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Study Of Occupational Safety And Health On Blasting Process In Andesite Stone Mining Area With Hirac Method In Cv. Artha Agung Bersama, Kecamatan Hulu Gurung, Kabupaten Kapuas Hulu

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Abstract

CV. Artha Agung Bersama is an andesite mining company that uses a blasting system. This mining activity can harm workers if they do not apply good K3 management in blasting activities. One of the hazards of blasting activity is flying rock. For this reason, it is necessary to identify potential hazards, assess the level of accident risk, and recommend risk control efforts. The method in this study is the HIRAC (hazard identification risk assessment and control) method. This activity has five potential hazards: broken drum straps, worker negligence, explosive sounds, fly rock, and workers walking in a hurry in locations with a lot of gravel. There are five risks of accidents from potential hazards: being hit by a drum, scratched hands, pinched fingers forming a critical cover, slipping, exposure to diesel fuel, hearing loss, and being hit by a rock. Of the five hazard risks, three risks are included in the priority one category, namely: scratched hands, pinched fingers forming key covers, slipping, exposure to diesel fuel, and being hit by rocks. One risk is included in priority category three: being hit by a drum. One risk category is very high, namely being hit by a rock. The recommended risk control hierarchy for blasting activities is engineering control, administration, and personal protective equipment.

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1. Introduction

CV. Artha Agung Bersama is an andesite mining company that uses an open pit mining system (CV ARTHA 2021). Mining activities in CV. Artha Agung Bersama starts from land acquisition, clearing topsoil, drilling, and blasting to transporting andesite to the crusher. Blasting activities have the potential to cause work accidents. Explosion in the mining industry is a process that is quite dangerous because it is associated with explosives (Budiarto and Cahyadi, 2011).

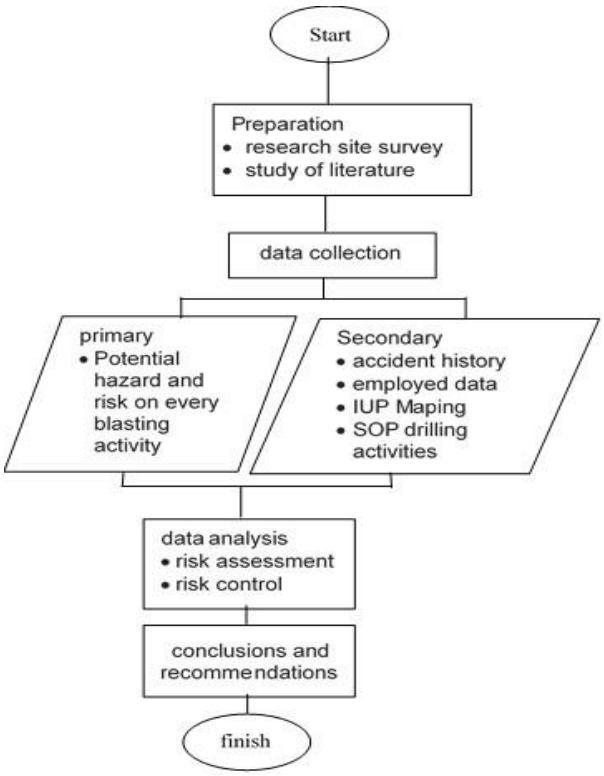
Efforts that can be made to minimize the impact of hazards that will be experienced are to ensure that every blasting activity is carried out with good OHS implementation. A good OSH system is formulated with steps starting from identifying hazards, assessing risks, and recommending efforts to control risks using the HIRAC method. Hazard Identification Risk Assessment and Control (HIRAC) is a process of identifying hazards that can occur in both routine and non-routine activities utilizing an assessment based on the identified hazards or risks. The results of the hazard or risk assessment are used as the formulation of the control process. In OHSAS 18001:2007, clause 4.3.1 requires organizations/companies that will implement SMK3 to prepare HIRAC for companies or their activities (Triswandana and Armaeni, 2020). The preparation of the HIRARC itself is divided into three stages, including the hazard identification stage, the risk assessment stage, and the risk control stage. The risk assessment stages use standard risk control matrices such as the AS/NZS 4360: 2004 Risk assessment matrix used in Australian and New Zealand standards (Triswandana and Armaeni, 2020).

