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ANALYSIS OF PERFORMANCE AND SAFETY RISKS IN THE NICKEL MINING SECTOR

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ABSTRACT
Mining safety performance refers to evaluating the effectiveness and efficiency of efforts made to maintain the safety and health of workers in the mining environment.The aim of this research is to analyze the performance and safety risks in the nickel mining sector at PT. Putra Perkasa Abadi Job Site MLP Southeast Sulawesi. This type of research is a mixed method which begins with quantitative research and continues with qualitative research. The research subjects/respondents in this study were 653 people. Risk analysis uses bow tie analysis. The data collection method for assessing the level of mining safety performance consists of several methods, namely document review, questionnaire distribution, data analysis, interviews, observations, focus group discussions, and simulations.The mine worker participation indicator is at a proactive level with an achievement value of 0.13. Indicators of Responsibility of Work Unit Leaders; Accident statistics are at a proactive level with an achievement value of 0.32. The statistical indicators for accidents, dangerous events, incidents resulting from occupational diseases and occupational diseases are at the planned level with an achievement value of 0.17. The Control Efforts indicator is at a proactive level with an achievement value of 0.26. Based on the recapitulation results of all the Company's Mining Safety Performance indicators it is at the Proactive level with a value of 0.88. PT. PPA Job Site MLP has mining performance at a proactive level. This shows that this company is starting to involve workers in the improvisation stage of K3 management.

Keywords: mining safety; performance; risk

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INTRODUCTION

Mining safety performance refers to evaluating the effectiveness and efficiency of efforts made to maintain the safety and health of workers in the mining environment. This involves a number of factors, including measuring the number of work accidents and incidents, the level of compliance with safety procedures, the effectiveness of training programs, reporting of incidents and investigations, and the implementation of corrective and preventive actions. The mining industry faces various challenges and safety risks. Hazard identification and risk analysis are essential in preventing accidents and adverse events (Baghaei Naeini S. A & Badri A., 2023). The mining industry has challenges in managing risk effectively (The Mining Industry, 2023). Safety issues in mining include physical, chemical, biological, ergonomic, and psychosocial risks, as well as policy, legislation, management, design, geography, and uncertainty factors. ("GENERAL: Mining Safety and Security," 2023).

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 (Matei et al., 2022)(Mudzakir et al., 2022)(Guntur Suryaning Hadi et al., 2023). 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 (Skripnik et al., 2023). 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 (Galkin et al., 2022). 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 preventive measures, safety management systems help create safer work environments and protect worker well-being while improving overall company performance (Minister of Energy and Mineral Resources, 2018; Director General of Mineral and Coal and Energy and Mineral Resources, 2019).

PT Putra Perkasa Abadi (PPA) Job Site MLP 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 SMMS 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 (A. Ananth Chaitanya et al., 2023). To prevent accidents and protect workers' health, hazard identification and risk analysis are necessary (Chopde, 2023). Existing safety systems in the mining industry, such as ventilation, emergency response plans, and gas monitoring, provide sufficient air flow, and reduce accidents (Satapathy, 2023). Therefore, there is a need to improve these systems by leveraging advanced technologies and creative solutions (Komaricheva E. I & Vinogradova O.V., 2023). This study aims to assess performance as well as safety risks in the nickel mining sector at PT. PPA Job Site MLP Southeast Sulawesi.

METHOD

This type of research is a mixed method that begins with quantitative research and continues with qualitative research. carried out from August to September 2023. Safety Maturity Level Assessment measurements are carried out on workers in each department and employee level at PT. MLP PPA Job Site. Cumulatively, the maturity level of K3 implementation is divided into 5 levels, namely: Stage 1 Basic (<0.5), Stage 2 Reactive ($0.5 \leq x < 0.70$), Stage 3 Planned ($0.70 \leq x < 0.80$), Stage 4 Proactive ($0.80 \leq x < 0.90$), Stage 5 Resilient ($0.90 \leq x \leq 1$). There are 4 indicators in the safety maturity level, namely: Mining Worker Participation, Responsibilities of Work Unit Leaders, Accident Statistics, Dangerous Events, Occupations Due to Workforce Diseases, Occupational Diseases, and Control Efforts. Partially determining the achievement level category for each indicator, namely:

1. Mining worker participation: for achievement scores < 0.07, it is included in the basic category; achievement $0.07 \leq x$ 0.10 reactive level; $0.10 \leq x$ 0.12 planned level; $0.12 \leq x$ 0.14 proactive level; $0.14 \leq x$ 0.15 resilient level.
2. Responsibilities of work unit leaders: for achievement scores < 0.17 are included in the basic category; achievement $0.17 \leq x$ 0.24 reactive level; $0.24 \leq x$ 0.29 planned level; $0.29 \leq x$ 0.33 proactive level; $0.33 \leq x$ 0.35 resilient level
3. Mining worker participation: for achievement scores < 0.07 in the basic category; achieement $0.07 \leq x$ 0.10 reactive level; $0.10 \leq x$ 0.12 planned level; $0.12 \leq x$ 0.14 proactive level; $0.14 \leq x$ 0.15 resilient level.
4. Analysis and statistics of accidents, dangerous incidents, incidents resulting from occupational diseases, and occupational diseases: for achievement values < 0.10 are

included in the basic category; achievement of 0.10 ≤ x 0.14 reactive level; 0.14 ≤ x 0.17 planned level; 0.17 ≤ x 0.19 proactive level; 0.19 ≤ x 0.20 resilient level.

5. Control efforts: for achievement values < 0.15 are included in the basic category; achievement of 0.15 ≤ x 0.20 reactive level; 0.21 ≤ x 0.25 planned level; 0.25 ≤ x 0.28 proactive level; 0.28 ≤ x 0.30 resilient level.

Data collection for Mining Safety Level Assessment consists of several methods, namely document review, distribution of questionnaires, data analysis, interviews, observations, focus group discussions, simulations based on the Decree of the Director General of Minerba ESDM No. 10.K/MB.01/DJB.T/2023. Distribution of Questionnaires, FGDs and Interviews is carried out online. Meanwhile, Data Analysis, Observation, Document Review and Offline Simulation. The sampling method used is proportional sampling. The total population is 1215 people. The sample was 653 people consisting of Operational Responsible Persons, Vendors/Work Partners, Section Heads/Coordinators, Group Leaders, Operators, Mechanics, Labor Helpers, and Non-PPA and Labor Staff. For mining safety risk analysis, use Bow Tie analysis. Bow Tie Analysis is a risk management method used to identify, analyze and manage risks in a system or activity. This method takes its name from the shape of the resulting diagram, which is similar to a bow tie. The diagram has two main parts: a "bow tie" which is the center point, representing the risk event, and two "wings" which represent controls to prevent or reduce the negative impact of the event. Bow Tie Analysis helps in visualizing existing risks, identifying the causes and consequences of risk events, as well as evaluating the effectiveness of existing controls to manage those risks.

RESULTS

Table 1.
Characteristics of research subjects/respondents (n=653)

Gender	**f**	**%**
Male	623	95
Female	30	5
Marital status		
Married	351	54
Not Married	290	44
divorced	12	2
Position		
Top Management	9	1
Middle Management	93	14
Low Management	551	85
Work location	n	(%)
Field	65	10
Office	78	14
Field and Office	555	85
Work unit		
Production	268	41
Plant	109	17
Engineering	56	3
HCGA	98	15
Academy	11	2
FA & Log	92	8
SHE	19	3

Table 1 shows that based on gender characteristics, the majority of respondents were men, 623 (95%) and 30 (5%) were women. Based on marital status, the majority of respondents

were married people, 351 people (54%), while the number of unmarried people was also quite significant, namely 290 people (44%). Only a few have divorced in this population. Based on their position, the majority of respondents were in the "Low Management" category with 551 respondents or around 85%, while the fewest were in the "Top Management" category with only 9 respondents or around 1%. Based on work location, the majority worked either in the field or in the office, 555 respondents or 85%. Meanwhile, the lowest number was in the "Field/Field" category with only 65 respondents or 10%. The majority of work units are the production department with 268 respondents or around 41%, which shows that the majority of respondents work in the production department. Meanwhile, the work unit with the smallest number was "Academy" with only 11 respondents or around 2%.

