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Determining control in production suction vessels (KIP) 16 Bangka Ocean mining units PT Timah (Persero) Tbk

Endrizal
Doctoral Program of Environmental Science, Postgraduate – Universitas Negeri Padang, Indonesia
Corresponding author email: endrizal2011@gmail.com

Eri Barlian
Doctoral Program of Environmental Science, Postgraduate – Universitas Negeri Padang, Indonesia

Indang Dewata
Doctoral Program of Environmental Science, Postgraduate – Universitas Negeri Padang, Indonesia

Riri Rahmahwati Joni
Master Program of Environmental Science, Postgraduate – Universitas Negeri Padang, Indonesia

***Abstract*---**This research discusses the control of occupational safety and health in Production Suction Vessels (KIP) 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk using risk management methods of the Hazard Identification Risk Assessment Determining Control (HIRADC). HIRADC is a working accident identification method with risk assessment as one of the important points for implementing the Occupational Health and Safety Management System (SMK3) based on ISO 45001: 2018. The purpose of this research is to 1) analyze the causes of accidents in 1 (one) month using the formula for frequency rate (FR), safety rate (SR), and incident rate (IR); 2) analyze the accidents data statistics. This type of research is descriptive qualitative with are 2 (two) data collected, namely primary data and secondary data. Primary data was gotten from interviews with employees of KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk and employees of Occupational Safety and Health (K3), whereas secondary data was gotten from K3 documents. Based on the research results it can be concluded the following things: 1) the total of accidents that occurred in 1 million working hours/month was 14 accident cases and the percentage of accidents in 1 (one) month is 3%;

2) identify occupational hazards on the job: excavation of tin ore using a ladder with a value of 9 (unacceptable risk); tin ore washing process using a rotary sieve, primary jig, secondary jig and sluice box with a value of 2 (tolerable); welding work with a value of 6 (cannot be accepted within a certain time limit); work in charge of controlling machinery, such as earth pumping machines, hydraulic machines, and rudder propeller machines with a score of 6 (unacceptable within a certain time limit), as well as work in confined spaces such as pontoons with a value of 2 (tolerable).

***Keywords*---**HIRADC, SMK3, FR, SR, IR.

Introduction

PT Timah is a company that was developed on August 2, 1976, and it is a State-Owned Enterprise (BUMN) that participates in tin mining and has been listed on the Indonesia Stock Exchange since 1995 (Joni *et al.*, 2019). In carrying out mining operations, not all process activities will always function easily. This is because there will be interactions between humans and mining equipment and material with the environment (Levine, 2010; Day *et al*, 2018). This interaction is very risky and can cause work accidents. According to ISO 45001 (Nugraha, 2015; Eyers & Potter, 2017), the occurrence of work accidents is caused by four (4) processes including the interrelated elements of production, it was human, equipment, material, and environment (PEME) that interact to produce a product and service.
According to OHSAS 18001 (Pheng & Pong, 2003; Lo *et al.*, 2014), work accidents can be caused by 3 (three) factors it was human factors, their work, and the environment in the workplace. Human factors can be age, level of education, and work experience. Job factors such as the form of shifts and types of work. Meanwhile, environmental factors such as physical environment (lighting and noise), chemical environment, and biological environmental factors (King, 2005; Bluyssen *et al.*, 2011).

The accident prevention function is to minimize accidents and losses. Accident prevention work is carried out after determining the cause of accidents in the production process so that made steps how to handle workplace accidents correctly. Control of workplace accidents can be done by several approaches including the hazard approach, human approach, technical approach, administrative approach, and management approach.

According to Joni *et al* (2018), based on data from workplace accidents from 2005 to 2017, 132 cases of accidents occur in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk and this is high. The case consists of small accidents such as tripping, cuts, and scratches, typically only causing minor injuries, so workers can keep working. Lost time accident is an accident of work requiring workers to be taken to the hospital and took a temporary break, resulting in loss of working time. some of the causes of accidents lost time accident is twisted, hit, and pinched (to drop). While the accident is a fatality accident that can result in death. Details of the incident that occurred in work accidents in KIP 16 Bangka

Ocean Mining Units PT Timah (Persero) Tbk is 26.5% small accidents; 37.1% lost accident control and 36.4% died. The details of the accident data, it is proof of the lack of control and management of Occupational Safety and Health (K3) at KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk. So, the researchers were interested in analyzing HIRADC in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk. Before we have to know what is a hazard, the hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can result in an injury or illness. To control, it is need safety (de Koster, 2011).

One method to analyze work accidents is HIRADC. Muhanafi (2015); Naveh *et al.*, (2007), explained that HIRADC is a method of identifying occupational accidents with risk assessment as one of the important points for implementing an occupational SMK3. The purpose of the research was to analyze the causes of accidents and calculation the accidents data statistics and also analyze the HIRADC method.