2. Materials and Methods

The method in this study uses the HIRAC (Hazard Identification Risk Assessment and Control) method. The selection of this method is based on the concept of HIRAC which is simple, easy to use, and can facilitate the collection of data or data processing. Data collection methods used in research are observation and interview methods. The collected data will be processed and analyzed in a descriptive qualitative way. the location of

research was carried out at CV Artha Agung Bersama. In detail, the research stages can be seen in picture 1.

Figure 1 research flowchart



2.1. Theoretical Frame Work

A hazard is a situation that is possible or has the potential to occur for accidents, injuries, illnesses, death, damage, or the ability to perform operational functions that have been set (Tarwaka, 2008). Types of danger according to Ramli (2010) there are 5 types, that is mechanical hazards, electrical hazards, chemical hazards, and physical and biological hazards.

Risk is a combination or accumulation of potential hazardous/possible potentially hazardous events and exposures with the severity of the injury or impairment of health caused by the event or exposure (OHSAS18001,2007). The risks and hazards of mining activities can occur if there are no prevention efforts as early as possible. Hazard risk control will be carried out at a high and extreme risk level. Risk control measures used is a control hierarchy which includes: elimination, substitution, engineering, administration, and PPE. an explanation of the five control hierarchies can be seen in table 1. determination of risk control measures based on hazard conditions and level of risk generated (Ardyanti, 2020).

Table 1. Explanation 5 Hierarchy of Control

No	Hierarchy Control	Hierarchy explanation Control
1	Elimination	control techniques used by removing it immediately the dangers exist
2	Substitution	Control techniques performed by replacing something dangerous or safer equipment
3	Engineering control	Control techniques by changing workplace design, equipment, or machinery so the work process becomes a safety
4	Administrative	Focused control techniques in the use of SOP (Standard Operational Procedure) as a step to reduce the level of risk
5	Personal protective equipment (PPE).	The final control step done that works to reduce the severity of the consequences of the hazard generated

The blasting technique is one of several techniques used in conducting mining. The Blasting Technique is a follow-up to the activity Drilling aimed at removing rock from the rock parent to break into smaller fragments making it easier to push, load, transport, and material consumption in the installed crusher. Blasting technique mining is one of the activities that have a high enough risk. the highest risk is in the detonator closest to the center blasting activities. Explosion effects such as Flying Rock (flying stones), Ground Vibration, and Air Blasts too result in a hazard to settlements around the center of activity blasting. Blasting regulation or control system (blasting management system) is very necessary for all things involved in blasting activities (gultom dan hamzar 2015). There are six stages of the blasting process (herwandi et al, 2020):

a) Securing the field/work area and its surroundings during preparation and the blast.
b) Preparation of blasting equipment, including Blasting Machine, Blasting Ohmmeter, Shotgun, Crimper, Short/Long Stick, lead wire, ANFO loader, Lighter
c) Preparation of blasting equipment, including fire wicks/wicks explosives, ordinary/electric detonators and NONEL
d) Preparing the primer (Priming)
e) Explosion hole filling (Loading)
f) Connecting the circuit (Circuit)
g) Selection and preparation of the place/position of the blasting machine holder
h) Post-blasting inspection and securing of the blasting site

2.2. Research Location

the location of the research was carried out at I CV. Artha Agung With Hulu Gurung District, District Kapuas Hulu

2.3. Data requirements

The required data consists of two types: primary and secondary data. The primary data taken is the potential hazard and risks of blasting activities. Secondary data taken is data on workers (identities) who work regularly, history of accidents during blasting activities, and maps of the company's IUP.

Primary data collection is done by way of interviews and field observations. Interviews were conducted with the key person such as: the head of mine engineering, the Project Manager, Blaster, and the head of the Blasting Crew. Secondary data collection is done by requesting data from the company.

2.4. Analysis Method

The collected data will be analyzed to determine hazard and risk identification, risk assessment, and risk control.

A. Identification of hazards and risks

Hazard identification is the first step in a Risk control management system. The identification process includes searching for and recognizing all company activities, tools, products, and services, consisting of people, materials, machines, production results, and finance (Herwandi et al., 2020). Understanding the concept of hazards and risks from an activity is necessary to carry out the initial identification stage. Hazard is a condition that allows or has the potential for an accident to occur in the form of injury, illness, death, damage, or the ability to carry out defined operational functions (Tarwaka, 2008 in Ramadhan, 2017). The types of hazards can be divided into five classes, namely: mechanical hazards, electrical hazards, chemical hazards, physical hazards, and biological hazards (Ramli, 2010).

