

Implementation of safety management system in nickel mining: A case of PT Putra Perkasa Abadi Job Site MLP in 2023

Agus Amirudin ^{1,2}, Ikhsan Hidayanto ¹, Faham Burhanudin ³ and Syawal Kamiluddin Saptaputra ^{4*}

¹ Department of SHE PT. Putra Perkasa Abadi Jobsite MLP.

² Faculty of Masters in Management, Management of OSHE Concentration, Sahid University, Jakarta, Indonesia.

³ Operation Management PT. Putra Perkasa Abadi Jobsite MLP.

⁴ Faculty of Public Health, Halu Oleo University, Indonesia.

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Abstract

Background: The audit of the Mineral and Coal Mining Safety Management System aims to obtain an overview of the level of implementation of the mineral and coal mining management system, assess the capacity of the mining system to ensure compliance with the legislative requirements, evaluate the effectiveness of mining systems in meeting the set targets and identify the potential application of the MSMS to be enhanced at the P.T. Putra Perkasa Eternal Site of PT Makmur Lestari Primatama from the period January 1, 2023 until December 2023. The purpose of this study was to find out the implementation of the safety management system in nickel mining of PT. Putra Perkasa Abadi Job Site MLP in 2023.

Method: This type of research is quantitative descriptive. The research conducted in December 2023. Compliance measurements are carried out on 7 elements consisting of Policy, Planning, Organization and Personnel, Implementation, Monitoring, Evaluation and Follow-up Action, Documentation, and Management Review and Performance Improvement. Data collection methods are carried out with interviews, observations, and document explanations.

Results: The policy element achieved 74% compliance from the maximum achievable value. Although the maximum value has not been reached, it still shows a good level of compliance. The planning element achieves 59% compliance from the maximum achievable value. Further evaluation is needed to understand the factors that lead to this achievement. Organizational and staff elements reach 51% compliance from the maximum value. Implementation elements reach 38% compliance. There is great potential for improvement in the implementation of this element. The monitoring, evaluation, and follow-up elements reached 46% compliance. More effort is needed to improve performance in this regard. Despite low maximum values, documentation elements reach 58% compliance, indicating a good focus on document management but still requiring optimization. Management review elements and performance improvements reached 46% compliance. This aspect can be a focus of improvement to improve overall performance. Overall, the management system achieved 49% compliance from the maximum value.

Conclusion: In general, PT Putra Perkasa Abadi Job Site MLP has procedures and mechanisms that support the creation of a mining safety system. However, improvements are needed that can be directed to elements with lower compliance scores. It requires optimization of each element consisting of Policy, Planning, Organization and Personnel, Implementation, Monitoring, Evaluation and Follow-up, Documentation, as well as management review and performance improvement. Data collection methods were carried out using interviews, observation and document review.

* Corresponding author: Syawal Kamiluddin Saptaputra

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1. Introduction

The safety management system in the mining industry is very important because of the high level of occupational risks faced by workers. Mining safety management systems have a positive impact on worker welfare by ensuring worker safety and health and reducing the risk of accidents and injuries (1–3). Implementing a safety management system also increases a company's productivity and sustainability, as it minimizes the loss of productivity and reputation damage caused by accidents (4). This system includes factors such as good governance, organizational safety culture, resource availability, planning and monitoring, management commitment, and effective occupational health and industrial hygiene management (5). It also addresses barriers such as low management commitment, inadequate safety leadership, and poor implementation of occupational health and safety strategies. By identifying hazards, conducting risk assessments, and implementing preventative measures, safety management systems help create safer work environments and protect worker well-being while improving overall company performance (6,7).

The mining industry faces various challenges and safety risks. Hazard identification and risk analysis are essential in preventing accidents and adverse events (8). The industry does not yet have a comprehensive and integrated classification system to identify and categorize hazards, making it difficult to manage risks effectively (9). Safety issues in mining include physical, chemical, biological, ergonomic, and psychosocial risks, as well as policy, legislation, management, design, geography, and uncertainty factors. (10).

