Conference Paper

Occupational Health and Safety Analysis of Mining Companies Using Hazard Identification, Risk Assessment, and Risk Control Methods

Tranggono*, Kinanti Resmi Hayati, Mochamad Tutuk Safirin, Albertus Adriyanto Satrio Prakosa, Fitriatus Sholeha

Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya 60294, Indonesia

Corresponding author:
E-mail:
tranggono.ti@upnjatim.ac.id

ABSTRACT

A mining company is a company engaged in the gold mining industry that implements an open-pit mining system. In carrying out mining operations, not all activities will always run smoothly. Based on incident trend data in mining companies, there are still a large number of incidents that occur in mining operational activities each year which result in property damage, minor injuries to workers, serious injuries to workers, occupational diseases, loss of working days, and losses to workers. company. The causes of work accidents are divided into several causes, namely, basic causes, indirect causes, and direct causes. The mining operations of mining companies are not free from hazards and work risks that can occur at any time in the mining work environment, especially in the work area in the pit main ridge. The main ridge pit work area is the main location for gold mining operations for mining companies which are now actively operating for many mining activities such as drilling, blasting, surveying, loading, and hauling activities where the condition of this work area has a relatively high level of danger and risk, by because it is necessary to analyze Occupational Health and Safety using the HIRARC method or identify potential hazards in the pit main ridge work area, then carry out an existing risk assessment to determine a control plan that is suitable for the conditions in the pit main ridge work area.

Keywords: HIRARC, a mining company, and occupational health and safety.

Introduction
Occupational health and safety
Occupational health and safety are intended to prevent, reduce, protect and even eliminate the risk of work accidents or usually called zero accidents in the workforce through the prevention of work accidents caused during activities. Occupational health and safety aim to reduce accidents and occupational diseases that can improve work systems and productivity (Aulia & Hermawanto, 2020). Occupational health and safety are a field related to the health, safety, and welfare of people working in an institution or project site. Health Work is a condition that is free from physical, mental, emotional, or pain disorders caused by the work environment. While workplace safety is the supervision of people, machines, materials, and methods that include the work environment so that workers do not get injured (Habibi et al., 2019).

Hazard identification, risk assessment, and risk control
Hazard identification is a process that assesses a job and determines hazard actions which include physical, chemical, mechanical, electrical, ergonomic, environmental, and other hazards. Accidents that occur while working are usually influenced by humans, machines, raw materials, and the environment (Abryandoko, 2018). Risk assessment is a series of risk analysis, assessment, and control processes. Results are presented in a risk matrix that shows organizational

performance (Smarandana et al., 2021). Risks that have the potential to arise in the settlement are always detrimental. Risk control is carried out on all hazards to determine priorities and how to control them (Azady et al., 2018).

Mining production system

A mining company is a company engaged in the gold mining industry that implements an open-pit mining system. In this business process, the raw material for production is one of the B3 wastes and uses hazardous chemicals, including HCL and Nitric Acid. The standard processing process using the hydrometallurgical method will produce waste that can be harmful to environmental health if not handled properly (Budijono et al., 2021). In addition, the mining operations of the mining company are also subject to work hazards and risks that can occur at any time in the mining work environment, especially in the work area at Pit Main Ridge. The Pit Main ridge work area is the main location for gold mining operations for the Mining Company which is now actively operating for many mining activities such as drilling, blasting, surveying, loading, and hauling activities where the condition of this work area has a relatively high level of danger and risk, by because it is necessary to analyze occupational safety and health using the Hirarc method or identify potential hazards in the pit main ridge work area, then carry out an existing risk assessment to determine a control plan that is suitable for the conditions in the pit main ridge work area.

Material and Methods

This research was conducted using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method which is the process of identifying hazards that can occur in routine or non-routine activities in mining companies for further risk assessment of these hazards. The elements in the risk assessment are the level of frequency, severity, and probability. The results of the risk assessment are useful for creating a hazard control program so that the company can minimize the level of risk that may occur to prevent work accidents. A work accident is something unplanned, uncontrolled, and something that was not previously anticipated so that it interferes with the effectiveness of one's work. The risk value that appears is classified according to the existing risk matrix in the company, this aims to determine the priority level in making improvements.

Results and Discussion
Hazard identification, risk assessment, and risk control

Hazard identification is a systematic effort made to find out potential hazards in work activities. Risk analysis is to determine the magnitude of a risk by considering the possibility of its occurrence and the magnitude of the consequences. Risk assessment is carried out using 3 formulas, namely probability, frequency, and severity, the result of multiplying these three formulas will get the total risk value. Risk Control is an activity to control the risks that occur to mitigate the impact of the risks that occur.

Hazard identification

Hazard identification is a systematic effort made to find out potential hazards in work activities. Potential hazards that can be identified are useful for increasing caution in doing a job, being alert, and taking security measures to avoid accidents.