Risk is the combination of the likelihood that a hazardous event will occur that is related to severe injury or health damage caused by the exposure or event (OHSAS 18001, 2019). Risk can also be said to be the cause of harm (Kelvin et al., 2020).

B. Risk Assessment

Risk assessment can be carried out by assessing the three main components, namely likelihood, exposure, and severity. Determination of the risk categories of likelihood, exposure, and severity can be seen in Table 2-4.

Table 2. Likelihood Level (AS/NZS 4360, 1999 in Herwandi et al., 2020)

Likelihood		
Category	Description	Ratings
Almost certain	The most frequent occurrence	10
Likely	The chances of it happening are 0-50%	6
Unusually	It might happen but it's rare	3
Remotely Possible	Very unlikely event to occur	1
Conceivable	It might happen, but it never happens despite years of exposure	0.5
Practically Impossible	Impossible or highly unlikely to occur	0.1

Table 3. Exposure Levels (AS/NZS 4360, 1999 in Herwandi et al., 2020)

Exposure		
Category	Description	Ratings
continuously	Happens continuously every day	10
frequently	Happens once every day	6
Occasionally	Occurs once a week to once a month	3
infrequent	Occurs once a month to once a year	2
Rare	It has happened but rarely, it is not known when it happened	1
Very Rare	Very rare, unknown when it occurs	0.5

Table 4. Severity Level (AS/NZS 4360, 1999 in Herwandi et al., 2020)

Severity		
Category	Description	Ratings
Catastrophe	Fatal and very severe damage, cessation of activities, and very severe environmental damage	100
Disasters	Events associated with death, as well as minor permanent damage to the environment	50
Very Serious	Permanent disability or disease and temporary damage to the environment	25
Seriously	Serious injury but not a permanent serious illness and little environmental impact	15
Important	Injury requiring medical attention, exhaust emission occurs, off-site but does not cause damage	5
Noticeable	Minor injuries or illnesses, bruises to body parts, minor damage, minor damage and temporary cessation of work processes but do not cause pollution outside the location	1

After obtaining the level of likelihood, exposure, and severity, an assessment of the risk value is carried out by:

Risk Score=severity x likelihood x exposure (1)

The risk value will then categorize the level of risk using a semi-quantitative analysis risk level assessment method. Category Risk level can be seen in Table 5.

Table 5. Assessment of the Risk Level of the Semi-Quantitative Analysis Method (AS/NZS 4360, 1999 in Herwandi et al., 2020)

Risk Assessment		
Risk Level	Category	Action
>350	Very Hight	Activities are stopped until the risk can be reduced to an acceptable or permissible level
180-350	Priority 1	Need control as soon as possible
70-180	substantial	Requires technical improvement
20-70	Priority 3	It needs to be monitored and cared for on an ongoing basis
<20	Acceptable	The intensity that poses a risk is reduced to a minimum

C. Risk Control Efforts

Risk control efforts are actions that can minimize moral and material losses caused by accidents. Determining risk control measures is based on the hazard conditions and the level of risk posed (Ardyanti et al., 2020) and the OHSAS standard 18001:2007.

3. Results and Discussion

Based on the results of observations and interviews conducted, it is known that the stages of blasting activities are divided into 4, namely the preparation stage for blasting equipment and equipment, the stage for transporting explosives, the stage for preparing for blasting, the highest potential hazard of the four blasting activities is the straps with diesel fuel drums coming off or breaking, negligent in work, walking on uneven site in a rush with lots of pebbles in blasting site, an explosion sound effect. In detail, the analysis of identification of the potential and risk of hazards from blasting activities can be seen in Table 6.