Assessment of Mining Safety Performance Achievement Level Indicators

The assessment of indicators for the level of achievement of mining safety performance consists of the participation of mine workers, the responsibilities of work unit leaders, analysis and statistics of accidents, work-related diseases, incidents resulting from occupational diseases, and dangerous incidents, and the control efforts carried out which can be seen in Figure 1.

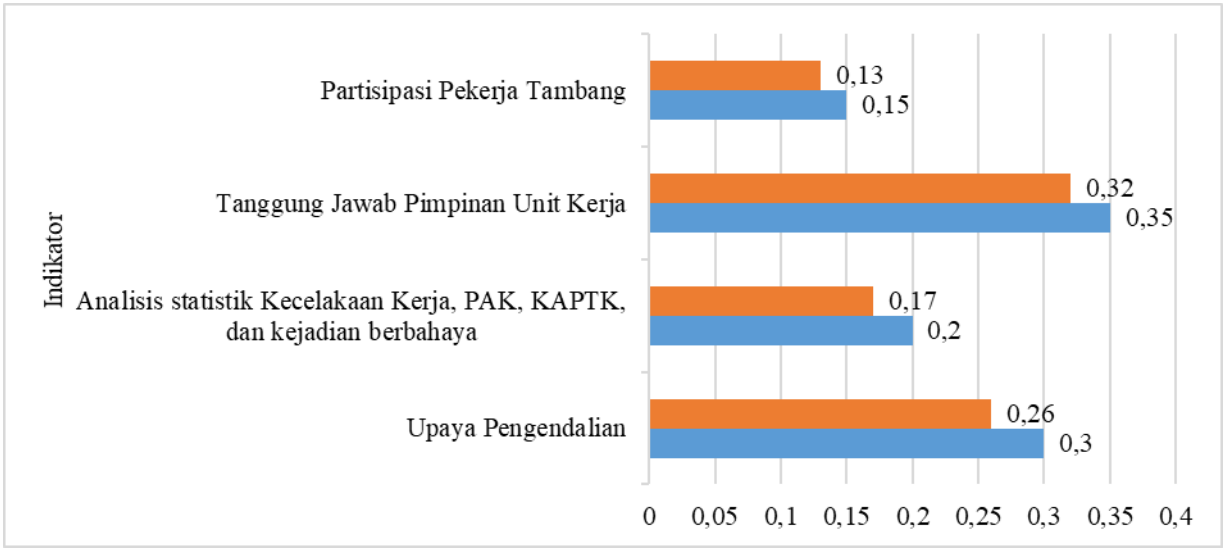

Figure 1 Assessment of Mining Safety Performance Achievement Level Indicators

Based on Figure 1, the aspect of mining worker participation obtained is an achievement value of 0.13. This shows that indicators of miner participation are at a proactive level. The assessment of indicators of responsibility of work unit leaders obtained an achievement value of 0.13. This shows that the Work Unit Leadership Responsibility indicator is at a proactive level. For the indicators for Analysis and Statistics of Accidents, Occupational Diseases, Occurrence Due to Occupational Diseases, and Dangerous Events, an achievement value of 0.13 was obtained, which is at the planned level. For the assessment of the Control Efforts Implemented indicator, an achievement value of 0.26 was obtained, so it is at the Proactive level.

