www.ijarp.com ISSN 2456-9992 Page: 01-14

International Journal Advanced Research Publications

Research Article

Volume: 02
Issue: 01

WORK ACCIDENT RISK POTENTIAL ANALYSIS IN TUGBOAT DOCKING PROCESS USING HIRARC METHOD AT PT. DOKMOR OPTIMA KAJAYAN YEAR 2025

Aisyah Srikandi[1]*, Jafriati[2], Syawal Kamiluddin Saptaputra[3]

[1]Health and Safety Departement, Faculty of Public Health, Halu Oleo University, Indonesia.

[2]Public Health Departement, Faculty of Public Health, Halu Oleo University, Indonesia.

[3] Health and Safety, Faculty of Public Health, Halu Oleo University, Indonesia.

Article Received: 16 December 2025, Article Revised: 04 January 2026, Published on: 24 January 2026

***Corresponding Author: Aisyah Srikandi**

Health and Safety Departement, Faculty of Public Health, Halu Oleo University, Indonesia.

DOI: https://doi-doi.org/101555/ijarp.9938

ABSTRACT

Background: *The tugboat docking process is a high-risk job because it involves heavy equipment, a pressurized air system, and a water working environment. This condition has the potential to cause work accidents if occupational safety and health (K3) risks are not managed optimally.* ***Methods:*** *This study uses a qualitative descriptive approach to analyze the potential risk of work accidents in the tugboat docking process at PT Dokmor Optima Kajayan in 2025. Data was collected through observation, interviews, and document review. Risk analysis was carried out using the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method based on the AS/NZS 4360:2004 standard.* ***Results:*** *Hazard identification shows that there are 18 potential hazards that come from mechanical, environmental, and human factors. The results of the risk assessment showed 1 type of hazard with low risk, 6 types of hazard with medium risk, and 11 types of hazard with high risk. The risk control that has been implemented includes routine inspections, safety briefings, prohibitions on being in dangerous areas, and the use of personal protective equipment. The researcher recommends improving control through engineering engineering, strengthening administrative control, and the use of appropriate PPE.* ***Conclusion:*** *The tugboat docking process has a significant potential risk of work accidents, so it is necessary to implement more effective risk control according to the K3 control hierarchy.*

KEYWORDS: *Tugboat Docking, Work Accident Risk, HIRARC.*

INTRODUCTION

The increasingly complex world of work, the dangers and risks of work cannot be ignored. Efforts to prevent work accidents through hazard identification, implementation of health and safety programs, and the development of a good safety culture are essential to protect workers and create a safe work environment. Work accidents are a serious issue faced by every company, regardless of its size or industry. In the ever-evolving world of work, accident risk is becoming increasingly complex, influenced by various factors such as the type of industry, the technology used, and risk control efforts. Broadly speaking, there are two main factors that cause work accidents, namely unsafe human actions and dangerous environmental conditions (1).

The risk of work accidents is definitely present in every workplace. Several factors affect how much risk may occur such as the type of industry, technology, and efforts in K3 control carried out. Work accidents are accidents related to work activities in a company. That is, these work accidents occur as a result of a job or when someone does a job. In addition to the safety factor, K3 is also related to productivity in the company. Through the implementation of good K3, it can reduce the number of work accidents so that workers can work more productively (2).

The application of occupational safety and health (K3) in ship repair work in the shipyard area has a lot of influence on the factors of work accidents, employees and must comply with standards (K3) so as not to make things negative for employees. As in the shipyard area, accidents during work are largely due to the factors of several employees who do not comply with the use of personal protective equipment and the lack of employees about the importance of personal protective equipment and work safety at work (3).

Docking is the process of moving the ship from water/sea to the shipyard with the help of supporting facilities. Before carrying out the process of docking the ship, it is necessary to prepare carefully and do it carefully. The purpose of the process *docking* The ship is for the purpose of cleaning the hull below the line, inspecting the damage, continuing to repair the damage and painting the hull below the sea line (4).

According to *International Labour Oganization* (2022), more than 395 million workers worldwide suffer non-fatal work injuries. In addition, nearly 3 million workers died from accidents and work-related illnesses. The number of deaths from occupational diseases accounted for 2.6 million, while occupational accidents resulted in 330,000 deaths. Based on data from *National Institute for Occupational Safety and Health* (NIOSH) through the *Fatality Assessment and Control Evaluation* (FACE), every day about 15 workers in the

United States die from traumatic injuries in the workplace (*Fatality Assessment and Control Evaluation*, 2024). In addition, reports from *Bureau of Labor Statistics* (BLS) in 2023 recorded 5,283 cases of fatal work accidents, with a fatality rate of around 3.5 per 100,000 full-time workers (*Bureau of Labor Statistics*, 2023).