Table 6. Identification of Potential Hazards and Risks in Blasting Activities

Stages	Observed activity	Potency	Risk
Preparation of blasting equipment and supplies	Diesel Transport	Oil drum straps Disconnect/disconnect	Worker crushed by oil drum
Transportation of Explosives	Opening of Explosives Warehouse Door	Negligent Worker	Scratched hands, pinched fingers, bumped against explosives

Table 6 (Continued) . Identification of Potential Hazards and Risks in Blasting Activities

Stages	Observed activity	Potency	Risk
			warehouse lock cover
Blasting Preparation	Distribution of solar explosives	Workers walk in a hurry in a location where there are lots of pebbles	Slipped and exposed to diesel
Blasting	The detonation is controlled by blast control and carried out by a blaster	Explosion Sound	Hearing disorders
		Flying rock	Stone Crushed

The potential hazard from the preparation stage for blasting equipment and equipment is that the drum straps come off or break during diesel fuel transport activities. This activity can result in the risk of being crushed by a drum. The possibility of this hazard occurring is very small because the safety of transporting diesel fuel is very good, and workers or operators work carefully. This is to the results of observations and interviews conducted. The probability level is included in the Remotely Possible category. This level of risk exposure is very rare, so it is included in the very rare category. If the risk of this activity occurs, it can result in the death of workers and minor permanent damage to the environment. This is because the drum being transported has a capacity of 200 liters, so if a worker hits it, it can cause a high hazard cause death. This Severity Level is included in the disaster category.

The potential hazard of the stages of transporting explosives is the negligence of workers in the activity of opening the explosives warehouse door. This activity can result in the risk of accidents on the hands; namely, the hands are scratched, and the fingers are pinched. Based on observation and interview data, the possibility of this risk occurring has a probability of 0-50%. Based on the results of observations for four days, this risk occurred two times so that the level of exposure included in this category could happen once a week or even once a month. The risks from scraping hands, pinching fingers, and bumping into shed lock covers can result in serious injury to workers but not permanent serious illness and little impact on the environment. The severity of this risk is included in the category of serious severity.

Slipped and exposed to diesel. This risk is due to the conditions in the field, where many gravel stones are the basis for workers to walk. This risk is the result of direct observation in the field.

The condition of the access road, which is contoured, gravel, and the burden of transporting diesel fuel to the explosive hole mean that the scale of the possibility of this risk occurring has a probability of 0-50%. Based on the results of observations for four days, this risk occurred twice, so the level of exposure included in this category could occur once a week or even once a month. The risk of slipping and exposure to diesel fuel while transporting it to the explosive pit can result in serious injury to workers but not a permanent serious illness. Injuries that can be experienced by workers are bruises, sprains in the legs and arms, and exposure to diesel fuel spills.

The risk of hearing loss is the effect of detonation, which can last for ± 4 seconds with an exposure of 97.18 dB (nata et al., 2021). This risk often occurs because blasting activities are carried out four times a week, and in one day, more than one blasting can be carried out. This risk exposure level is included in the Frequent category, which occurs daily. The impact of these risks can result in permanent disability or illness and temporary damage to the environment. Disabilities or diseases experienced from this risk are likely to be deaf. This can occur if exposure to noise is 97.18 with exposure for more than 8 hours (Asrun A et al., 2013)

Flying rock is a potential hazard that must occur in the blasting process and is very dangerous, this is because the impact of flying rock can cause death and damage to the environment. This risk has a level of possibility that it may occur but rarely occurs. This is because the SOP for the safe distance of workers during detonation has been properly implemented. Based on the results of interviews conducted, the risk of flying stones has occurred once in the past few years, so the level of exposure falls within the criteria of infrequent occurrence. If this risk occurs, it will result in fatal and severe damage impacts, cessation of activities, and severe environmental damage. Assessment of the risk level of the risk of each activity that occurs can be seen in Table 7.

Table 7. Analysis of Risk Value in Blasting Activities

Risk	Assessment Component			Total
	Possibility	exposure	Severity	
Worker crushed by oil drum	1	0.5	50	25
Scratched hands, pinched fingers, bumped against explosives warehouse lock cover	6	3	15	270
Slipped and exposed to diesel	6	3	15	270
Hearing disorders	10	6	25	1500
Stone Crushed	3	1	100	300

Based on the results of the risk assessment carried out during blasting activities, it is known that the highest risk value is found in the risk of hearing loss, with a value of 1500. Meanwhile, the smallest risk value is the risk of workers being crushed by oil drums. The risk level analysis in table 6 can be grouped according to the risk level referring to table 5. The results of grouping risk value categories can be seen in Table 8.