Risk assessment

After all, risks have been identified, a risk assessment is carried out through risk analysis and evaluation. Risk analysis is intended to determine the magnitude of a risk by considering the possibility of its occurrence and the magnitude of its consequences. Based on the results of the

analysis, a risk rating can be determined so that it can be separated from risks that have a large impact on the company and risks that are mild or can be ignored.

Table 1. Hazard identification in the pit main ridge area

No	Hazard Source Identification (HAZARD)	Period		Potential Hazard
1	Repair of the unit near the loading point in the pit main ridge area	All Shift	1.1	Get hit by a hauler unit while repairing the unit
2	Fatigue when operating the unit in the pit main ridge work area	All Shift	2.1	Psychic Pressure
			2.2	Hits Units, embankments, or employees who are on duty in the pit area
3	Insufficient/over-lighting in the pit work area,	All Shift	3.1	Exposure to low/high light intensity
4	The unit does not meet the safety requirements for the vehicle	All Shift	4.1	The operator collided with another unit
			4.2	Hit by an operating unit
5	Operator/driver using a mobile phone when operating the unit in the pit main ridge area	All Shift	5.1	Hitting an embankment or unit operating in the pit area
			5.2	Got hit by another unit that was passing through the pit area
6	Limited visibility (heavy rain, fog) in the pit main ridge work area	All Shift	6.1	Crash into embankments or other units in pit area
7	Noise in heavy equipment unit activity (drill)	All Shift	7.1	Noise energy release in the pit main ridge work area
8	Non-standard embankment in the pit main ridge area	All Shift	8.1	Falling/Slumping
			8.2	Falling from a height to a lower level
9	The communication device in the unit was damaged during operational activities	All Shift	9.1	Crashing hauler, Lv, excavator and etc units in the pit area
			9.2	Hit by a passing unit
			9.3	Interrupted communication operations in the Pit area
10	Blasting failed	All Shift	10.1	Explosion due to blasting activity

Risk assessment

After all, risks have been identified, a risk assessment is carried out through risk analysis and evaluation. Risk analysis is intended to determine the magnitude of a risk by considering the possibility of its occurrence and the magnitude of its consequences. Based on the results of the analysis, a risk rating can be determined so that it can be separated from risks that have a large impact on the company and risks that are mild or can be ignored.

Table 2. Risk code

Multiplication Result	Risk Code	Category
1-8	C	Low
9-18	B	Moderate
20-36	A	High
40-125	AA	Critical

Risk Control

Risk control is an activity to control the risks that occur to mitigate the impact of the risks that occur and overcome the potential hazards contained in the work environment. In risk control, there are corrective actions and preventive actions to eliminate causes of non-conformities or other undesirable situations.

Table 3. Risk score matrix and corrective action

Code		Corrective action
C	Low	1. Report to superior or make an improvement plan
B	Moderate	2. Work continues
A	High	1. Stop work 2. Make temporary repairs 3. Report to superior 4. The supervisor assesses the risk of the work with the improvements that have been made 5. If the risk value becomes B / C the work can be resumed 6. If the risk value is still A, the work must be stopped and repairs are made 7. Work can be continued after the risk value drops to B or C
AA	Critical	1. Stop work 2. Make temporary repairs 3. Report to superior 4. Take corrective action by considering the risk control hierarchy 5. The supervisor assesses the risk of the work with the improvements that have been made 6. If the risk value becomes B / C the work can be resumed 7. If the risk value is still AA/A, the work must be stopped and repairs are made 8. Work can be continued after the risk value drops to B or C

Incident trends

Incidents are work-related events that cause injury, work-related illness, or death (death) to occur. Based on incident trend data at mining companies, the number of incidents that occurred in the period 2014-2021, stated that there were as many as 289 incidents that occurred in the last 8 years. The following diagram details the number of incidents that occurred in 2014-2021.

Trend Insiden 2021

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2020	2	1	4	1	1	1	1	1	1	1	2	-
OJI 2020	-	-	-	-	1	1	-	-	-	-	1	-
2021	0	1	0	3	1	1	0	0	0	2		
OJI 2021	-	-	-	-	-	-	-	-	1	-	-	-

