J E M T
Journal of Earth and Marine Technology
homepage URL: ejurnal.itats.ac.id/jemt

Strategic Risk Management in Nickel Mining: Hazard Identification and Assessment at PT. Nusantara Traisser on behalf of PT. Vale Indonesia in Sorowako, South Sulawesi

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Article info

Received:
Jan 30, 2024
Revised:
Feb 21, 2024
Accepted:
Mar 20, 2024
Published:
Mar 31, 2024

Keywords:
AS/NZS 4360:2004, consequence, exposure, hazard identification, risk level, risk assessment, probability.

Abstract

This study conducts a thorough analysis of occupational hazards and evaluates the risk management strategies at PT. Nusantara Traisser, a safety contractor for PT. Vale Indonesia located in Sorowako, South Sulawesi. Using the AS/NZS 4360:2004 framework and the William T. Fine method, this research identifies and assesses potential risks in various work areas within the mining sector. The objective is to enhance understanding of the key risk factors and develop effective mitigation strategies that can be implemented to reduce workplace accidents and promote a safer working environment. Field observations and semi-quantitative assessments reveal eleven primary hazards across four distinct work areas, with detailed risk values assigned to each. The study not only categorizes these risks but also proposes specific control measures, including engineering and administrative solutions, to address high-priority hazards effectively. This case study highlights the critical role of integrated risk management in improving occupational safety in the mining industry and provides valuable insights into the practical application of hazard identification in complex work environments.

1. Introduction

Mining, particularly in nickel-rich regions such as Sorowako in South Sulawesi, Indonesia, is fraught with significant occupational hazards. These risks are exacerbated by the demanding physical environment and the necessity for handling complex machinery and toxic materials. At PT. Nusantara Traisser, a safety contractor for PT. Vale Indonesia, the imperative to enhance safety measures is not only regulatory but crucial for operational sustainability and environmental stewardship. This study employs the widely recognized AS/NZS 4360:2004 framework along with the William T. Fine method to perform an exhaustive hazard identification and risk assessment at the Sorowako site.

Occupational safety in the mining industry is a globally acknowledged concern, influenced by a variety of factors including equipment reliability, environmental conditions, and human behavioral factors, all of which contribute significantly to the sector's high incident and accident rates. Effective hazard management is crucial not only for preventing loss of life and serious injuries but also for enhancing productivity and achieving compliance with stringent industry standards (Kepmen [4]; S. Ramli [14]). The emphasis on rigorous safety protocols and active management of workplace risks is further underscored by recent regulations such as the Minister of Energy's Decision No. 26 of 2018, which mandates companies to ensure robust safety measures are in place (Menteri Energi dan Sumber Daya Mineral Republik Indonesia [7]).

In addition to regulatory compliance, there is a growing recognition of the need for a proactive approach to occupational health and safety, which involves regular risk assessments and the adaptation of safety measures to technological advancements and changing workplace practices (Y. Adityawan [6]; I. Shofiana [10]). This is particularly relevant in the context of PT. Nusantara Traisser's operations, where the integration of safety and operational procedures can significantly mitigate the inherent risks associated with mining activities.