The report of accident cases in Indonesia is in accordance with the annual report of the Social Security Administration Agency (BPJS) Employment in 2024 recording the number of work accident cases in Indonesia as many as 462,241 cases. In detail, there were 74,319 cases of work accidents experienced by wage earners (PU), 5,585 cases in non-wage earners (BPU), and 867 cases of work accidents involving construction service workers. The data shows that the most cases of work accidents occur in the group of wage earners, namely workers who are in formal employment ties with companies or employers (8).

Based on data from the Southeast Sulawesi Provincial Manpower and Transmigration Office (Disnakertrans), the number of work accidents in the last four years shows a fluctuating trend. In 2021, there were 246 cases with 21 workers dying, increasing to 485 cases in 2022 with 25 deaths, and again rising to 504 cases in 2023 with 20 deaths. Most accidents occur in the mining sector, such as workers falling, being pinched by machines, or being hit by materials. Until 2024, 258 cases were recorded, showing a decrease compared to the previous year, but fatal incidents still occur, especially in the mining and construction sectors. Most of the cases recorded fall into the category of minor to moderate injuries, such as cuts, sprains, or fractures due to lack of compliance with occupational safety procedures (9).

Hazard Identification, Risk Assessment, and Risk Control (HIRARC) is a process used to identify and evaluate potential hazards in the workplace and methods used to reduce or eliminate identified hazards. Hazard control programs. The implementation of K3 begins with good planning, including hazard identification, risk assessment and control which is part of risk management. *Hazard Identification, Risk Assessment, and Risk Control* (HIRARC) is what determines the direction of the implementation of K3 in the company (10).

PT Dokmor Optima Kajayan, which operates in South Konawe, is a company engaged in *shipyards*. The main focus of its business activities is the repair of ships such as barges and *tugboats*, as well as providing marine *services* and the sale of ship parts. In this region, the company carries out ship structural repair activities and shipping trials. PT Dokmor Optima Kajayan is one of the growing maritime industry players in Southeast Sulawesi with ship repair facilities that support shipping and marine logistics activities in the region.

The selection of PT Dokmor Optima Kajayan as the research location was based on several considerations that are relevant to the focus of the study on the analysis of the potential risk

of work accidents in the *tugboat docking* process. As one of the shipyards that actively carry out *docking*, maintenance, and repair activities for tugboats, PT Dokmor Optima Kajayan has the characteristics of high-risk work involving technical activities such as welding, material cutting, painting, work in limited spaces, and the use of heavy equipment. The complexity of the docking process carried out by the company makes it the right working environment to study the application of hazard identification, risk assessment, and risk control through the HIRARC method. In addition, this company has not been extensively researched in the context of occupational safety, so this research is expected to make a real contribution to improving the K3 system in the company, as well as adding academic references regarding work risks in the shipyard sector. Thus, PT Dokmor Optima Kajayan is seen as a representative location to comprehensively *and in-depth describe the potential risk of work accidents in* tugboat docking activities.

METHOD

This research uses a descriptive qualitative approach aimed at systematically describing the potential risks of work accidents during the docking process of tugboats at PT. Dokmor Optima Kajayan. Data were collected through field observations of the work environment, docking process stages, equipment, and worker behavior, complemented by interviews with management and workers to identify hazards and the implementation of Occupational Health and Safety (OHS) practices in the company. Data analysis employed the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method, which includes hazard identification, risk assessment based on severity and likelihood, and risk control according to the hierarchy of controls. Subsequently, residual risk calculations were performed to evaluate the effectiveness of the controls implemented and to determine continuous improvement steps in accordance with OHS standards.

Table 1. Scale *Probability* on the AS/NZS 4360:2004 Standard.

Level	Level	Explanation
1	*Rare*	May occur only under special conditions/after once a year
2	*Unlikely*	It may occur in some specific conditions, but it is unlikely
3	*Possible*	May occur in some specific conditions
4	*Likely*	May occur in almost any condition
5	*Almost Certaian*	Can occur in all conditions

*Source :*Rumaf *et al.*, 2023

Table 2. Scale *Saverity* on the AS/NZS 4360 : 2004 Standard.