PT Putra Perkasa Abadi Site PT Makmur Lestari Primatama is a company that is concerned with occupational health and safety in the mineral and coal mining sector. One concrete form of this is conducting an audit of the implementation of MSMS which is carried out internally and is being carried out for the first time. A mining safety management system is essential to ensure safe working conditions for mining workers. The mining industry is known for its high accident rate (11). To prevent accidents and protect workers' health, hazard identification and risk analysis are necessary (12). Existing safety systems in the mining industry, such as ventilation, emergency response plans, and gas monitoring, provide sufficient air flow, and reduce accidents (13). Therefore, there is a need to improve these systems by leveraging advanced technologies and creative solutions (14).

Safety Mining Management System (MSMS) audits are provisions in the Minister of Energy and Mineral Resources of Indonesia Republic of Regulation Number 26 of 2018 and Decree of the Director General of Minerals and Coal Number 1827.K/30/MEM/2018 Appendix IV and Decree of the Director General of Minerals and Coal Number 185.K/30/DJB/2019 concerning Technical Instructions for the Implementation of Mining Safety, Assessment and Reporting of Mineral and Coal.

The MSMS audit aims to obtain an overview of the level of implementation of Mineral and coal MSMS, evaluate the ability of MSMS to ensure compliance with statutory and regulatory requirements, evaluate the effectiveness of MSMS in meeting the stated objectives and identify potential MSMS implementation to be improved at PT Putra Perkasa Abadi Site PT Makmur Lestari Primatama from January 1 2023 to December 2023. The purpose of writing this article is to find out the Implementation of the Safety Management System in PT Nickel Mining. Putra Perkasa Abadi Year 2023.

2. Material and methods

This type of research is quantitative descriptive. This research was conducted in December 2023. Measurement of Compliance with MSMS is carried out in 7 elements consisting of Policy, Planning, Organization and Personnel, Implementation, Monitoring, Evaluation and Follow-up, Documentation, as well as management review and performance improvement. Data collection methods were carried out using interviews, observation and document review. This audit was carried out based on appointment letter Number 001/KTT_MSMS-PPA/XII-2023. The audit was carried out by 2 internal auditors on behalf of Agus Amirudin (Reg No.: 184/AUD-MSMS/37/04/DBT/2023) and Ikhsan Hidayanto (Reg No.: 122/AUD-MSMS/37/04/DBT/ 2023).

Audit finding categories are grouped into 3 categories, namely minor, major and critical categories. Minor category if non-compliance with the provisions of laws and regulations, standards, guidelines and other references. Major Category if the element inspection results reveal a sub-element whose value is less than 50% (fifty percent) of the maximum value of the sub-element; and there are minor findings for one audit sub element in more than 30% (thirty percent) of locations. Meanwhile, the critical category is findings that can result in death (fatality).

The audit value calculation consists of 4 components. The first component is the Total Element Value which is obtained from the Sub-Element Values plus the Sub-Sub Element Values. Second, the Element Value Presentation (%) is obtained from $(\text{Total Element Value} / \text{Maximum Total Element Value}) \times \text{Maximum Value Percentage}$. Third, the Total Value of MSMS Implementation is obtained from the Addition of the Element Values. Fourth, the Total Percentage is obtained from the Addition of the Value Percentages of the Elements.