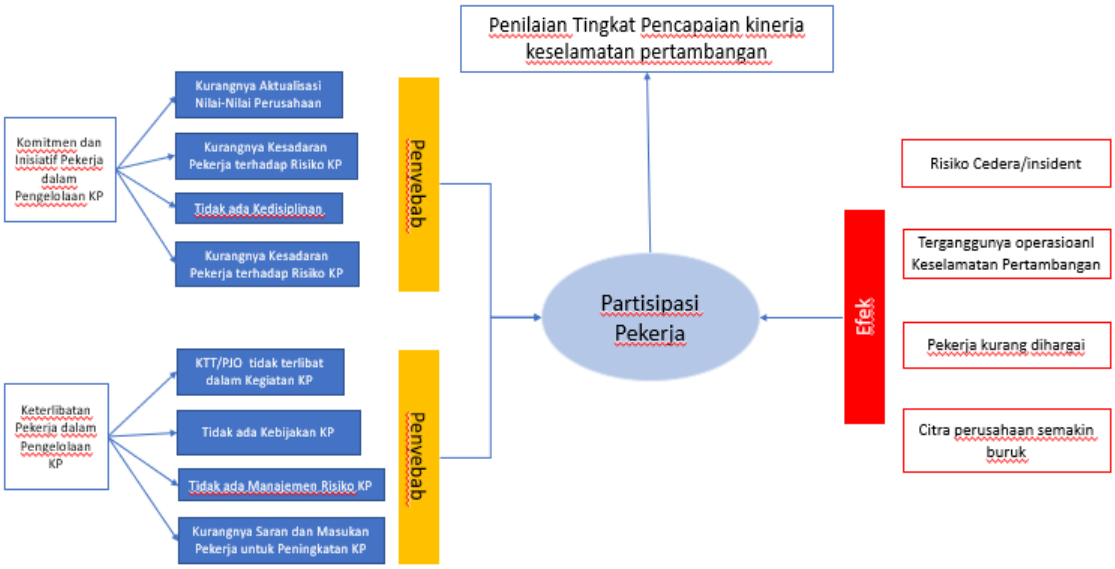

Figure 2 Bow Tie Analysis of Mining Worker Participation

Figure 2 explains that things that can influence worker participation in achieving mining safety performance are the lack of commitment and initiative of workers in managing mining safety (MS). Apart from that, the lack of optimal worker involvement in MS management also affects worker performance. This can have an impact on the risk of injuries/incidents, disruption of MS operations, workers feeling underappreciated, and the potential for a decline in the Company's image.

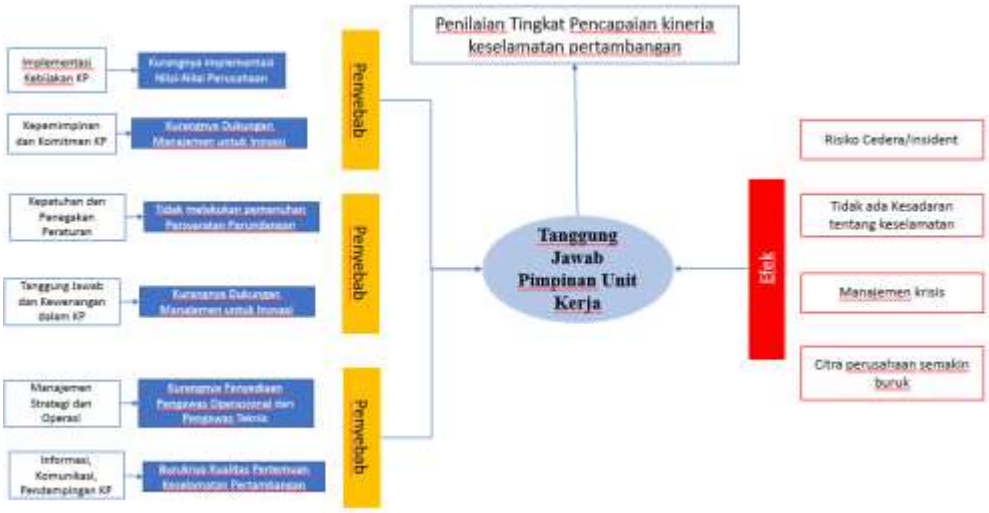

Figure 3 Bowtie Analysis Responsibilities of work unit leaders

Figure 3 explains that the things that influence the achievement of mining safety performance in terms of the responsibilities of work unit leaders are several things that have not been optimal, including the implementation of MS policies; MS's leadership and commitment; regulatory compliance and enforcement; responsibility and authority in MS; strategy and operations management; information, communication and MS assistance. This can have an impact on the risk of injury/incident, lack of awareness of work safety, crisis management, and a decline in the company's image.