Methods

The type of research used in this research is descriptive qualitative. The descriptive research method is carried out on a set of objects which usually aims to see a Figure of the phenomena that occur in a certain population. In general, this method is used to assess the current condition and implementation of a program, then the results are used to develop a plan for improving the program (Thomlison, 2001; Sukidjo, 2010).

Sources of information in this research were obtained from primary data and secondary data. Primary data were gotten with observation and interviews. Whereas secondary data were gotten from libraries, articles, journals, documentation, company internal data, and other supporting documents. 1) Primary data using interview techniques to selected informants, namely several parties who are responsible for understanding the implementation and problems of K3 in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk. They are the head of the K3 section, the work safety section, the fire, and safety department section, field workers, and other parties related to the implementation of K3 in the company; and 2) Secondary data in this study include work accident data, company profiles, production equipment, and other supporting K3 documents or information. Data analysis is the process of compiling data so that it can be interpreted. Data interpretation or interpretation means giving meaning to analysis, explaining patterns or categories, and looking for relationships between various concepts (Nasution, 1988).

Analysis of the causes and calculation of work accident statistics

Calculation of work accident statistics using FR, SR, and IR in units of time per month. FR is the frequency of lost working time which is used to identify the number of injuries that result in being unable to work each million workers where 2 (two) important data must be present to calculate the frequency rate: 1) the number of hours worked lost due to work accidents, and 2) the number of hours worked. SR is the total number of lost workdays each1000 human hour, which

serves to determine the severity of work accidents. While the IR act to inform the percentage of the number of accidents that occur in the workplace.

- *Frequensy Rate* (FR) $= \frac{(amount\ of\ accident\ in\ time)\times 1000.000}{(amount\ of\ hours\ worked)}$
- *Saferity Rate* (SR) $= \frac{(amount\ of\ working\ days\ lost)\times 1000.000}{(amount\ of\ hours\ worked)}$
- *Incident Rate* (IR) $= \frac{(amount\ of\ accident\ in\ time)\times 100\%}{(amount\ of\ wokers)}$

According to OHSAS 18001 (Pheng & Pong, 2003), that work-related accident are caused by three (3) factors: human, work, and environmental factors at work. 1) human factors are age, education level, and work experience; 2) work, factors are shift work and type of work; dan 3) environmental factors are the physical environment, chemical environment, and biological environment.

Composing HIRADC in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk

The composition of the HIRADC inKIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk, namely: 1) Identifying hazards of equipment and work activities at KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk; 2) Conduct a risk assessment of a hazard posed by equipment and other activities by considering the adequacy of existing controls and deciding whether the risk is acceptable or not; and 3) Determine the selection and use of appropriate treatment to reduce risk.

Results

Causes of accidents and calculation of accident data statistics

Statistical calculation

Researchers analyzed one of the accident data samples contained in the 2012 annual report at the Bangka Marine Mining Unit. The date are the amount of working hours per month is 207,856 hours; the amount of lost working days is 6084 days and the amount of accidents is 3 (three) cases consisting of 1 (one) minor accident, 1 (one) lost time accident and 1 (one) fatality accident. To find the value of FR, SR and IR, the formula used is as follows:

Frequensy Rate (FR) $= \frac{(amount\ of\ accident\ in\ time)\times 1000.000}{(amount\ of\ hours\ worked)}$

Frequency Rate (FR) $= \frac{3\times 1000.000}{207,856}$

Frequency Rate (FR) = 14,43, means, for workers who work for 1 month with a time of 1000,000 hours there have been 14.43 ≈ 14 accidents.

Saferity Rate (SR) $= \frac{(amount\ of\ working\ days\ lost)\times 1000.000}{(amount\ of\ hours\ worked)}$

Saferyty Rate (SR) $= \frac{6084\times 1000.000}{207,856}$

Saferyty Rate (SR) = 29,270 means, During that period, there has been a loss of working time of 29 days each million working hours of human.

Incident Rate (IR) $= \frac{(amount\ of\ accident\ in\ time)\times 100\%}{(amount\ of\ wokers)}$

Incident Rate (IR) $= \frac{3\times 100\%}{100}$

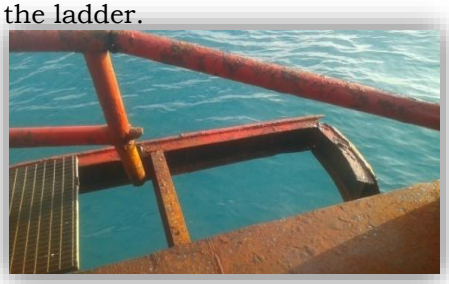
Incident Rate (IR) = 3% means, the percentage of the total of accidents that occur during 1 month is 3%.

