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Hazard and Risk Analysis of Oil Drilling Heavy Equipment Logistics Activities Using Job Safety Analysis (Case Study: PT Corro Shield Indonesia)

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Abstract

In response to increased drilling demands, heavy equipment rental services have emerged as a new business activity that involves crucial logistics processes, that have potential hazards and risks. This case study uses the Job Safety Analysis (JSA) method, following AS/NZS 4360:2004, to pinpoint and reduce the risks in these operations. Through observations and interviews with three experts, 25 hazards are successfully identified. There are 13 hazards during loading and transport, while the other 12 are during unloading activities. The risk assessment result highlights 2 extreme-risk hazards and 9 high-risk hazards. Emphasizing strict safety protocols and supervision is crucial for protecting workers and maintaining efficiency. Implementing these measures demonstrates PT Corro Shield Indonesia's commitment to worker safety, environmental responsibility, and reliability, as well as building client trust.

Keywords
risk assessment, risk identification, Job Safety Analysis, logistics activities, oil drilling industry

1. Introduction

PT Corro Shield Indonesia specializes in wastewater processing solutions, drilling waste management, clean water processing in the petroleum and gas industry, and offers additional services such as Toxic Gas Management and cooling drilling mud (Mud Cooler System). Nowadays, the drilling industry is experiencing significant growth in business due to the high demand for oil and gas products. Drilling companies prefer to rent drilling equipment rather than purchase it since the investment and maintenance costs are relatively high when associated with ownership. To meet this demand, PT Corro Shield Indonesia provides heavy equipment rental services for drilling and handling all related logistics processes, including loading, unloading, and transportation of the equipment.

Logistics activities for heavy equipment, such as those conducted by PT Corro Shield Indonesia, involve complex processes that require careful planning. These activities include loading equipment at the storage location, transporting it to the drilling site, and unloading it at the destination. According to the literature, logistics for heavy equipment carries high risks, particularly related to safety and potential equipment damage during transportation. Therefore, an efficient logistics management system and adherence to strict safety standards are essential to mitigate these risks in whole logistics processes. This process needs specialized equipment and certified workers to ensure each stage is done safely and efficiently.

In heavy equipment logistics activities, there are common risks that can happen which are the potential accidents during loading and unloading, equipment damage during transportation, and the risk of worker injuries. Literature indicates that accidents with heavy equipment logistics are common and can cause significant financial losses and negatively impact workplace safety. Several accidents have involved falling heavy equipment, improper positioning of containers during delivery, and errors in the loading process, resulting in serious worker injuries.

1.1 Objectives

It is crucial for companies to implement strict safety protocols and use advanced technology to minimize these risks. By establishing stringent standard operating procedures, providing safety training for all workers, and continuously monitoring the logistics process, companies can reduce the possibility of accidents and ensure that heavy equipment arrives at the drilling site in optimal condition and on time. These efforts not only enhance operational efficiency but also protect valuable assets and ensure workers' safety.

In oil and gas drilling, many risks can arise if hazards and risks at the work site are not properly managed. Common accidents occur when containers are not correctly positioned on the truck's bedliner seat, leading to seat breakage and damage to the container parts being lowered to the work location. Ensuring proper installation when raising the container onto the bedliner reduces the risk of containers falling and injuring workers.

This hazard and risk analysis aims to identify, assess, and manage various risks to ensure operational safety, equipment security, and worker safety throughout all stages of storage and transportation activities. By understanding and mitigating these risks, PT Corro Shield Indonesia maintains safe and efficient operations while strengthening its commitment to occupational health, safety, and environmental responsibility. This commitment builds client trust, guarantees safety during the rental process, enhances customer satisfaction, and increases the company's reliability by minimizing risk. A thorough analysis also allows the company to continuously improve safety procedures and management systems, thereby reducing the likelihood of future incidents. This research utilizes the Job Safety Analysis (JSA) method and risk assessment. The JSA method identifies potential dangers in loading/unloading and shipping activities, is widely used by companies, easy to implement, and provides detailed explanations of activities, potential hazards, and control measures.

2. Literature Review

2.1 Work Health and Safety

Workers are frequently at risk in the workplace, particularly those in the construction industry 712 accidents and 798 fatalities were reported as of the end of November 2018. It is clear from this data that there is a significant fatality rate. Issues with occupational health and safety in the construction sector are international in nature and do not limit themselves to a single nation. In the United States, fatal construction injuries made for around 18% of all work-related fatalities in 2014. With 991 fatalities, or the third-highest rate of occupational fatalities at 10.1%, private construction accounted for the greatest number of fatal injuries in 2016 (Zhang, et. al., 2020).