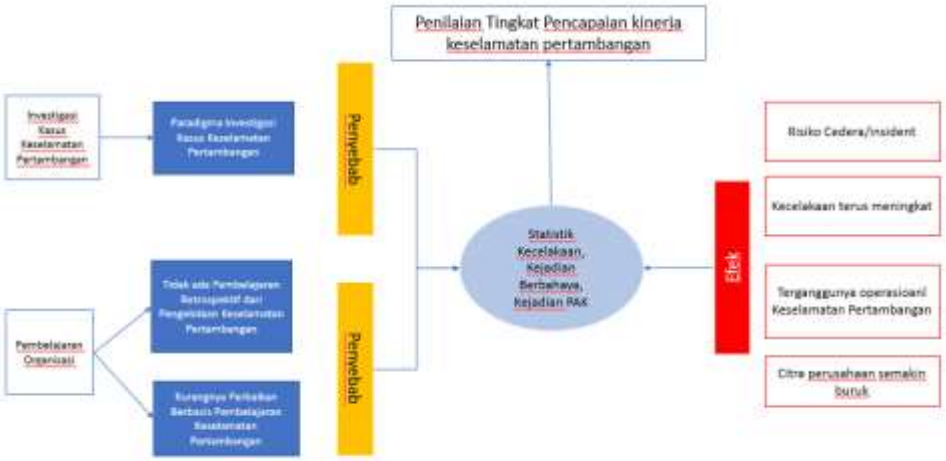

Figure 4 Bowtie Analysis of Statistical Indicators for Accidents, Dangerous Events, Occurrences Due to Workforce Diseases, Occupational Diseases

Figure 4 shows that the factor that causes mining performance to be not optimal in terms of statistics, accidents, dangerous incidents and occupational disease (PAK) is that MS case investigations and organizational learning are still not optimal. This can have an impact on the risk of injuries/incidents, increased cases of work accidents, disruption of MS operations and a decline in the Company's image.

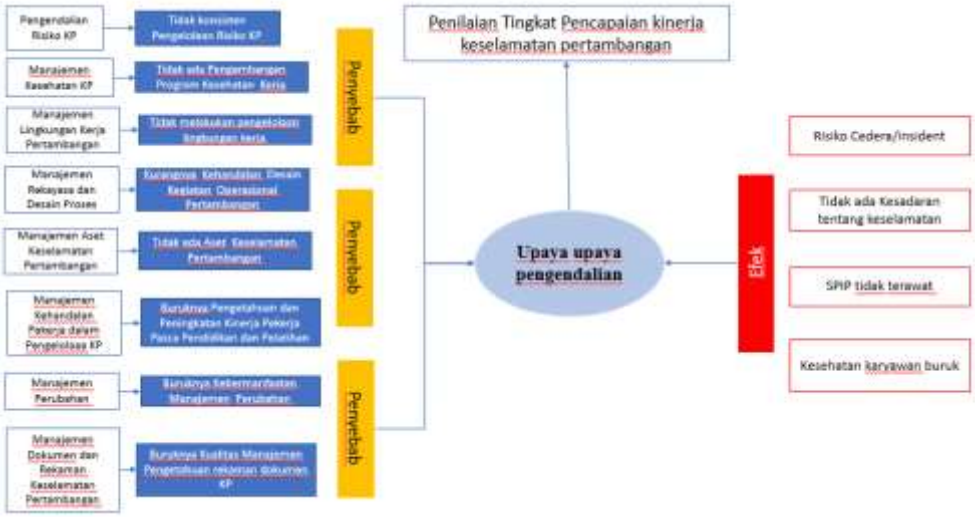

Figure 5 Bowtie Analysis of Control Effort Indicators

Figure 5 shows the factors that cause mining performance to be not optimal in terms of control efforts, namely several things that are less than optimal, including: MS risk control; MS Health management; mining work environment management; engineering management and process design; MS asset management; worker reliability management in MS management; change management; management of MS documents and records. This can have an impact on the risk of injuries/incidents, lack of mining safety awareness, SPIP not being maintained, and declining employee health.