3. Results and discussion

3.1. Assessment of Elements in Mining Safety Management System

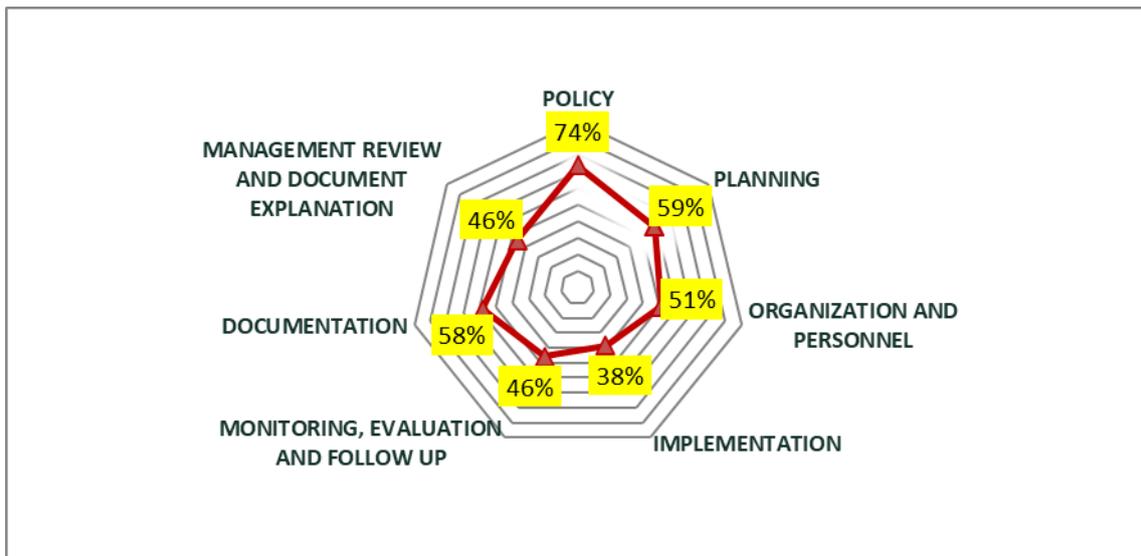
Element assessment in Mining Safety Management System (MSMS) refers to the process of evaluating and assessing various aspects or elements related to occupational safety and health in the mining industry. MSMS is a system designed to ensure that mining activities are carried out with high safety principles in mind. Each element in the MSMS represents a specific area that needs to be measured and assessed to ensure that workplace safety practices comply with established standards. As for the MSMS assessment at PT. PPA Site MLP can be seen in table 1.

Table 1 MSMS Element Assessment

No	Elements	Maximum Value	Achievement	% Compliance
1	Policy	10%	7%	74%
2	Planning	15%	9%	59%
3	Organization and Personnel	17%	9%	51%
4	Implementation	35%	13%	38%
5	Monitoring, Evaluation, and Follow Up	15%	7%	46%
6	Documentation	3%	2%	58%
7	Management Review and Document Explanation	5%	2%	46%
	Total	100%	49%	

Source: (Primary Data, 2023)

Table 1 includes the evaluation or assessment of various elements related to the management system of an aspect (perhaps safety or quality) by depicting the maximum value, actual achievement value and compliance percentage for each element. The policy element achieved 74% compliance with the maximum achievable value. Even though it has not reached the maximum value, it still shows a good level of compliance. The planning element achieved 59% compliance with the maximum achievable value. Further evaluation needs to be carried out to understand the factors that cause this achievement value. Organizational and personnel elements achieved 51% compliance with the maximum value. Special attention is needed to increase achievement in this element. Implementation elements achieved 38% compliance. There is great potential for improvement in the implementation of these elements. Monitoring, evaluation and follow-up elements achieved 46% compliance. Further efforts are needed to improve performance in this regard. Despite the low maximum value, the documentation element achieved 58% compliance, indicating a good focus on document management but still requiring optimization. Management review and performance improvement elements achieved 46% compliance. This aspect can be the focus of improvement to improve overall performance. Overall, the management system achieved 49% compliance with the maximum achievable value. It provides an overview of the extent to which the entire system complies with established standards or criteria. Improvements can be directed to elements with lower compliance scores.