Table 8. Assessment of the Risk Level category in blasting activities

Risk	Total Risk Value	Risk Level
Worker crushed by oil drum	25	Priority 3
Scratched hands, pinched fingers, bumped against explosives warehouse lock cover	270	Priority 1
Slipped and exposed to diesel	270	Priority 1
Hearing disorders	1500	Very hight
Stone Crushed	300	Priority 1

Based on the risk categories carried out in blasting activities, three levels of risk are included in the priority one category, one risk is included in the priority three category, and one risk is in the very high category. The highest risk is hearing loss caused by the sound effects of explosions. The action to overcome this risk is to stop activities until the risk can be reduced to an acceptable or acceptable limit (AS/NZS 4360: 1999). The second highest level of risk is the risk of getting your hands scratched, your fingers pinched, bumped, slipped, exposed to diesel fuel, and crushed by rocks. The action to overcome this risk is to carry out risk control as soon as possible (AS/NZS 4360: 1999). The third highest risk is the risk of being hit by an oil drum. The action to overcome this risk is to carry out routine supervision (AS/NZS 4360: 1999).

The risks caused by blasting activities can be minimized by implementing risk control. Risk control is a way to overcome potential hazards that occur in the work environment. Risk control can be carried out by adopting a control hierarchy approach (Wijaya et al., 2015). The risk control hierarchy is a sequence of risk prevention and control that may arise, which consists of several levels sequentially (Tarwaka, 2008 in Ramadhan, 2017). Based on the OHSAS 18001: 2007 standard, the risk control hierarchy consists of elimination, substitution or replacement, technical control or engineering, administration, and use of personal protective equipment (PPE).

Types of risk control that can be carried out on blasting activities are engineering, administrative, and PPE engineering. An example of an engineering control is designing the blasting geometry according to the surrounding environmental conditions. An excellent geometric design can minimize the

possibility of a fly rock risk. Administrative control that can be carried out to reduce the risk of oil drum straps breaking is to periodically check the condition of the ropes used. Control with PPE can be done by using gloves, helmets, earplugs, and so on. In detail, recommendations for the type of control that can be carried out for the risks and potential hazards that occur in blasting activities can be seen in Table 9.

Table 9. Recommendations for Risk Control Efforts

Potency	Risk	Type of Control	Control Recommendations
Oil drum straps Disconnect/ disconnect	Worker crushed by oil drum	Administration and PPE	Administration: Conduct periodic checks on the ropes that will be used to transport diesel fuel. PPE: use gloves, safety helmets, vests, and safety shoes
Negligent Worker	Scratched hands, pinched fingers, bumped against explosives warehouse lock cover	Administration and PPE	Administration: the opening of the warehouse door should be done by one person to avoid miscommunication PPE: use of helmets, vests, safety shoes, and gloves (welding gloves)
Workers walk in a hurry in a location where there are lots of pebbles	Slipped and exposed to diesel	Administration and PPE	Administration: conducting briefings on how to work and directing when transporting diesel jerry cans it is better to carry it on hand PPE: use gloves made of rubber, helmets, vests, and safety shoes
Explosion Sound	Hearing disorders	APD	The use of earplugs (the use of earplugs is an effective thing that can be done because the condition of the shelter used is an excavator tool with a distance of ± 200 meters from the blasting site)
Flying rock	Stone Crushed	Engineering and Administrative Engineering	Engineering: The blaster designs the blasting geometry according to the conditions in the mining environment, (both for the direction of the explosion and the blasting pattern used) Administration: blast control directs all workers to a safer location with a predetermined safe distance (Gultom, G ., and Hamza. 2015)

4. Conclusion

Blasting activities have five potential hazards: broken drum straps, worker negligence, explosive sounds, fly rock, and workers walking in a hurry in locations with a lot of gravel. There are five risks of accidents from potential hazards: being hit by a drum, scratched hands, pinched fingers forming a key cover, slipping, exposure to diesel fuel, hearing loss, and being hit by a rock. Of the five hazard risks, three risks are included in the priority one category, namely: scratched hands, pinched fingers forming key covers, slipping, exposure to diesel fuel, and being hit by rocks. One risk is included in priority category three: being hit by a drum. One risk category is very high, namely being hit by a rock.

The recommendation for the risk control hierarchy in blasting activities is engineering control, administration, and use of Occupational Safety and Health.

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