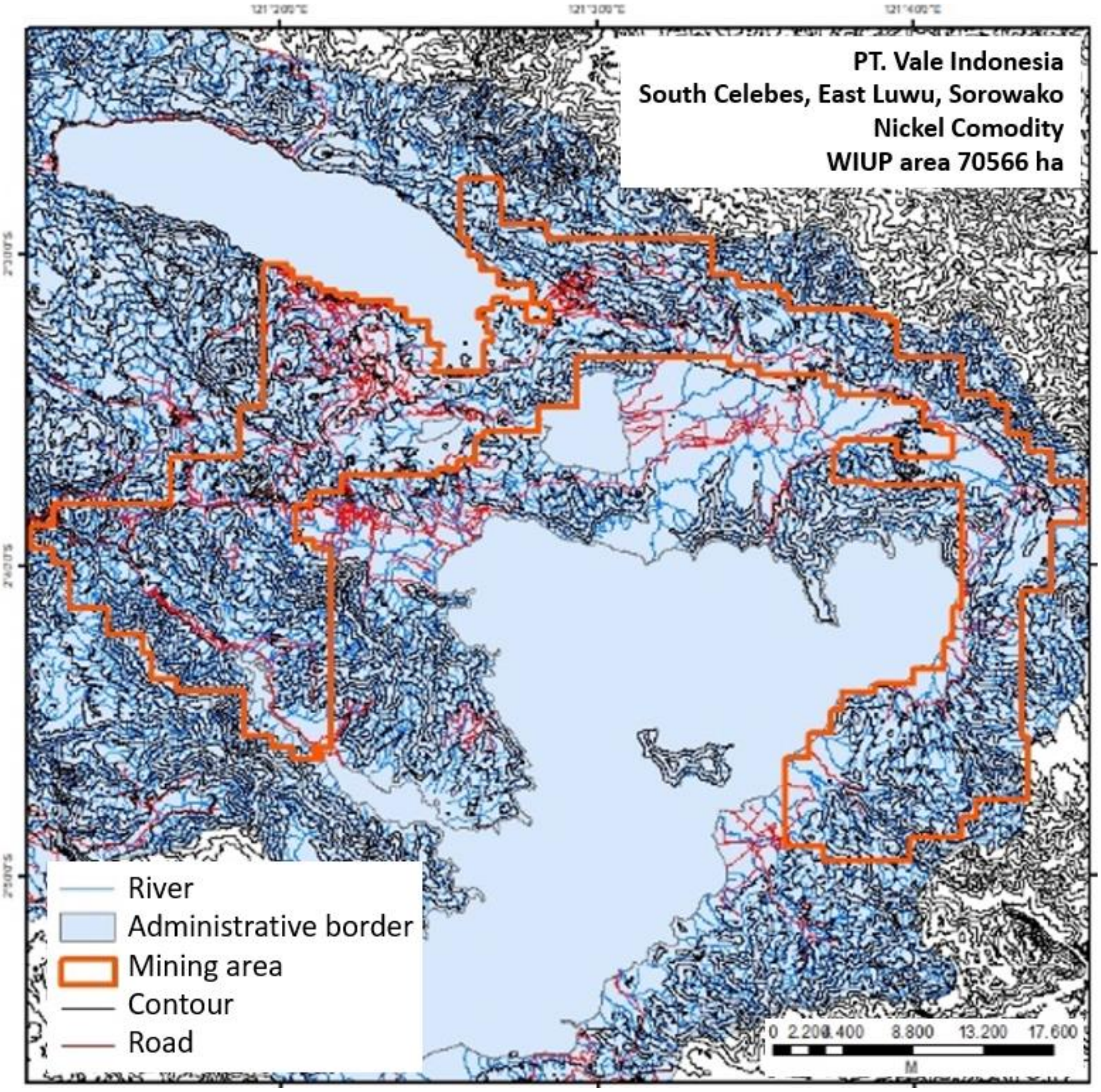

Figure 1. The map of the WIUP location

The methodology adopted in this study—the AS/NZS 4360:2004 standard for risk management—is complemented by the semi-quantitative approach of the William T. Fine method, which together provide a robust framework for identifying potential hazards and evaluating their respective risks (A. R. Adinugraha [13]). This dual-methodology approach allows for a comprehensive assessment that not only identifies and categorizes risks but also proposes practical mitigation strategies tailored to the unique conditions of the Sorowako site.

The significance of this study lies in its potential to contribute to the body of knowledge regarding effective risk management practices in the mining industry, particularly within developing countries where regulatory frameworks and safety practices may still be evolving. Furthermore, by documenting the specific conditions and challenges at the PT. Nusantara Traisser site, the research provides actionable insights that could guide similar mining operations in Indonesia and beyond in adopting more rigorous safety standards, thereby enhancing the overall safety culture within the industry (N. Syam et al. [15]; M. Akib et al. [17]).

In conclusion, this research not only documents the current safety conditions but also advances a set of actionable strategies for risk mitigation. It aims to foster a safer working environment that could serve as a benchmark for mining operations in Indonesia and other similar contexts globally, thus contributing to the ongoing efforts to enhance safety standards and reduce occupational hazards in the mining sector.

2. Methodology

This study adopts a rigorous semi-quantitative descriptive approach to hazard identification and risk assessment at PT. Vale Indonesia, specifically focusing on the operations of PT. Nusantara Traisser in East Luwu, South Sulawesi. Employing the William T. Fine method alongside the AS/NZS 4360:2004 standard for risk management allows for a structured and systematic analysis of workplace hazards and their associated risks (A. R. Adinugraha [13]).

Data Collection

Data were collected through a combination of direct field observations and the review of existing documentation. Field observations were conducted by the research team, who visited various work areas to gather firsthand data on the types of activities performed, the environmental conditions, and the interactions of workers with machinery and equipment. This primary data collection focused on identifying potential hazards as they occurred in real time, providing insights into the immediate risks present in the workplace environment.