No	Criteria	Explanation
1	*They don't mean*	No injuries, financial very small
2	*Minor*	Minor injuries requiring P3K can be handled directly at the scene, material losses are moderate
3	*Moderate*	Missing working days, requiring medical treatment, material losses are quite large
4	*Major*	Injuries result in disability or total loss of bodily function, large material losses
5	*Extreme*	Causing a huge material disaster

Source : Rumaf *et al.,* 2023

Table 3. Australia-New Zealand Standard Risk Assessment Matrix.

AS/NZS 4360 : 2004		***SAVERITY***					
		They don't mean	***Minor***	***Moderate***	***Major***	***Extreme***	
PROBABILITY	***Almost certainly***	*Moderate*	*High*	*High*	*V. High*	*V. High*	5
	Likely	*Moderate*	*Moderate*	*High*	*High*	*V. High*	4
	Possible	*Low*	*Moderate*	*High*	*High*	*High*	3
	Unlikely	*Low*	*Low*	*Moderate*	*Moderate*	*High*	2
	Rate	*Low*	*Low*	*Moderate*	*Moderate*	*High*	1
		1	2	3	4	5	

Source : Rumaf *et al.,* 2023

Table 4. Risk Matrix Description.

Remarks	**Explanation**
Low	Requires rules or procedures
Moderate	Requires direct handling
High	Requires control planning
Very High	Requires immediate handling and involves top management

Source : Rumaf *et al.,* 2023

RESULT AND DISCUSSION

Hazard Identification

Hazard identification in this study aims to find out what are the sources of hazards in the *tugboat docking* process that have the potential to cause the risk of work accidents, identify work accidents/nearmisses that have occurred and have great potential for danger, then these things become potential for work accidents in the *tugboat docking process.*

Activities/Processes	**Potential Hazards**	**Impact**
Tool Preparation (Airbag	Airbag exploded and hose	Injury, injured fragments (eyes,

Condition Check	came off	face, body)
Walk to the docking area	Slippery/hole/inundated surfaces	Slipping, tripping, falling
Sling preparation	Broken sling strap	Injuries to body parts
Installation of a pull chain in the urlug hole	Unbalanced placement	Hand and foot injuries due to falls/slips, pinched hands
What is the use of connect sling?	Imperfect locking	Falling weights, injuries to body parts, pinched hands
Connect towing from the wheel loader (if required)	Tali towing putus	Injuries to body parts
Airbag installation and filling	Airbag explodes, compressor hose comes off	Injuries to body parts
The tugboat withdrawal process is simultaneous with the addition of airbags	Broken sling	Injuries and deaths
	Pinched/overlapping airbag	Injuries to body parts
	Airbag explodes	Injuries to body parts
	Lack of Explanation	Stumbled, hit by heavy equipment
	Miscommunication	Slipping, pinched airbag
	Fatigue	Decreased focus
	Sea snake bites	Convulsions, shock, death
	Cold/polluted seawater	Hypothermia, skin irritation
Arrangement of stock blocks and woodblocks	Woodblock and stock blockover/hand cut	Hand, finger, foot injuries
Heavy equipment airbag removal	Run over or hit	Fatal injuries due to heavy equipment
Disconnect the sling	Hand clamped sling	Hand injuries

Based on the results of the hazard identification carried out at PT Dokmor Optima Kajayan, it is known that the tugboat docking process has a fairly high potential hazard and is spread across almost all stages of work. Hazards arise not only in the main activities of boat towing, but also in the preparation stage of tools, installation of slings and airbags, to the release of airbags and the preparation of support materials. This shows that the docking process is a complex job and requires thorough safety control.

The most dominant type of hazard is mechanical hazards, such as exploding airbags, broken slings or towing ropes, as well as the risk of being pinched and crushed due to the movement of heavy loads. In addition, environmental hazards were also found in the form of slippery work surfaces, holes, and lack of lighting, which can increase the risk of workers falling or being hit by heavy equipment. Working conditions in aquatic areas also raise other potential hazards, such as exposure to cold or polluted seawater and the risk of sea snake bites.