2.2 Hazard and Risk Identification

Hazard identification, risk assessment and control are considered successive holistic processes placed at the core of risk management in today's business world and require good planning, management, and feedback systems. It is a systematic OSH procedure used to identify and evaluate existing and potential hazards in the workplace and control and minimize their impact to acceptable levels. Companies that properly fulfill this process can recognize risks related to jobs, workplaces, and employees and achieve positive outcomes. In this way, they can be aware of risky procedures that do not comply with standards, causing death, injury and material loss and take necessary corrective-preventive actions. This systematic process should be repeated at certain intervals and updated following a philosophy of continuous improvement. It's called controlling risk and making revisions if necessary (Celik, 2021).

2.3 Job Safety Analysis Method

JSA (Job Safety Analysis) is a method used to identify jobs that have potential hazards. This method aims to make corrections before an accident occurs. JSA, or often referred to as Job Safety Analysis, is a risk assessment and hazard identification system which in its implementation emphasizes the dangers that arise at each stage of the work/task carried out. Work energy analysis or work safety is the method/method used to check and find previous hazards. Ignoring in designing the workplace, facilities/tools, machines used and advantages. Job Safety Analysis describes

potential hazards that can occur during processes in the work area and how to control them. There are four steps to implementing Job Safety Analysis (Celik, 2021):

1. Select the work to be analyzed. JSA can analyze all work in the workplace, but must be prioritized based on the following criteria:
    a. Jobs that have a high accident rate
    b. Jobs that have a high accident rate based on the number of workdays lost or medical needs.
    c. Work that can cause serious injury.
    d. Work that causes accidents or serious injuries, due to simple human error
    e. New work, non-routine work, or changes in work procedures.
2. Dividing work into work stages
3. Identify potential dangers and accidents.
4. Explain safe work procedures.

2.4 Hazard Prevention and Control

After identifying hazards that might occur in a work environment, the next step is to design measures used in preventing the hazards. The measurement tool widely used by companies is the "Hierarchy of Controls". This method can be used to identify and prioritize safeguards to protect workers from hazards (OSHA (Occupational Safety and Health Administration), 2023). The priorities are ranked by five categories of least effective to most effective controls, namely: (1) Personal protective equipment (PPE), which is the use of complete safety attire while in the work environment; (2) Administrative controls, which are policies that regulate how workers work; (3) Engineering controls, which are efforts to prevent workers from experiencing hazards by creating barriers between workers and hazards; (4) Substitution, which is changing or replacing dangerous processes or materials to reduce exposure to hazards; and (5) Elimination, which is the most effective hazard control that is done to completely eliminate hazards (Heavy Equipments Colleges of America, 2018).

2.5 Risk Assessment Method

Risk assessment assesses the risk of potential hazards in the work environment. With this effort, the organization can determine the priority of risk handling so that it can ensure that the resources used are indeed to handle the most critical risks (Graves, 2000). The assessment components in risk assessment are Probability (PR) and Severity (SV). Probability is the likeliness of accidents that can occur in the work environment. While Severity shows the severity of the consequences of potential hazards that exist in the work environment (Rahmadani, Ramadhanti, & Dewanti, 2023). Based on the Australian/New Zealand Risk Management Standard (AS/NZ S 4360:2004), the probability scale in risk assessment starts from value 1 (Rare) to value 5 (Almost Certain). Meanwhile, the severity scale starts from value 1 (Negligible) to value 5 (Catastrophic).

2.6 Critical Review

In the work health and safety scope, JSA and risk assessment methods have been commonly used in research papers to identify hazards and risks that could possibly happen in the work environment. These two methods help to identify the source of hazards and create a strong foundation for developing effective preventive measures in the work environment. Researchers (Aleahmad & Biglar, 2021) used the JSA method to identify hazards in caster-line operational activities in one of the metal industries in Iran. The researcher also conducted an assessment based on risk scoring to measure severity. They identified 20 hazards in the operational process of which 50% were at an unacceptable risk level. The main causes of these hazards include exposure to graphite fumes and metal leakage. They concluded that action should be taken by the authorities and health and safety experts to reduce the unacceptable risk level to an acceptable risk level.