Table 2.
Total Mining Safety Performance Achievement

Indicator	Total Indicator Value	Achievement Category
Mine worker participation	0,13	Proaktif
Responsibilities of Work Unit Leaders	0,32	
Analysis and Statistics of Accidents, Occupational Diseases, Occupations Due to Workforce Diseases, and Dangerous Events	0,17	
Control Efforts	0,26	
Total Performance Achievement Value	0,88	

Table 2 shows that based on the results of the recapitulation of indicators for Mining Workers' Participation, Responsibilities of Work Unit Leaders, Analysis and Statistics of Accidents, Occupational Diseases, Workforce Disease Events, and Dangerous Events, as well as Control Efforts Implemented, an achievement value of 0.88 was obtained. This shows that the Safety Maturity Level is at the Proactive level.

DISCUSSION

Mine worker participation

Worker involvement in work safety programs is very important as a form of worker awareness of work safety programs. Engagement and Involvement is a form of employee participation and active feedback from all levels of the organization. Employee involvement and participation can take the form of decision-making processes, K3 planning, and contributing ideas for improvement (Lingard, 2014). Employee involvement in program development and implementation is required. Active involvement from employees can improve compliance and create a strong safety culture (Knode, 2020). Providing adequate training to all personnel regarding occupational safety and health. Increase awareness of potential risks and the importance of worMSlace safety practices (Samchuk-Khabarova & Gaponov, 2023).

Based on the mining safety performance assessment carried out, it was found that employee participation with the parameters of Individual Concern and Behavior towards Mining Safety Risks means that employees or workers who work as mine workers understand the Golden Rules of Mining Safety (Golden Rules) as well as company values and are able to actualize them in their work. Apart from that, workers take an active role and collaborate to achieve goals in Mining Safety Activities, from non-supervisory workers to management level. In the implementation of hazard reporting, it is carried out proactively and consistently by workers with a level of participation. The application of leadership requires employee involvement in work planning. Worker involvement in work safety programs is very important as a form of worker awareness of work safety programs. A good safety culture in an organization, employee empowerment is carried out to ensure that employees understand their important role in promoting safety. With this empowerment, employees tend to have more responsibility for ensuring operational security (Wiegmann, Douglas, 2004). Responsibility is a thing or situation that an individual must do, carry out and complete when they receive a task or activity properly and correctly. Describes the level of responsibility of employees which is characterized by a sense of care and attention in maintaining the safety and health of themselves and others in the worMSlace (Zaira & Hadikusumo, 2017).

Responsibilities of Work Unit Leaders

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 (Guntur Suryaning Hadi et al., 2023). 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. Policies should reflect a proactive approach to accident prevention, risk identification and continuous improvement of safety performance. A mining Safety Management System 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 aspects of work in the mining industry.

Leadership is a personality attitude that can organize, give, give an example to others to have a positive impact on those around or the ability to influence a group towards achieving its vision and mission. (Lingard, 2014). The reflection of achieving a good work safety culture is in sustainable organizational learning through several applications such as feedback systems, monitoring and analysis, concern for sources of danger in the form of sharing safety information. (Gadd & Collins, 2022). Based on survey data in assessing mining safety performance, it was found that the responsibility of work unit leaders to workers with the parameters of Mining Safety Strategy and Operations Management is that management formulates mining safety strategies that are in accordance with SMART (Specific, measurable, achievable, relevant, and time-bound goals and there is a clear and detailed Explanation and Alignment of the Mining Safety Management Strategy. In addition, management always carries out continuous Monitoring and Measurement of Mining Safety Management Performance, which can detect critical conditions that can seriously affect system performance, challenges and opportunities, in the short term & long term. long - positively or negatively, and able to follow up knowing what to look for to maintain performance.In the parameters of Information, Communication, Mentoring, Mining Safety Consultation that management provides Space and Access for Submitting Mining Safety Information from Workers as well as implementing Mentoring, Coaching and Counseling for Workers from Work Team Leaders.