In addition to direct observations, secondary data were gathered from several sources, including the company's safety records, accident reports from the past two years, standard operating procedures (SOPs), and training schedules. This secondary data provided a historical context for the study, offering a baseline against which the current safety practices could be evaluated (M. R. Eko et al. [16]).

Risk Assessment Methodology

The risk assessment process was structured according to the AS/NZS 4360:2004 methodology, which involves the calculation of risk scores based on the probability of occurrence, exposure levels, and potential consequences of each identified hazard. This semi-quantitative approach enables the categorization of risks into various levels, facilitating prioritization and management (S. Ramli [14]).

1. **Identification of Hazards:** Hazards were identified through both the review of secondary data and direct observations in the field. Each hazard was documented with details regarding its nature, location, and the conditions under which it occurred.

2. **Risk Analysis:** For each identified hazard, the probability of occurrence and potential consequences were estimated using the William T. Fine method. This involved consulting with onsite safety officers and engineers to derive ratings that reflect the likelihood of each hazard leading to an accident and the severity of potential outcomes.

3. **Risk Evaluation:** The risks were then evaluated by calculating a risk score for each hazard. This score was derived by multiplying the probability, exposure, and consequence ratings. The resulting scores helped in classifying the risks such as low, medium, high, or extreme, thus determining the urgency and type of interventions required.

4. **Development of Risk Control Strategies:** Based on the risk evaluation, specific control measures were recommended for each hazard. These measures ranged from engineering controls to administrative changes and the use of personal protective equipment, aligned with the best practices in occupational safety and health management.

Research Flowchart

The research flowchart outlines the sequential steps from data collection through to the analysis and formulation of recommendations. It serves as a visual guide to the systematic approach adopted in this study, ensuring that each stage of the hazard identification and risk assessment process is thoroughly documented and aligned with established risk management principles.

This methodology not only ensures a comprehensive assessment of the current safety conditions at PT. Vale Indonesia also provides a robust framework for ongoing risk management and safety enhancement in mining operations.

3. Results and discussions

The hazard identification and risk assessment were conducted at PT. Nusantara Traisser's project site at PT. Vale Indonesia revealed varying levels of potential hazards across four distinct work areas within the Mining Business License Area. These areas include Training & Competency Facilities, Safety Equipment Inspection, Anoa North Ground Training (Mines & HSOR Department), and Enggano Coal and Sulfur Storage.

In the PT. Nusantara Traisser project at the PT. Vale Indonesia site, there are 4 categories of work areas and there is 1 main activity conducted in each work area located within the Mining Business License Area of PT. Vale Indonesia Tbk, namely Training & Competency Facilities, Safety Equipment Inspection, Anoa North Ground Training (Mines & HSOR Department), and Enggano Coal and Sulfur Storage.
From the research data obtained from the 4 work areas, each has the following potential hazards: Training & Competency Facilities has 2 potential hazards, Safety Equipment Inspection has 4 potential hazards, Anoa North Ground Training (Mines & HSOR Department) has 3 potential hazards, and Enggano Coal and Sulfur Storage has 2 potential hazards.

Table 1. Work Area, Potential Hazards and Sources of Potential Hazards

No	Working Area	Potential Hazards	Sources of Potential Hazards
1.	*Training & competency Facilities*	The training schedule is too packed	Human
		practice area at height (scaffolding and stairs)	Human
2.	*Safety Equipment Inspection*	Movement of DT, Bus, and LV	Human
		The inspection area has mounds of soil and water puddles.	Environment
		Exit doors are too narrow for large units.	Human
		Stamp tools for tires and electrical flow.	Human
3.	*Anoa North Ground Training(Mines & HSOR Department)*	Mining traffic	Human
		There are muddy roads, slippery roads, and uphill, and downhill conditions	Environment
		Presence of bees and snakes.	Environment
4	*Enggano Coal and Sulphur Storage*	Mining traffic	Human
		Enggano coal and sulfur area has water puddles.	Environment

The method and calculation for risk assessment based on AS/NZS 4360:2004 on risk management using the risk assessment score Finechart (William T. Fine) can be seen in the following table.

The risk assessment process, aligned with the AS/NZS 4360:2004 guidelines, utilized the William T. Fine method to calculate risk scores based on probability, exposure, and consequence of each hazard identified (AS/NZS 4360:2004 cited in [14]). This approach has facilitated the prioritization of risks, allowing for targeted intervention strategies.