Research conducted by (Sugarindra et al. 2017) focuses on identifying hazards and assessing health and safety risks using the JSA approach in a plantation company that produces Low-Grade SIR 20 rubber and has frequent cases of work accidents. The results showed that workers who operate shredder machines have a high-risk value with an extreme risk level so preventive measures need to be taken that can minimize accidents, such as providing proper PPE, counseling on occupational health and safety, monitoring worker activities by the company, and giving awards to workers who comply with company regulations.

JSA and risk assessment methods were used by (Adekitan, 2018) to identify potential hazards and manage risks in the repair and recertification process of aircraft fuel tanks at an offshore facility. This research highlights the risks

associated with repainting and repair operations on aircraft fuel tanks where leaks in the finish can result in contamination of fuel by tank metal. The commonly used cleaning method, grit blasting, can cause sparks that could potentially ignite aircraft fuel vapors. In this study, researchers conducted a thorough risk analysis and implemented appropriate controls to prevent fires and explosions during the aircraft fuel tank recertification process. Thus, this approach improved operational safety and reduced potential risks to personnel and facilities.

In the oil drilling industry, the JSA method is widely used to identify hazards and risks in drilling activities, such as research conducted by (P Sulistyo, Hartadi, & Hendrawati, 2022). The research focused on analyzing activities in the oil drilling field area, especially in the stages of work in the Rig Well Service (RWS) work area environment and the Drill Pipe (DP) lowering stage during the Drill Out Cement (DOC) process into the well. This research uses a descriptive qualitative approach involving assessments from experts in the field. The results showed that there were 13 potential hazards and a total risk of 15. In addition, 7 additional hazards were also found in the field, with a total risk of 11. Thus, the total potential hazards identified were 20, and the potential risk reached 26. Control of these hazards and risks is carried out by implementing administrative control and using personal protective equipment in accordance with Standard Operating Procedures (SOP).

Researchers (Amir-Heidari et al. 2015) used the risk assessment method to assess risks in oil and gas well drilling activities at one of the onshore drilling sites in Iran, focusing on human factors. The researchers identified, analyzed, and evaluated 17 major hazards arising from human factors. Their findings showed that the residual risks of all identified hazards were within the acceptable zone or transition zone, and these risk levels were expected to be further reduced by implementing appropriate controls.

From several studies that have been conducted previously, those methods can be used in analyzing hazards and risks that occur in business activities in various industrial fields, especially in the field of oil drilling. However, there is no research that focuses on the logistics activities of heavy oil drilling equipment, especially the loading, transporting, and unloading of heavy equipment in storage. This research intends to fill the gap by analyzing the hazards and risks of heavy equipment logistics activities to find the most appropriate solution in minimizing potential hazards and risks in the work area.

3. Methods

The research flowchart in Figure 1 illustrates the stages involved in conducting this study.

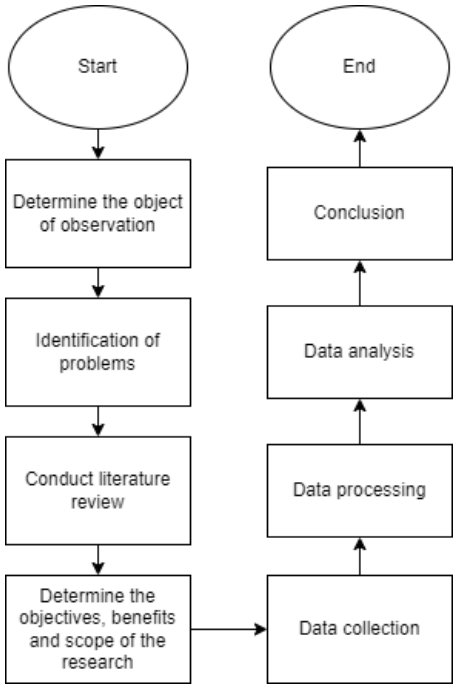

Figure 1. Research Flowchart

The first step in this research is to determine the observation objective and identify the problem. Following this, a literature review is conducted to deepen the understanding of risk and hazard identification topics and to support data processing. This literature review also includes a deep review of previous studies on the use of Job Safety Analysis (JSA) in various industries to identify research gaps. After the literature review, the research defines its objectives, benefits, and scope. The next stage involves data collection through interviews with three experts from the company to support data processing. These interviews are conducted to understand in detail the sequence of activities involved in the loading, transporting, and unloading processes of the equipment. Information regarding the names and roles of these three experts is as follows in Table 1.