In addition to technical and environmental factors, human factors also play a role in the emergence of potential work accidents. Miscommunication between workers and fatigue can reduce concentration and increase the likelihood of work errors. Thus, the hazard identification in this study shows that the risk of work accidents in the tugboat docking process is multidimensional and is influenced by the interaction between workers, equipment, and the work environment.

RISK ASSESSMENT

After the hazard identification is carried out, the next stage is to conduct a potential hazard assessment analysis in the *tugboat docking process*. To determine the level of risk, a risk assessment is carried out by multiplying the probability and the impact *(severity).*

Yes	Activities/Processes	Potential Hazards	Impact	Risk Assessment		
				P	S	Risk Level
1	Tool Preparation (Airbag Condition Check	Airbag exploded and hose came off	Injury, injured fragments (eyes, face, body)	3	3	*High*
2	Walk to the docking area	Smooth surface/ holes/puddles	Slipping, tripping, falling	4	1	*Moderate*
3	Sling preparation	Broken sling strap	Injuries to body parts	3	5	*High*
4	Installation of a pull chain in the urlug hole	Unbalanced placement	Hand and foot injuries due to falls/slips, pinched hands	1	3	*Moderate*
5	What is the use of connect sling?	Imperfect locking	Falling weights, injuries to body parts, pinched hands	3	2	*Moderate*
6	Connect towing from the wheel loader (if required)	Tali towing putus	Injuries to body parts	3	5	*High*
7	Airbag installation and filling	Airbag explodes, compressor hose comes off	Injuries to body parts	3	5	*High*
8	The tugboat withdrawal process is simultaneous with the addition of airbags	Broken sling	Injuries and deaths	3	5	*High*
		Pinched/overlapping airbag	Body parts injuries	2	2	Low
		Airbag explodes	Injuries to body parts	3	5	*High*
		Lack of Explanation	Stumbled, hit by heavy equipment	5	2	*High*
		Miscommunication	Slipping, pinched airbag	5	2	*High*

		Fatigue	Decreased focus	5	5	*Very High*
		Sea snake bites	Convulsions, shock, death	1	5	*Moderate*
		Cold/polluted seawater	Hypothermia, skin irritation	5	2	*High*
9	Arrangement of stock blocks and woodblocks	Woodblock and stock blockover/hand cut	Hand, finger, foot injuries	3	3	*Moderate*
10	Heavy equipment airbag removal	Run over or hit	Fatal injuries due to heavy equipment	1	5	*High*
11	Disconnect the sling	Hand clamped sling	Hand injuries	3	3	*Moderate*

The results of the risk assessment using the HIRARC method show that most of the potential hazards are at moderate to high risk levels. High category risks are generally found in activities involving air pressure, heavy loads, and ship movement, such as airbag installation and charging, the simultaneous tugboat towing process, and the potential for slings or towing ropes to break. These hazards have serious impacts, and even have the potential to cause fatal injuries and deaths.

Moderate category risks are found in activities where the likelihood of occurrence is relatively low or the impact is not directly life-threatening, such as tripping due to uneven work surfaces, pinched hands when disconnecting the sling, and unbalanced tensile chain placement. Nonetheless, medium category risks still need attention because they can cause injuries, lost working days, and reduce worker productivity.

The dominance of risk at moderate and high levels shows that the tugboat docking process still has a significant potential for work accidents. Therefore, more effective control efforts are needed to lower the level of risk to acceptable levels in accordance with occupational safety and health standards.

Risk Control

The risk control interview is conducted to find out what controls or efforts are made by the company to avoid the risk of accidents and work-related diseases in the *tugboat docking* process. Interviews were also conducted to find out what according to the expected control workers that had not been carried out by the company.

Yes	**Activities/Processes**	**Potential Hazards**	**Impact**	**Current Control**	**Control Recommendations**	
1	Tool Preparation (Airbag condition check)	Airbag exploded and hose came off	Injury, injured fragments	Regular inspection of airbags and	Implement technical controls with the installation of	