TREND INSIDEN TAHUN 2014-2020

	2014	2015	2016	2017	2018	2019	2020
Series2	95	38	50	47	19	16	16

TOTAL INSIDEN YTD 2021

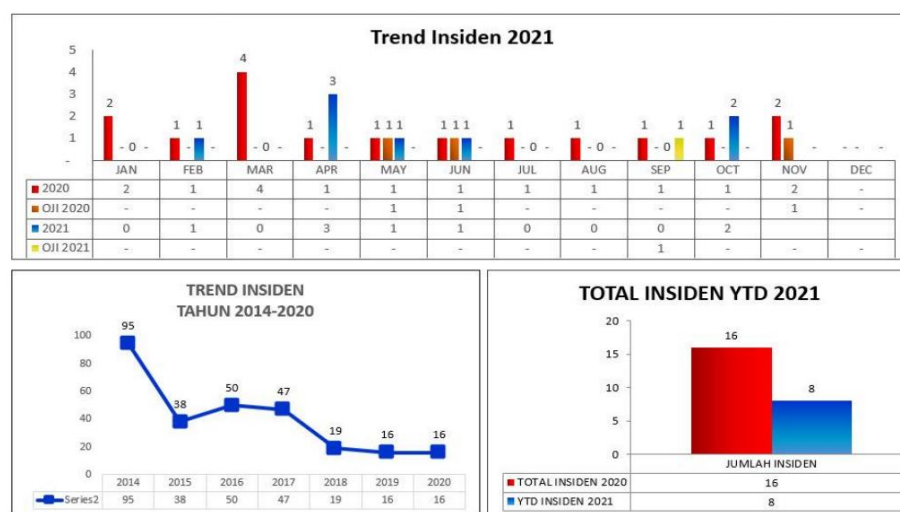|	JUMLAH INSIDEN
TOTAL INSIDEN 2020	16
YTD INSIDEN 2021	8

Figure 1. Trend insiden

From the diagram data above, it can be seen that in 2014 the Mining Company recorded that there were 95 incidents, in 2015 there were 38 incidents, in 2016 there were 50 incidents, in 2017 there were 47 incidents, in 2018 there were as many as 19 incidents, in 2019 there were 16 incidents, in 2020 there were 16 incidents and in January-October 2021 there were 8 incidents. It can be seen that every year incidents that occur in mining companies have decreased in the percentage of incidents that occur in their work environment.

Occupational health and safety analysis using the HIRARC Method

Based on secondary data and direct observations in the field, 10 hazard conditions have high-risk values with high (A) and Critical (AA) categories in the pit main ridge work area, including repairing units near the loading point in the pit main ridge area, fatigue during operate the unit in the pit main ridge work area, lighting is less/more in the pit work area, the unit does not meet the safety requirements for vehicles, the operator/driver uses a mobile phone when operating the unit in the pit main ridge area, limited visibility (heavy rain, fog) in the pit main ridge pit main ridge work area, noise in heavy equipment (drill) unit activities, non-standard embankments in the pit main ridge area, communication equipment in the unit damaged during operational activities, and failed to explode.

Conclusion

Based on the results of the HIRARC analysis, it is known that 10 conditions of hazard sources that have been identified, risk assessment and risk control have been carried out regularly by the Mining Company properly, therefore the risk value of 10 hazard source conditions in the pit location the main ridge which initially had a highly risk value (A) to a critical risk value (AA) after controlling for the control, the risk value decreased to moderate (B) and low (C) risk values.

Acknowledgment

References

Abryandoko, E. W. (2018). Penilaian Risiko Keselamatan dan Kesehatan Kerja dengan menggunakan Metode HIRARC dan Safety. *Jurnal Rekayasa Sipil. 12*(1), 50–57. Doi:10.21776/ub.rekayasasipil/2018.012.01.7

Aulia, L., & Hermawanto, A. R. (2020). Analisis risiko keselamatan kerja pada bagian pelayanan distribusi listrik dengan metode HIRARC. *Jurnal Ilmiah Nasional Bidang Ilmu Teknik, 8*(1), 20–27.

Azady, A. W., Widowati, E., & Rahayu, S. R. (2018). Penggunaan job hazard analysis dalam identifikasi risiko keselamatan kerja pada pengrajin logam. *Higeia Journal of Public Health Research and Development. 2*(4), 510–519. Doi.org/10.15294/higeia.v2i4.23564

Budijono, Z., Ronyastra, M., & Soegiharto, S. (2021). Studi kelayakan pendirian industri ekstraksi emas dari e-waste di Surabaya. *Jurnal Sains dan Teknologi.* 2(1), 30-38. Doi.org/10.24123/saintek.v2i1.4050

Habibi., Widiastuty, L., & Hidayat, G., (2019). Gambaran perilaku petugas pengangkut sampah dalam penerapan kesehatan dan keselamatan kerja di kecamatan Tallo Kota Makassar. *Jurnal Kesehatan Lingkungan. 5*(1), 1-15.

Smarandana, G., Momon, A., & Arifin, J. (2021). Penilaian resiko K3 pada proses pabrikasi menggunakan metode hazard identification, risk assesment and risk control. *Jurnal INTECH Teknik Industri Universitas Serang Raya. 7*(1), 56-62. Doi.org/10.30656/intech.v7i1.2709