Table 1. Experts Information

Name	Role	Years of Experience
Mr. Novian Luhur Budi	HSE Manager	8 years
Mr. Febryan Romadhony	QHSE Engineer	5 years
Mr. Pius	Mechanical Engineer	less than 5 years

After the sequence of activities data is obtained, the data is processed using the Job Safety Analysis (JSA) method to identify potential risks and develop preventive actions to mitigate these risks. The data, organized into JSA sheets, is then discussed in a second interview with the experts to assess the probability and severity scales of the risks before any preventive actions are implemented. The experts also assist in evaluating the risks, hazards, and severity for each activity. Finally, the data is analyzed to draw research conclusions.

4. Data Collection

Risk assessment is done by multiplying the possibility of risk to happen (probability) and the severe damage of the risk (severity). The scale used to assess the probability and severity is based on the Australian / New Zealand Risk Management Standard (AS / NZS 4360: 2004). The details of the probability scale can be seen in Table 2, and Table 3 shows the severity scale.

Table 2. AS/NZS 4360 Probability Scale

Scale	Probability Category	Description
1	Rare	Unlikely to occur 0 times in 1 year
2	Unlikely	Likely to occur 1 time in 1 year
3	Possible	Likely to occur 1 time in 6 months
4	Likely	Likely to occur 2 times in 1 month
5	Almost Certain	Likely to occur 1 time in 1 week

Table 3. AS/NZS 4360 Severity Scale

Scale	Severity Category	Description
1	Insignificant	No/infrequent injuries, small financial loss
2	Minor	Minor injuries, moderate financial loss
3	Moderate	Moderate injuries, requiring medical attention, large financial loss
4	Major	Severe injuries, affecting more than one-person, major loss, production disruption
5	Catastrophic	Fatal, affecting more than one person, very large loss and long-term

After knowing the probability and severity scale for each identified risk, the next step is to calculate the Risk Rating to determine the level of risk so that it can be minimized. The Risk Rating formula is as follows, where PR indicates probability and SV indicates severity.

$$Risk\ Rating\ = PR \times SV \quad (1)$$

Besides knowing the risk level, with the probability and severity values, it can also be known whether the risk is included in the low, medium, high, or extreme risk category. The determination of the category is based on the Risk Assessment Matrix Level by AS/NZS 4360 below in Table 4.

Table 4. AS/NZS 4360 Risk Matrix Scale

Probability	**Severity**				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost Certain (5)	High	High	Extreme	Extreme	Extreme
Likely (4)	Medium	High	Extreme	Extreme	Extreme
Possible (3)	Low	Medium	High	Extreme	Extreme
Unlikely (2)	Low	Low	Medium	High	Extreme
Rare (1)	Low	Low	Medium	Medium	High

Description:

1. Extreme: extreme risk, immediate action required. Marked in red
2. High: high risk, senior management attention required. Marked in orange.
3. Medium: medium risk, management responsibility must be determined. Marked in yellow.
4. Low: low risk, can be managed with routine procedures. Marked in green.

5. Results and Discussion

5.1 Numerical Results

The business process of PT Corro Shield Indonesia begins when they accept a contract for equipment rental. Initially, heavy materials are loaded from the yard warehouse into containers and transported to the client-designated refinery site. At the refinery site, the heavy equipment is unloaded and utilized by the client. Upon the rental's expiration, the equipment is transported back to PT Corro Shield Indonesia's warehouse location. This process involves transportation, unloading equipment, and subsequent storage (Table 5 and Table 6).

Table 5. Loading to Transport Activity Job Safety Analysis from Interviews with 3 Experts

Activity		**Loading Equipment to Truck and Transport**						
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Assessment**			**Risk Category**
					PR	**SV**	**RR**	
1	Attach sling ropes to equipment	Fragile sling ropes	The sling rope breaks and injures worker	Workers injured	3	3	9	High
		The rope is not fitted correctly	The sling rope came loose and injured a worker	Workers injured	3	3	9	High
2	Moving equipment into	Line of Fire	Worker's hand is pinched	Worker's hand injured and require MTC	3	3	9	High