Source: (Primary Data, 2023)

Figure 1 Compliance of Mining Safety Management System

3.2. Policy

In the context of the Mining Safety Management System, "policy" refers to a written statement or formal commitment from an organization related to occupational safety and health in the mining environment (1). There is a need for a clear statement regarding the organization's commitment to occupational safety and health as a top priority. In addition, setting specific goals to be achieved by the organization in terms of safety and health in the workplace, a statement that the organization will comply with all applicable laws, regulations and safety standards in the mining industry, as well as recognition of the importance of worker involvement in creating a strong safety culture. and sustainable. The policy must reflect a proactive approach to accident prevention, risk identification and continuous improvement of safety performance. The MSMS Policy is not only a formal document, but also a foundation for building a strong safety culture and ensuring that safety is considered a core value in every aspect of work at mining industry.

PT PPA Site PT MLP has policy content containing vision, mission and objectives, as well as a commitment to implementing Mining Safety (OSH and OS), all contents of the Mining Safety policy have been reduced to a Mining Safety work program. Apart from that, PT PPA Site PT MLP has established written policies, has been approved by the highest leadership and is dynamic, namely adapting to changes that exist at PT PPA. On the other hand, there are several things that need to be optimized, this can be seen in table 2.

Table 2 Problems and Follow-up of Policy Element

Problems	Follow Up
The company has not fulfilled the 3 requirements for preparing an initial review, namely comparison, a comparison has been carried out but it has not covered the entire benchmark objective.	The company evaluates the preparation of an initial review of one of the benchmark reports
The company's socialization regarding policies is not yet comprehensive, so there are one (sample) non-staff employees (HCGA and PLANT) who do not yet understand the Company's policies.	The company carries out socialization and evaluation of policy communication by including: conducting socialization on P5M/GST, conducting Post-Leave/New Hire Inductions, conducting Pretests and Post Tests on policy-related Inductions, conducting evaluations related to socialization media.
Companies need to distribute MOM information, the previous year's management review was not comprehensive, so not all departments knew and follow-up actions had not been carried out.	The company carries out the previous year's management review MOM distribution.

Source: (Primary Data, 2023)

3.3. Planning

Planning plays an important role in a mining safety management system. Effective planning includes a comprehensive assessment of the environmental and social impacts associated with resource extraction, as well as incorporating wise management of natural resources. Sustainable management practices and responsible use of natural resources can minimize negative impacts and contribute to sustainable regional development (15). In the context of underground mining safety management, a study proposed a framework model that uses process node management and probabilistic multi-plan analysis to analyze and rank key risk factors. This model can assist in implementing risk factor management control plans (16). Another study introduced a mine safety management system that includes a safety monitoring subsystem, a health monitoring subsystem, a potential accident analysis subsystem, and a potential accident prediction subsystem. The system enables monitoring of geology, miner health status, and analysis of potential accidents, ultimately leading to accident prediction and safety management (17). In addition, adopting an occupational health and safety management system based on international standards is important for mining companies. Internal audits can identify critical system points and help improve safety at the mine (18).

PT PPA - MLP has carried out an initial review in planning, determining the level of achievement of Mining Safety performance that is in accordance with the conditions. Apart from that, PT PPA – MLP has Hazard Identification and Risk Assessment (HIRA) but in several cases it still requires optimization which can be seen in Table 3.

Table 3 Problems and Follow-up of Planning Element

Problems	Follow Up
The company has reported the mining safety Performance Level Assessment but has not included the output of the activity, only explaining the results and there is no follow-up program	It is necessary to review reports/activities for the KP Performance Level Assessment and create a program for follow-up to the results of the Performance Level Assessment of mining safety
The company has carried out HIRA review activities, but the implementation has not been carried out regularly/periodically because it has not involved stakeholders	It is necessary to carry out PT PPA of HIRA review activities, determine the HIRA review schedule for all departments periodically, determine HIRA review activities in the TSP program, determine the review period in PT PPA HIRA procedures, involve each department and related stakeholders and conduct HIRA training
The company has carried out HIRA review activities, but the implementation has not been carried out regularly/regularly because it has not involved stakeholders	It is necessary to conduct internal and external issue reviews with company stakeholders periodically, establish a schedule for regular internal and external issue reviews, determine internal and external issue review activities in the TSP program
The company has carried out HIRA review activities, but the implementation has not been carried out regularly/regularly because it has not involved stakeholders	It is necessary to carry out PT PPA of HIRA review activities, determine the HIRA review schedule for all departments periodically, determine HIRA review activities in the TSP program, determine the review period in PT PPA HIRA procedures, involve each department and related stakeholders and conduct HIRA training