Table 2. Hazards Identification and Risk Assessment

Potential Hazards	Risk	Probability	Exposure	Consequence	Risk Level
The training schedule is too packed	*Fatigue*	0.5 (*conceivable*)	2 (*Infrequent*)	1 (*noticeable*)	1 (*acceptable*)
practice area at height (scaffolding and stairs)	Falling while climbing up and down stairs or scaffolding due to not maintaining the 3-point contact and being suspended by a body harness after falling from a platform can pose a serious risk	0.5 (*conceivable*)	2 (*Infrequent*)	1 (*noticeable*)	1 (*acceptable*)
Movement of DT, Bus, and LV	Colliding with another unit due to the absence of a safe distance line in the queue, the operator getting down from the vehicle and being hit by another unit, being hit by an uncontrollable moving unit, falling while getting in and out of the DT cabin during inspection, hands getting caught in the unit's door, or head hitting the unit's body during inspection.	0.5 (*conceivable*)	2 (*Infrequent*)	25 (very serious)	25 (*Priority 3*)
Inspection area has mounds of soil, water puddles.	Tripping while conducting inspections in the heavy equipment inspection area due to traversing mounds of soil and slipping because of water puddles formed by rainfall between the inspection areas for buses, light trucks, and LV	0.5 (*conceivable*)	1 (*rare*)	1 (*noticeable*)	1 (*acceptable*)
Exit doors are too narrow for large units.	The exit door of the inspection area and the unit parked in front of the inspection area exit door are hit by the DT or Bus due to limited maneuvering space for turning.	3 (*unusual butpossible)*	2 (*Infrequent*)	15 (*serious*)	90 (*substantial*)
Stamp tools for tires and electrical flow.	Blistered skin due to contact with a hot tire stamping tool and electrocution from an electric current due to wet working conditions.	0.5 (*conceivable*)	2 (*infrequent*)	5 (*important*)	5 (*acceptable*)
Mining traffic	Collided with another vehicle while operating LV on public roads.	6 (*likely*)	2 (*infrequent*)	25 (very *serious*)	300 (*priority* 1)
There are muddy roads, slippery roads, uphill, and downhill conditions	*LV overturned due to imbalance caused by slippery, muddy, uphill and downhill road conditions, gravel, and the LV unit collided with the embankment due to loss of control or panic.*	0.5 (*conceivable*)	2 (*infrequent*)	1 (*noticeable*)	1 (*acceptable*)
Presence of bees and snakes.	Stung by bees or bitten by a snake due to activities outside the LV.	3 (*unusual butpossible)*	2 (*infrequent*)	5 (*important*)	30 (*priority* 3)
Mining traffic	Collided with another vehicle while operating LV on public roads.	6 (*likely*)	2 (*infrequent*)	25 (very *serious*)	300 (*priority* 1)
Enggano coal and sulfur area has water puddles.	Participants and instructors slipped due to water puddles while inspecting the unit.	0.5 (*conceivable*)	2 (*infrequent*)	1 (*noticeable*)	1 (*acceptable*)

The critical risks identified, such as the high probability of collisions due to mining traffic which has a risk score of 300 (Priority 1), necessitate immediate attention. This risk, alongside the substantial risks posed by narrow exit doors and electrical hazards during equipment inspections, underlines the urgent need for revising safety protocols and implementing more stringent control measures.

The findings echo previous studies that emphasize the importance of continuous monitoring and updating of safety measures to adapt to dynamic environmental conditions and operational changes (S. Ramli [14]). Furthermore, the need for specialized training programs to mitigate human-related hazards, especially in high-risk areas such as mining traffic and equipment operation areas, is critical (N. Syam et al. [15]). These programs should focus on both skill enhancement and awareness of potential dangers, aiming to reduce the occurrence of accidents related to human error.

Moreover, the environmental risks identified, such as water puddles and uneven terrain, suggest that there is a significant opportunity for improving workplace safety by upgrading physical infrastructure and ensuring regular maintenance to manage these hazards proactively (M. R. Eko et al. [16]).

The comprehensive risk assessment conducted at PT. Nusantara Traisser's project site at PT. Vale Indonesia identifies several critical hazards across different work areas, each presenting unique challenges to workplace safety. This study's findings resonate with global safety management practices and illuminate the path forward for both immediate and long-term risk mitigation strategies.