Activity		**Loading Equipment to Truck and Transport**						
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Assessment**			**Risk Category**
					PR	**SV**	**RR**	
	containers using a forklift	Equipment falls while being moved	Equipment falls on workers and nearby objects	- Workers injured - Equipment damaged - The surrounding objects were damaged due to being hit by the equipment.	3	3	9	High
		Forklifts are not load compliant	Forklifts are unbalanced or roll over	- Workers injured - Equipment damage - Property damage	2	2	4	Low
3	Closing and locking the container door	Line of Fire	Risk of being pinched, punctured	Worker injury, worker requires MTC (Medical Treatment Case)	2	2	4	Low
4	Moving a container to a truck using a crane	Container falls while being moved, unit position is incorrect, sling rope breaks	Container falls and hits workers and surrounding objects	Workers injured or killed, equipment damaged, and surrounding objects damaged due to being hit by the container	3	4	12	Extreme
		- Line of Fire - Drop object	Container hits worker, worker gets pinched	Workers injured	3	3	9	High
		- Crane not suitable for the load - Muddy area	Crane unbalanced or slips	- Workers injured - Equipment damaged, and surrounding objects damaged due to being hit by the container	2	3	6	Low
5	Delivery using Truck	Truck and container overturned	Transportation and material damage	Workers injured or killed and incurred losses	2	3	6	Low
		Heavy loaded truck, crushed cable, and cable snagged	Electrical cable disconnected	Sosial Impact	3	3	9	High

Activity		Loading Equipment to Truck and Transport						
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Assessment**			**Risk Category**
					PR	**SV**	**RR**	
		Blocked by the community or PK	Trucking blocked by local communities and demonstrations	Delayed delivery or occurring lateness	3	2	6	Medium
		Journey Management Plan (JMP) is not available	Journeys are not in the right direction and irregular	Journey routes and driver conditions are undetected	4	1	4	Medium

Table 6. Unloading Activity Job Safety Analysis from Interviews with 3 Experts

Activity		Unloading Equipment						
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Assessment**			**Risk Category**
					PR	**SV**	**RR**	
1	Container checking on top of the truck	Slip, trip, fall	Worker injured	Worker requires MTC	3	3	9	High
2	Installing container sling ropes	Fragile sling ropes	The sling rope breaks and injures worker	Workers injured	2	3	6	Medium
		Sling not properly installed	Sling ropes come loose and injure workers	Worker injured	2	3	6	Medium
3	Lifting containers with a crane	Improper container positioning	Container detached from crane sling and falls	- Worker fatally injured - Cargo damage - Property damage	3	4	12	Extreme
		Crane not suitable for load	Crane breaks, bends, collapses, or overturns	- Worker injured - Equipment and property damage - Operation stoppage	3	3	9	High
4	Lowering the container to the designated location	Miscommunication between operator and signalman / rigger	Container strikes object or infrastructure due to unclear directions	Equipment and infrastructure damage	3	2	6	Medium

Activity		Unloading Equipment						
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Assessment**			**Risk Category**
					PR	**SV**	**RR**	
		Surface conditions of the lowering area unstable	Container unstable after being lowered (tilting, shifting, or overturning)	Damage to the container and equipment inside	3	3	9	High
5	Opening container doors	Line of Fire	Risk of being pinched and punctured	Worker injury, worker requires MTC	2	2	4	Low
6	Removing equipment from the container using a forklift	Line of Fire	Worker pierced and trapped	Worker injured	2	3	6	Medium
		Equipment falls while being moved	Equipment falls and hits workers and surrounding objects	Workers injured, equipment damaged, and surrounding objects damaged due to being hit by the equipment	2	3	6	Medium
		Forklift not suitable for load	Forklift unbalanced or overturns	Workers injured, equipment damaged, and surrounding objects damaged due to being hit by the equipment	2	3	6	Medium
7	Placing equipment at the designated location	Equipment unstable when placed on uneven ground	Workers experience equipment falling and property damage	Workers suffer serious injuries	2	3	6	Medium

5.2 Proposed Improvements

After conducting risk identification and assessment, and determining the risk categories, this research also recommends preventive actions for mitigating those risks in logistics activities. These recommendations were reviewed by company experts to ensure their suitability for implementation in the company's operations. The preventive actions follow the hierarchy of controls, starting from the least effective (wearing PPE) to the most effective (correct use of the forklift). Tables 7 and 8 show the detailed preventive actions for each risk in each activity (Table 7).