Cause of accidents

Based on the results of interviews at KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk, the causes of accidents that often occur in KIP namely: 1) careless/not careful in work; 2) the amount of liquid oil scattered everywhere; 3) do not use PPE when working; 4) there is no protective fence on rotating machines; 5) placement of PPE around rotating machines; 6) perforated floor; 7) scattered equipment; 8) Don't understand how the machine works; 9) not following the SOP; 10) SOP is not adequate; 11) unsafe workplace; 12) Some production machine don't have SOP; 13) work out of line; 14) Lack of coordination; and 15) Non-standard tools. The potential hazards contained in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk can be seen in Table 1 below.

Table 1. Potential hazards

Location	Potential Hazard	APD
The location in Fig 1 is on the 2nd floor of the KIP in front of the command room. In the photo it can be seen that workers are repairing the anchor winch.  Figure 1. Welding	In Fig 1 it can be seen that the workers do not use PPE when doing welding. Potential hazards that can be caused: – Exposed to bursts of sparks from the welding machine. – Stumbled on the safety iron, due to the small scope of the work area. – Bumped. – Electrocution. – Hot. – Burnt skin. – Noisy. – Erusluice box on the eye. – Fatigue due to hot temperatures.	– Safety helmets. – Safety shoes. – Welding goggles. – Welding mask. – Welding gloves. – Welding work apron. – Earplugs. – Lifebuoy, – Work clothes (coverall).

Location	Potential Hazard	APD
The location in Fig 2 is on the left side of the KIP body.  Figure 2. Left side of KIP body	In Fig 2, it can be seen that the side of the ship is not equipped with ropes or chains, while in the regulation of Ministerial Decree No. 555 K Ps 275 it is required. Potential hazards can be caused: – it can't hold on to the ropes of the ship, if somebody or anything fall into the sea (can't swim).	– Lifebuoy. – Rope. – Rubber tire. – Anchor. – Work clothes (coverall).
The location in Fig 3 is next to the ladder.  Figure 3. KIP Front	In Fig 3 it can be seen that the equipment is not neatly arranged (scattered). Potential hazards can be caused: – Stumble. – fell. – bumped. – Slip. – Hit by a falling object. – Pinched.	– Safety shoes. – Safety helmet. – Common work gloves. – Lifebuoy. – Work clothes (coverall).
The location in Fig 4 is in front of the ladder.  Figure 4. KIP front fence	In Fig 4 it can be seen that there is a broken ship guard/barrier. Potential hazards can arise: – Falls into the sea. – Slipped.	– Lifebuoy. – Rope. – Rubber tire. – Anchor. – Work clothes (coverall).

Location	Potential Hazard	APD
The locations in Fig 5[a] and 5[b] are near the HSD (fuel storage area).  Figure 5[a]. Broken KIP Floor  Figure 5[b]. KIP floor that damaged	In Fig 5a and 5b, it can be seen that many of the ship's floors are damaged and have holes. Potential hazards can be caused: – Falls. – bumped. – Pinched. – Being hit by a falling object. – Stumble.	– Safety shoes. – Safety helmet. – Lifebuoy. – Rope. – Work clothes (coverall).
The location of Fig 6 is in the engine room.  Figure 6. Rudder propeller machine	In Fig 6, you can see clothes being dried on the rudder propeller engine safety. Potential hazards can be caused: – Disturbing work so that you don't focus on work. – Exposed to heat. – Twisted.	– Safety shoes. – Safety helmet. – Earplug. – General work gloves. – Do not place clothing on rotating object guards. – Lifebuoy. – Work clothes (coveralls)

Location	Potential Hazard	APD
The location of Fig 7 is near the generator. 	In Fig 7, it can be seen that the oil reservoir is placed near the generator. Potential hazards can be caused: – Burnt. – Explode.	– Flame retardant suit. – Safety shoes. – Safety helmets. – Lifebuoy. – Earplugs. – Work clothes (coverall).

Figure 7. Oil reservoir that placed near the generator

HIRADC in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk

1. According to Muhammad (2015), HIRADC is one method of identifying work accidents with risk assessment as one of the important points for SMK3. To perform the HIRADC analysis, the researcher used a reference source from PT Inspektindo Pratama. Where the steps for the preparation of HIRADC and identify activities that include: 1) Routine and non-routine activities; 2) Activities of all workers including business partners and guests; and 3) Facilities at work, whether provided by the company or other parties.
2. Determine the hazards of the activities carried out by the division/section/department that carries out these activities.
3. Determine the severity score of each potential adverse hazards, as in Table 2 below.