			(eyes, face, body)	fillers.	calibrated pressure gauges and conduct periodic inspections to control the risk of overpressure	
2	Walk to the docking area	Smooth surface/ holes/puddles	Slipping, tripping, falling	-	Permanently seals the hole, providing a safe pedestrian path in the docking area	
3	Sling preparation	Broken sling strap	Injuries to body parts	Routine inspections, briefings, Warning signs	Adding warning signs	
4	Installation of a pull chain in the urlug hole	Unbalanced placement	Hand and foot injuries due to falls/slips, pinched hands	Balancing Aids	Develop and implement SOP for the placement of the pull chain which includes the work sequence, safe position of workers, as well as balance checking methods and provide special training to docking workers on safe withdrawal techniques and the recognition of load imbalance danger signs.	
5	What is the use of connect sling?	Imperfect locking	Falling weights, injuries to body parts, pinched hands	Double check	Uses a double locking system (main lock and backup lock) on critical connections	
6	Connect towing from the wheel loader (if required)	Tali towing putus	Injuries to body parts	Prohibition of standing on the track	Using towing ropes according to load capacity (SWL), conducting inspections before use, and replacing worn or damaged ropes	
7	Airbag installation and filling	Airbag explodes, compressor hose comes off	Injuries to body parts	Regular inspections	Perform compressor hose connection checks before operation and avoid overpressure	
8	The tugboat withdrawal	Broken sling	Injury to body parts	Reminding workers	Adding a warning sign for a break-prone	

	process is simultaneous with the addition of airbags		and causes death	to stay away from the sling during the pulling process	sling strap	
		Pinched/overlapping airbag	Injuries to body parts	Lifting using heavy equipment	Establish a *safety zone* around the airbag and prohibit workers from being in the airbag's movement path during the operation	
		Airbag explodes	Injuries to body parts	Move away from the airbag area When finished filling the airbag	Implement technical controls with the installation of calibrated pressure gauges and conduct periodic inspections to control the risk of overpressure	
		Lack of Explanation	Stumbled, hit by heavy equipment	Using workwear that has reflective	Adding lights in the tugboat docking area	
		Miscommunication	Slipping, mismaneuvering, airbag pinch	Availability of HT	Implement a clear communication system and add HT	
		Kelelahan (fatigue)	Decreased focus, technical errors	The docking process is carried out once a day (there is a break) and vitamins are always given to docking workers	Ergonomic workwear, lightweight and comfortable PPE	
		Sea snake bites	Convulsions, shock, death	During the docking process, the HSE pumped seawater to ensure that no snakes approached	Installation of a safety net for the underwater work area	
		Cold/polluted seawater	Hypothermia, skin irritation	Provide warm water for workers and	Using complete PPE and preparing towels	

				make campfires to warm the body		
9	Arrangement of stock blocks and woodblocks	Woodblock and stocknblock overpass/hand cut	Hand, finger, foot injuries	Remind workers to always focus and remove stock blocks using heavy equipment	Keeping a safe distance from workers from the lifting area	
10	Heavy equipment airbag removal	Run over or hit	Fatal injuries due to heavy equipment	Prohibit workers from being behind heavy equipment because there are blind spots on heavy equipment	Establishing pedestrian safe lanes	
11	Disconnect the sling	Hand clamped sling	Hand injuries	Support from the machine for seals that cannot be lifted manually	Prohibits workers from holding the sling when the load is lifted and ensures a secure hand position before the lifting process	

The results of interviews with the company and workers show that several risk control efforts have been implemented, such as regular inspections of equipment, safety briefings before work, the use of communication tools, and the enforcement of bans on being in hazardous areas. However, most of these controls are still administrative and highly dependent on workers' compliance and vigilance.

When reviewed based on the hierarchy of risk control, existing controls need to be improved with the implementation of technical and engineering controls. Examples are the use of calibrated pressure gauges on airbags, double locking systems on sling joints, additional lighting in the docking area, and the establishment of safe lanes and clear safety zones. Administrative control and the use of personal protective equipment are still necessary, but they should serve as the last layer after technical controls are implemented.

The application of the HIRARC method in this study provides a systematic overview of the source of danger, risk level, and control needs in the tugboat docking process. The results of this research are expected to be the basis for companies to improve the K3 management system, so that the risk of work accidents can be reduced and worker safety is more guaranteed.

CONCLUSION

1. Potential hazards identified in the *tugboat docking* process at PT. The Dokmor Optima Kajayan in 2025 totals 18 potential hazards.
2. Analysis of the risk level with *risk assessment* in the *tugboat docking* process at PT. Dokmor Optima Kajayan in 2025 has 1 type of low risk, *6 types* of moderate risk, *10 types* of high risk, *and 1 type of* very high risk.
3. The control recommended by the researcher on the *docking tugboat* at PT. Dokmor Optima Kajayan in 2025 is engineering control, administrative control and personal protective equipment (PPE).

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