Table 7. Preventive Action Recommendation for Loading and Transport Activity

Activity		**Loading Equipment to Truck and Transport**				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
1	Attach sling ropes to equipment	Fragile sling ropes	The sling rope breaks and injures worker	Workers injured	High	Conduct periodic checks and replace sling ropes if they no longer meet safety standards
		The rope is not fitted correctly	The sling rope came loose and injured a worker	Workers injured	High	- Implement strict SOPs in the installation of rope slings - Workers must be certified to perform this work
2	Moving equipment into containers using a forklift	Line of Fire	Worker's hand is pinched	Worker's hand injured and require MTC	High	- Workers who run forklifts must have certification - Install safety sign for line of fire - Install safety line/police line - Ensure that workers are in good health
		Equipment falls while being moved	Equipment falls on workers and nearby objects	- Workers injured - Equipment damaged - Surrounding objects damaged due to being hit by the equipment.	High	Workers are prohibited from approaching areas close to the activity and workers running forklifts must be certified
		Forklifts are not load compliant	Forklifts are unbalanced or roll over	- Workers injured - Equipment damaged - Surrounding objects damaged due to being hit by the equipment.	Low	- Use a forklift with a lifting capacity that matches the weight of the equipment. - Ensure the driver has a license/SIO - Ensure all forklift documents are complete
3	Closing and locking the container door	Line of Fire	Risk of being pinched, punctured	Worker injury, worker requires MTC (Medical Treatment Case)	Low	- Position the body in a safe place - Avoid pinch points - Observe safety signs

Activity		**Loading Equipment to Truck and Transport**				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
4	Moving a container to a truck using a crane	Container falls while being moved, unit position is incorrect, sling rope breaks	Container falls and hits workers and surrounding objects	Workers injured or killed, equipment damaged, and surrounding objects damaged due to being hit by the container	Extreme	Workers are prohibited from approaching areas near the activity, and workers operating the crane must be certified
		- Line of Fire - Drop object	Container hits worker, worker gets pinched	Workers injured	High	- Sling ropes must be tied securely, sling rope angles must be correct, and rigger must be competent - Inspection of sling and crane must be documented - Workers must be in good health - Position the body parts in a safe place
		- Crane not suitable for the load - Muddy area	Crane unbalanced or slips	- Workers injured - Equipment damaged, and surrounding objects damaged due to being hit by the container	Low	- Ensure using a crane with lifting capacity matching the weight of the equipment - Ensure if the area is muddy, install durabase or secondary container
5	Delivery using Truck	Truck and container overturned	Transportation and material damage	Workers injured or killed and incurred losses	Low	- The driver complies with the JMP (Journey Management Plan), - Driver in good health and avoids the use of illicit drugs
		Heavy loaded truck, crushed cable, and cable snagged	Electrical cable disconnected	Sosial Impact	High	- Conducting route assessment - Adding to the JMP - Socializing to drivers
		Blocked by the community or PK	Trucking blocked by local communities and demonstrations	Delayed delivery or occurring lateness	Medium	Permit to stakeholders in the area being passed through

Activity		**Loading Equipment to Truck and Transport**				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
		Journey Management Plan (JMP) is not available	Journeys are not in the right direction and irregular	Journey routes and driver conditions are undetected	Medium	- Ensure the JMP is created and approved by the user and HSE department - Conduct road assessment before departure

Table 8. Unloading Activity Job Safety Analysis from Interviews with 3 Experts

Activity		**Unloading Equipment**				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
1	Container checking on top of the truck	Slip, trip, fall	Worker injured	Worker requires MTC	High	Using safety shoes that comply with safety standards
2	Installing container sling ropes	Fragile sling ropes	The sling rope breaks and injures worker	Workers injured	Medium	Conduct regular checks and replace sling ropes when no longer meeting safety standards
		Sling not properly installed	Sling ropes come loose and injure workers	Worker injured	Medium	Implement strict SOPs for sling rope installation and workers must be certified to perform this task
3	Lifting containers with a crane	Improper container positioning	Container detached from crane sling and falls	- Worker fatally injured - Cargo damage - Property damage	Extreme	Ensure the container is properly positioned and securely secured before lifting it.
		Crane not suitable for load	Crane breaks, bends, collapses, or overturns	- Worker injured - Equipment and property damage - Operation stoppage	High	- Conduct routine inspection and maintenance on the crane - Use a crane suitable for the load lifted
4	Lowering the container to the designated location	Miscommunication between operator and signalman / rigger	Container strikes object or infrastructure due to unclear directions	Equipment and infrastructure damage	Medium	- Conduct briefing sessions before operation - Ensure responsible operators and

