court. The mining safety inspector can require the mining company to hire an independent professional engineer to do an independent evaluation related to compliance with the mining safety regulations. This independent evaluation is being done at the expense of the mining company.

Discussion

The purpose of the mining regulations in Canada is the protection of the environment as well as protection of the health and safety of the personnel. Environmental protection is always being considered and evaluated before the mining permit is issued. The environmental protection assessment of the proposed mining site is being conducted at the expense of the province and can take up to two years. The Ministry of Labor is administering environmental protection and mining safety procedures. The changes and ongoing modifications of the mining safety requirements are being done in partnership with the Ministry of Labor, miners' labor union, and the mining company management. This three-way partnership was found to be an effective method in achieving the goals related to the health and safety of miners. The partnership approach for updating and changing the safety regulations is on the list of best practices to be followed by others.

Environmentally friendly extraction and protection of livelihoods of local communities and indigenous peoples are included and described in Agenda 21 Section 13.15b (1992). Continuous monitoring and control of the impact of the mining industry on the environment are also the guidelines of Agenda 21. The Canadian mining industry's approach to sustainability has evolved over the years. The Canadian Mining Association (MAC) introduced the Whitehorse Mining Initiative (WMI) in the early 1990s. WMI focused on sustainable development with a holistic approach to a partnership involving a number of stakeholders. Since 2010, the Association (MAC) has operated under the Towards Sustainable Mining (TSM) strategy, reflecting broader corporate tendencies to solve social and environmental problems as part of corporate social responsibility (CSR). However, on a compulsory basis, the extractive industry must respect comprehensive regulatory obligations introduced by the national government or provincial government (Fitzpatrick et al., 2011). The implementation of the assumptions of sustainable development is possible thanks to the implementation of improved planning and effective tools for environmental management. It is important to use cleaner technologies, implement social responsibility principles toward stakeholders, and create partnerships for sustainable development. By doing so, a mine can improve both environmental and socioeconomic performance (Hilson et al., 2000). The social responsibility of mining companies should also be understood in the context of waste management. There are many different types of waste in the mining industry, but also many possible methods for their management. Sustainable management of waste from the extractive industry responds to the current pursuit of the objectives of a continuously sustainable economy, which meets both environmental and legal requirements (Kalisz et al., 2022; Elbakian et al., 2018; Pivarciova et al., 2019). Smart mines are also developing, where modern technologies are used to improve economic efficiency, safety, and environmental protection (Hartlieb-Wallthor et al., 2022). For the functioning of smart mines, it is worth adopting the cognitive technology tools proposed for industrial enterprises and society (Kwilinski et al., 2019, Kwilinski and Kuzior, 2020). Modern cognitive tools should improve the operations of mining companies and optimize mining processes.

Conclusions

The focus of the article is to identify the best practices and provide recommendations for the mining industry based on a case study from Canada. One of the recommendations is a three-way partnership (Ministry of Labor, miners' labor union, and mining company management) for frequently updating and revising mining safety regulations. Protecting the health and safety of miners is the common goal of the three partners working together to establish practical safety regulations. The second recommendation is the opportunity for mining companies in Europe to conduct mining activities in Canada. The third recommendation is to indicate the possibility of adapting

cognitive technology solutions. Finally, the mining company's activities focus on sustainable development, social responsibility, and a continuously sustainable economy. Good practices in this area will allow for more rational management of natural resources and protection of the natural environment while meeting the needs of local communities.

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