Source: (Primary Data, 2023)

3.4. Organization and Personnel

Organization and personnel play an important role in the mining safety management system. Mining companies need organizational and technical solutions to reduce the risk of injury and ensure the safety of personnel involved in the production process (19). In the coal mining industry, the industrial relations system can involve management organizations, workers, unions, and government agencies, all of which contribute to workplace safety (20). Mining personnel management system, as the article explains (21), utilize monitoring hosts, management workstations, network servers, and various equipment to track and manage personnel in the mining environment. This system allows automatic identification and management of personnel, ensuring their safety in different working conditions. Overall, effective organizational and personnel management is essential to maintaining a high level of safety in the mining industry.

PT PPA Site PT MLP already has a PJO (PPA-MLP-F-SHE-128) which received approval from the PT Makmur Lestari Primatama Summit (04/PJO/MLP-PPA/X/2022) and the PJO has met the administrative and qualifying requirements. technical requirements according to statutory and regulatory criteria with PJO competence, namely POU. In terms of organization and personnel, several things that still require optimization can be seen in Table 4.

Table 4 Problems and Follow-up of organization and personnel Element

Problems	Follow Up
The company has not updated the SO for integration of Operational Supervisors and socialization is lacking and concern for each GL is lacking	Companies need to update/review the company's SO, socialize job descriptions, conduct training related to duties and responsibilities, and add induction material related to duties and responsibilities.
The company has not carried out comprehensive socialization of the SO and job description and there is a lack of concern for each GL	Need to update/review again regarding company SO, socialize job description and SO, conduct training related to duties and responsibilities and add Induction material related to duties and responsibilities
The company has not updated its competency matrix so it does not yet know the updates on competent operational and technical supervisors	Review and update competency matrices, as well as appoint operational and technical supervisors
The company has not updated the competency matrix so it does not yet know the updates on competent technical personnel	Update the competency matrix and appoint technical personnel

Source: (Primary Data, 2023)

3.5. Implementation

Table 5 Problems and Follow-up of Implementation Element

Problems	Follow Up
The company does not carry out HIRA review activities regularly/periodically because it does not involve stakeholders.	It is necessary to carry out HIRA review activities, determine the HIRA review schedule for all departments periodically, determine HIRA review activities in the TSP program, determine the review period in PT PPA's HIRA procedures, involve each department and related stakeholders and conduct HIRA training.
The company has not carried out regular review of procedures.	It is necessary to review periodic procedures, review the master list of periodic documents, review periodic LPI recommendations and conduct periodic HIRA reviews.
No Special Work Instructions (Confined Space) were found during last year's work	It is necessary to review the master list of documents periodically, review the list of document records, and review document control procedures.
There are still employees whose understanding of the function of PPE is not yet comprehensive	It is necessary to carry out training related to Personal Protective Equipment (PPE), create a PPE training program and evaluate understanding of PPE.
There has not been a review of environmental monitoring and measurement procedures	It is necessary to review environmental monitoring and measurement procedures, as well as create an annual schedule for reviewing procedures.