Activity		**Unloading Equipment**				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
						signalmen are certified - Use clear and reliable communication systems, such as two-way radios with clear and uninterrupted frequencies, and standardized hand signals - Install safety lines - Keep away from lifting areas
		Surface conditions of the lowering area unstable	Container unstable after being lowered (tilting, shifting, or overturning)	Damage to the container and equipment inside	High	Ensure the lowering area is flat, strong, and free from obstacles before lowering the container.
5	Opening container doors	Line of Fire	Risk of being pinched and punctured	Worker injury, worker requires MTC	Low	- Position yourself and your body in a safe place - Avoid pinch points - Observe safety signs
6	Removing equipment from the container using a forklift	Line of Fire	Worker pierced and trapped	Worker injured	Medium	- Positioning oneself and the body in a safe place - Avoiding pinch points - Looking at safety signs
		Equipment falls while being moved	Equipment falls and hits workers and surrounding objects	Workers injured, equipment damaged, and surrounding objects damaged due to being hit by the equipment	Medium	- Securely tie and secure the equipment before moving it - Forklift operators must be trained and have active certification or SIO - Operators must be in good health and free from narcotics and psychotropic substances - Install boundary lines or safety lines

Activity		Unloading Equipment				
No	**Sequence of Basic Activity Steps**	**Hazard**	**Risk**	**Consequence/ Severity**	**Risk Category**	**Proposed Preventive Action**
		Forklift not suitable for load	Forklift unbalanced or overturns	Workers injured, equipment damaged, and surrounding objects damaged	Medium	Using a forklift with a lifting capacity matching the weight of the equipment
7	Placing equipment at the designated location	Equipment unstable when placed on uneven ground	Workers experience equipment falling and property damage	Workers suffer serious injuries	Medium	- Place equipment in a flat and sturdy area - Use supports to prevent equipment from slipping

5.4 Validation

Based on Table 5 and Table 6 above, it can be identified that in the loading and transport activity, 13 hazards and risks were identified. Among these, one risk is categorized as extreme, six risks are categorized as high, two risks are categorized as medium, and four risks are categorized as low. While in the unloading activity, there were 12 hazards and risks identified. There is one risk that is categorized as extreme risk, three risks are high, seven risks are categorized as medium, and one risk is included as low risk.

Therefore, there are two activities in the extreme risk category, namely:

1. “Moving a container to a truck using a crane” in loading activity, with the potential hazard of "Container falls while being moved, unit position is incorrect, sling rope breaks."
2. “Lifting containers with a crane” in unloading activity, with the potential hazard of "Improper container positioning".

Both activities require a crane for movement. If these activities are not properly executed, they can result in death if the crane or container falls on a worker. Therefore, these activities must be closely monitored, with strict SOPs applied and the proposed preventive actions followed. These preventive actions include prohibiting workers from approaching areas near the activity, ensuring that crane operators are certified, and confirming that the container is properly positioned and securely fastened before lifting.
There are nine potential hazards in the high risks category, as follows:

1. Fragile sling ropes
2. The rope is not fitted correctly
3. Line of Fire
4. Equipment falls while being moved
5. Line of Fire, drop object
6. Heavy loaded truck, crushed cable, cable snagged
7. Slip, trip, fall
8. Crane not suitable for load
9. Surface conditions of the lowering area unstable

Each activity with these potential hazards must be monitored thoroughly, with implementing the preventive action proposed in Table 7 and Table 8.

6. Conclusion

By conducting a risk assessment using the JSA method, which refers to AS/NZS 4360:2004, it was found that there are two risks that categorized as extreme risk in the logistics activities, which is associated with moving a container

onto a truck using a crane and lifting containers with a crane. Therefore, companies must focus more on these two activities to prevent extreme impacts. As stricter preventive actions are implemented, the expected severity and occurrence should approach 0 or 1, although some risk will always remain. Therefore, the HSE manager and team are tasked with identifying, mitigating, and training workers to work more safely. However, immediate safety at work depends entirely on workers' compliance with SOPs and the use of appropriate personal protective equipment.

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