Something that is no less important related to leadership responsibilities is related to 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 (Rujiman, 2023). 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 (Gao et al., 2020). 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 (Linxin, 2018). 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 (Llaque & Andre, 2017).

Analysis and Statistics of Accidents, Dangerous Events, Occupations Due to Workforce Diseases, Occupational Diseases

Based on the results of the mining performance assessment, it was found that the variables Analysis and Statistics of Accidents, Occupational Diseases, Occurrences Due to Workforce Diseases, and Dangerous Incidents where management has carried out a Mining Safety Case Investigation Paradigm, in this case investigations if there are incidents (nearmisses or work accidents) so that they can improve the capability of all pre-conditions that support operational activity work systems. Management can take retrospective learning from mining safety management (things that are learned from experience, both from failure and success) and follow up on the results of mining safety management learning. Communication and information is a process of conveying messages from one party to another party with the aim of expressing opinions, providing information, and obtaining clear and correct information. Describes awareness, attention and willingness to communicate information and problems related to occupatonal health and safety (OSH) (Zaira & Hadikusumo, 2017).

Mining companies need organizational and technical solutions to reduce the risk of injury and ensure the safety of personnel involved in the production process (Peryatinskiy & Poleshchuk, 2023). 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 (Cai, 2019). Mining personnel management system, as the article explains (Jialiu & Sheng, 2017), 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.

In terms of analysis and statistics of accidents, dangerous incidents, incidents resulting from occupational diseases, occupational diseases, documentation also plays an important role. Comprehensive safety documents are required to ensure proper construction and compliance with mine use guidelines for a specific purpose (Słota, 2023). 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 (Bala, 2017). Dalam konteks dokumen keselamatan, sistem telah dikembangkan untuk mencari persyaratan, yang merupakan kelas argumen tertentu, dalam dokumen keselamatan seperti peraturan dan dokumen bisnis (Choi & Saint-Dizier, 2013). Secara keseluruhan, dokumentasi sangat penting untuk memastikan keselamatan, kepatuhan, dan manajemen yang efisien di industri pertambangan.

Furthermore, efforts are needed to build an effective system for reporting incidents, including minor incidents. Incident analysis can provide valuable insights for future improvement and prevention (Budi et al., 2022). Incident analysis provides valuable insights that can help identify causes and implement corrective actions (Fernando et al., 2023). 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 (Onifade & Said, 2023).

Control Efforts

The company has developed key risk indicators as an early warning system throughout the organization, there is contingency planning in various operational scenarios. Risk management methods are continuously developed referring to statutory regulations and following advances in science and technology. Each individual has a role in control. In addition, management carries out adaptive work planning by continuously looking for the

possibility of new, undetected risks for future operational plans, both short and long term. Implementation in the Mining Safety Management System includes 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 (Guntur Suryaning Hadi et al., 2023). 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 (Rusba et al., 2022).Hazard identification, risk assessment and risk control are important components of risk management in mining operations (Skripnik et al., 2023). 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 (Galkin et al., 2022). Safety partnership management systems in coal mining companies can influence miners' behavior and increase their benefits through rewards and punishments (Liu et al., 2022). delivering information about SMMS regularly through effective counseling and communication. Ensure that all parties involved understand applicable safety policies and procedures (Han et al., 2022).

CONCLUSION

PT. PPA Job Site MLP is in the proactive category in terms of mining safety performance. This shows that in its implementation it begins to involve workers in the improvisation stage of K3 management. Awareness and involvement of workers in K3 management is starting to change the pure top-bottom management approach into two-way communication in the sense that all levels of positions actively participate in efforts to create a safe, comfortable, healthy and safe work environment. On the other hand, increased efforts are needed to optimize supervision and innovative programs to minimize unsafe acts and unsafe conditions in the workplace.

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