Source: (Primary Data, 2023)

Implementation elements in the Mining Safety Management System include good governance, organizational safety culture, resource availability, SMART planning and monitoring, management commitment and strategy, effective Occupational Health & Industrial Hygiene (OH-IH) management, compliance, and safety leadership (1). The commitment of the company's top management and the translation of this commitment into company policy is very important for the implementation of occupational safety protection (22). Hazard identification, risk assessment and risk control are important components of risk management in mining operations (4). The operation of mining facilities

should be based on the principles of industrial risk management, including monitoring of the internal and external environment, labor and production processes, and the structural and functional basis of the labor safety system (23). Safety partnership management systems in coal mining companies can influence miners' behavior and increase their benefits through rewards and punishments (24).

PT PPA - MLP has prepared, implemented and documented participation, consultation, motivation and awareness of MSMS and has prepared and established documented operational/work procedures. Apart from proof, PT PPA – MLP has prepared and established a documented Special Work Permit. However, there are things that still require follow-up. This can be seen in Table 5.

3.6. Monitoring, Evaluation and Follow-up

Elements of evaluation and follow-up in the mining safety management system include the level of success in implementing the mining safety management system (25). In addition, a safety partnership management system in coal mining companies can increase miners' benefits and stimulate the adoption of safe behavior (26). Strengthening rewards and punishments can accelerate the spread of safe behavior among miners (27). A relational analysis is used to effectively evaluate the relationship between safety investments and accident impact losses in mining occupational health and safety management systems (28). In addition, the mine safety system uses a wireless sensor network with various sensors such as temperature, humidity, air flow, noise, dust and gas concentration that can accurately monitor and ensure the safety of mine workers. Finally, a comprehensive safety evaluation index system is proposed, considering human factors, safety inputs, institutions, and organizational structure.

PT PPA - MLP has monitoring, evaluation and follow-up procedures. Apart from that, PT PPA - MLP has internal audit procedures and has procedures for improvement and follow-up plans. However, in several cases there are still things that need to be optimized. This can be seen in Table 6.

Table 6 Problems and Follow-up of Monitoring, Evaluation and Follow-up Element

Problems	Follow Up
The company has not carried out regular reviews regarding investigation reports and there has been no monitoring of investigation reports	It is necessary to determine a review of LPI PC 2140 and create a schedule for comprehensive LPI monitoring.
The company has not yet met its overall competency	It is necessary to establish a training schedule for annual competencies, establish an ATMP program, establish a TNA program, establish a competency matrix program, establish a schedule for periodic review of the ATM, TNA and competency matrix programs, determine ATM, TNA and competency matrix activities in the TSP program and establish procedures employee training.
Company Fulfillment of competency is not yet complete	It is need to establish a training schedule for competency and carry out internal audits.
The company has not carried out a review regarding overall follow-up and there has been no overall follow-up monitoring/PIC	Need to determine the LPI PC 2140 review, make a schedule for PICA monitoring and carry out an overall PICA review/follow-up.

Source: (Primary Data, 2023)

3.7. Documentation

Documentation plays an important role in a mining safety management system. It enables efficient management and exploitation of documentation related to mining projects, enabling information retrieval and extraction using natural language processing techniques (29). Comprehensive safety documents are required to ensure proper construction and compliance with mine use guidelines for a specific purpose (30). For safety critical projects, clear documentation of all process steps is essential to comply with standard norms and regulations and to facilitate subsequent verification by auditors (31). In the context of safety documents, systems have been developed to search for requirements, which are a specific class of arguments, in safety documents such as regulations and business documents (32). Overall, documentation is critical to ensuring safety, compliance and efficient management in the mining industry.

PT PPA - MLP has an MSMS manual, procedures, master list of documents to support the Mining Safety Management System. However, in the documentation elements there are still things that need to be optimized as seen in Table 7.