Human Factors and Training Necessities

The identified human-related hazards, particularly in training facilities and operational areas, underscore the necessity for robust training programs. These programs are crucial for minimizing human error, a significant risk factor in industrial accidents (Y. Adityawan [6]). For instance, overcrowded training schedules can lead to fatigue, which increases the likelihood of accidents due to decreased alertness. This is further complicated by high-altitude work areas where scaffolding and stairs present falling hazards. Implementing comprehensive training that emphasizes safety protocols and proper rest periods can mitigate these risks, aligning with strategies that have proven effective in other high-risk industries (A. P. Utami [11]; A. R. Adinugraha [13]).

Environmental and Equipment Hazards

The environmental hazards identified, such as water puddles and uneven terrain, can cause slips and falls, significantly impacting worker safety. These findings are consistent with previous studies which suggest that regular environmental assessments and maintenance are essential to ensure safe working conditions (M. R. Eko et al. [16]; E. H. Sujiono et al. [19]). Additionally, the risks associated with equipment, such as the potential for electrical hazards from stamp tools for tires, highlight the need for regular equipment inspections and maintenance (S. Ramli [14]; S. A. Dwi [3]).

Regulatory Compliance and Safety Standards

The study's alignment with the AS/NZS 4360:2004 risk management framework ensures that the risk assessment process is thorough and adheres to internationally recognized standards (N. Syam et al. [15]). Moreover, the use of the William T. Fine method provides a structured way to quantify risks based on probability, exposure, and consequence, facilitating effective prioritization of risk mitigation measures. This methodology is crucial for meeting and exceeding the safety standards mandated by local and international regulatory bodies (Menteri Energi dan Sumber Daya Mineral Republik Indonesia [7]; Direktorat Jenderal Ketenagalistrikan [8]).

Long-term Strategic Implications

The strategic implications of these findings extend beyond immediate risk mitigation. Developing a culture of safety within PT. Nusantara Traisser and PT. Vale Indonesia involves a long-term commitment to continuous improvement in safety standards and practices. This includes ongoing training, regular review and updating of safety protocols, and investment in safer infrastructure and equipment (I. Shofiana [10]; K. K. Pratama [12]). Furthermore, engaging with local and international safety experts to benchmark against best practices can drive significant improvements in safety performance (M. Akib et al. [17,18]).

This analysis of workplace hazards at PT. Nusantara Traisser's project site not only provides actionable insights for immediate improvements but also sets the stage for developing a comprehensive safety culture that can serve as a benchmark for the industry. By addressing both human and environmental factors, and aligning with rigorous safety standards, the organization can enhance operational safety and efficiency, ultimately leading to a safer and more productive workplace.

4. Conclusion

The comprehensive hazard identification and risk assessment conducted at PT. Nusantara Traisser's site within PT. Vale Indonesia in Sorowako, South Sulawesi, has identified a total of 11 significant hazards spanning across biomechanical, physical, biological, and social impact categories. This diverse range highlights the complex interplay of various factors that contribute to workplace safety risks, necessitating multifaceted risk management strategies.

Among these hazards, the most critical is mining traffic, which has been categorized as Priority 1 with a risk score of 300, indicating the necessity for immediate and targeted interventions to mitigate potential accidents and ensure worker safety. To address these concerns, the study recommends specific risk controls tailored to the distinct needs of each work area. For the Training & Competency Facilities, administrative and engineering controls are advised to enhance training safety and manage biomechanical risks effectively. In the Safety Equipment Inspection area, a comprehensive set of measures is suggested, including hazard elimination where feasible, enhancement of administrative protocols, the deployment of personal protective equipment (PPE), and reinforcement through engineering controls to manage physical and mechanical hazards.

Similarly, focused administrative and engineering controls are recommended for the Anoa North Ground Training (Mines & HSOR Department) to mitigate environmental and biological risks inherent in outdoor training environments. For the Enggano Coal and Sulfur Storage area, a robust combination of hazard elimination, administrative adjustments, engineering solutions, and protective equipment is essential to address the risks associated with materials handling and storage.

This study not only pinpoints the critical areas requiring immediate attention but also sets a framework for ongoing safety management practices. By adopting these recommendations, PT. Nusantara Traisser can significantly enhance its safety standards, align with best practices in industrial safety, and create a safer working environment that protects its workforce while maintaining operational efficiency. Future efforts should continue to monitor the effectiveness of implemented controls and adjust strategies as necessary to adapt to evolving workplace conditions and emerging risks, ensuring the long-term well-being of all employees.

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