Table 2. Severity level

Score	Definition
0	- No accidents - No pain - No cloudy kerusluice box tools.
1	- Minor accident - Mild pain - Don't lose work time - Kerusluice tool box in light scale
2	- Loss of work time due to accidents - Pain without permanent disability - Kerusluice toolbox in medium scale
3	- Loss of work time due to accidents - Pain without permanent disability - Kerusluice toolbox in medium scale

4. Determine the probability score of the event, as shown in Table 3 below.

Table 3. Probability level

Skor	Definition
0	very small chance
1	small possibility
2	medium probability
3	very likely

5. Calculate the risk level with the following formula:

risk level= severity x possibility

6. Analyze and decide control measures against these hazards according to Table 4 below.

Table 4. Risk Level

Level Resiko	Required Control Measure
0	Risk can be ignored
1-3	Minimum risk can be tolerated by the company
4-5	Risks require further control and remedial activities can be continued but require periodic risk monitoring
6-7	The risk cannot be accepted within a certain time frame but activities are still allowed under special control
8-9	The risk cannot be accepted by the company and the activity must be stopped
10	Life-threatening risks

After doing the HIRADC preparation, the results of the HIRADC analysis in KIP 16 will be obtained as shown in Table 5 below.

Table 5. HIRADC in KIP 16

Type of work	Hazards	*S*	*P*	Risk Levels
digging tin ore using ladder	- Intermittent wire split - Ladder caught in a working hole - Ladder demage	3	3	9
the process of washing tin ore using a rotary filter, primary jig, secondary jig and sluice box	The swivel filter is located on the 3rd floor and the potential hazards found in the swivel filter environment: - fall -Stumble - knock - Fall from a height The primary jig is located on	1	2	2

	the 2nd floor and the potential hazards found in the primary jig environment: - fall - knock -Stumble The secondary jig is located on the 1st floor, so the surface of the first floor is often inundated by seawater and potential hazards in the secondary jig environment: - fall - slipping - slip -Stumble - knock - Fall into the sea -Pinched - hit The sluice box is located on the 1st floor close to the secondary jig, the potential danger in the sluice box environment: - fall - slipping - slip -Stumble - knock - Fall into the sea			
Welding work	- Affected by bursts of sparks from the welding machin -Bending -Rum -Hot -Burnt skin -Noisy -Damage to the eyes -Fatigue due to hot temperatures	2	3	6
work on monitoring and controlling machinery, such as ground pump machines, hydraulic machines and rudder propeller machines	Potential hazards found in the ground pump engine environment: - Fast heat - Noisy -Pinched - knock - Hot exposure	2	3	6

	Potential hazards found in a hydraulic engine environment: - spinning - twisted - cut off -Pinched - knock - Noisy Potential hazards found in a rudder propeller engine environment: -Pinched - cut off - High heat pressure - twisted - knock - Noisy - Hot exposure			
Work in limited space	Potential hazards found in a confined space environment: - Lack of oxygen and excess oxygen - Stuck on the way out - Flammable and explosive material - Toxic materials (gas, fume, steam) - Solid or liquid substances stored in it - Mechanical energy, electricity and heat	1	2	2

Based on the results of HIRADC identification in Table 1, the following results are obtained:

1. The risk level of tin ore excavation work with a ladder gets a value of 9 (nine), which means the risk cannot be accepted by the company and the activity must be stopped.
2. The risk level of the tin ore washing process with a rotary sieve, primary jig, secondary jig, and sluice box gets a value of 2 (two) which means the risk is minimally tolerated by the company.
3. The risk level of welding work gets a value of 6 (six), which means the risk cannot be accepted within a certain time frame but the activity is still allowed under special control.
4. The risk level of the work of monitoring and controlling machineries, such as earth pumping machines, hydraulic machines, and rudder propeller machines gets a value of 6 (six), which means the risk cannot be accepted within a certain time frame but activities are still allowed under special

controls.

5. The level of work risk in a confined space (pontoon) gets a value of 2 (two), which means the risk is minimally tolerated by the company.

Conclusions

HIRADC is a risk management method that identifies all activities before a hazard occurs by assessing the level of risk. The types of work identified in KIP 16 Bangka Ocean Mining Units PT Timah (Persero) Tbk are excavation work, the washing process, welding work, work in charge of controlling machinery and work in confined spaces. Each type of work has a different level of risk. However, the type of work that has the highest level of risk will be handled first rather than work with a low level of risk. This is because the highest level of risk has a very large impact, so proper control is needed to minimize workplace accidents. So the first step before doing the HIRADC analysis is to calculate the number of accidents, the loss of working hours when the accident, and the severity of the accident using the FR, SR, and IR formulas.

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