Table 7 Problems and Follow-up of Documentation Element

Problems	Follow Up
The company has an MSMS manual but has not yet carried out comprehensive socialization	Need to socialize the Manual of MSMS
The company has not reviewed the master list of documents on a regular basis and document control procedures have not been socialized	It is necessary to socialize document control procedures and review the master list of documents periodically
The company has not reviewed records regularly	Need to review documents and records periodically
The company has not reviewed the master list of documents regularly and has not socialized document control procedures	It is necessary to socialize document control procedures and review the master list of documents periodically

Source: (Primary Data, 2023)

3.8. Management Review and Performance Improvement

Management review and performance improvement are important aspects of a mining safety management system. The close relationship between regional development and mining safety management system planning, emphasizes the need for a comprehensive assessment of the environmental and social impacts associated with resource extraction (15). Ineffective or inappropriate training methods are often associated with accidents and deaths in the mining industry. Therefore, it is very important to systematize knowledge about the causes of work accidents and use this information to improve the design of mining projects. Attention should be paid to equipment such as conveyor belts, dump trucks, and dumpers, especially during maintenance or repair activities. Effective monitoring, control of machine operations, and appropriate training programs are stated measures to minimize accidents (33).

PT PPA - MLP has management review procedures in terms of mining safety. On the other hand, there are still matters that require follow-up as seen in Table 8.

Table 8 Problems and Follow-up of Management Review and Performance Improvement Element

Problems	Follow Up
The company has not periodically reviewed the Management Review procedures according to site relevance	It is need to review Management Review procedures.
The company has not recorded management review status records	It is need to record management review status records.
The company has not carried out any follow-up recording of management review status records.	It is need to carry out follow-up recording of management review status records
The company has not recorded records of management review status records, has not carried out follow-up recording of management review status records and has not made requests for management follow-up.	It is necessary to record management review status records, carry out follow-up recording of management review status records and carry out management follow-up requests

Source: (Primary Data, 2023)

3.9. Efforts to Improve the Mining Safety Management System Implementation Programs

Improving the Mining Safety Management System (MSMS) implementation program involves a series of strategic actions and ongoing efforts to ensure that occupational safety and health in the mining environment is well managed (1). The following are several efforts that can be taken to improve the mining safety management system implementation program:

- Routine Audits and Evaluations: Companies need to carry out regular audits and evaluations of MSMS to identify weaknesses and areas of potential improvement. This can help in assessing the extent to which the program is running in accordance with applicable standards and requirements as well (2), and include a comprehensive assessment of the environmental and social impacts associated with resource extraction in the safety management system (34)
- Employee Participation: Employee involvement in program development and implementation is required. Active involvement from employees can improve compliance and create a strong safety culture (35).
- Training and Awareness: Providing adequate training to all personnel regarding occupational safety and health. Increase awareness of potential risks and the importance of workplace safety practices (36).
- Incident Reporting System: Establish an effective system for reporting incidents, including minor incidents. Incident analysis can provide valuable insights for future improvement and prevention (37). Incident analysis provides valuable insights that can help identify causes and implement corrective actions (38)
- Continuous Improvement: Implement a continuous improvement cycle by evaluating audit results and incident reporting in order to correct problems and weaknesses in the management system. Identify opportunities for improvement and implement necessary corrective actions (1).
- Counseling and Communication: delivering information about MSMS regularly through effective counseling and communication. Ensure that all parties involved understand applicable safety policies and procedures (39).
- Application of Safety Technology: Technological advances have greatly improved safety and efficiency in mining operations. Various technologies, such as mechanization and automation, have been developed to overcome safety challenges in surface and underground mines (40).
- Leadership Commitment: Company leadership needs to demonstrate full commitment to safety. Company leadership sets a good example and supports safety programs with adequate resources and support (1).

In general, it should be noted that improving the MSMS implementation program is a continuous effort involving all organizational levels within the company. Through the active involvement of all relevant parties, it is hoped that the safety program can continue to be improved to optimize work safety standards in the workplace.

4. Conclusion

In general, PT Putra Perkasa Abadi Job Site MLP has procedures and mechanisms starting from the elements. Policy, Planning, Organization and Personnel, Implementation, Monitoring, Evaluation and Follow-up, Documentation, as well as management review and performance improvement. Data collection methods were carried out using interviews, observation and document review.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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