Identification of Mooring and Unmooring Risks to Minimize Workplace Accidents on the MV. CTP Honor Using the Hierarchy Method

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Abstract.
Occupational safety during mooring and unmooring activities is an important aspect in ship operations because these activities have a high risk of accidents, especially due to snap-back hazards, work environment conditions, and human factors. This study aims to identify potential hazards, analyze the level of occupational accident risk using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method, and determine risk control measures in mooring and unmooring activities on board the MV. CTP Honour. The study uses a descriptive quantitative approach. The study population includes all mooring and unmooring activities and the crew involved, while the sample is focused on the crew's work activities in the deck area during the mooring and unmooring process. Data were collected through observation, interviews, and documentation, then analyzed using the HIRARC method. The results showed that there were 20 potential hazards consisting of 4 Extreme Risk categories, 11 High Risk categories, and 5 Medium Risk categories. The highest risks were found in activities related to mooring rope tension and the presence of crew in the snap-back zone area. The research conclusion shows that the implementation of risk control through increased supervision, implementation of safety meetings, use of PPE, effective communication, and compliance with SOPs can minimize the risk of work accidents during mooring and unmooring activities on board ships.

Keywords : *Hazard Identification, HIRARC, Mooring, Occupational Safety and Risk Assessment.*

I. INTRODUCTION

Shipping safety is a fundamental aspect of the maritime industry because it directly relates to the protection of human life, ship security, and the protection of the marine environment. For Indonesia, as an archipelagic nation, shipping safety is a key factor in ensuring the smooth operation of its maritime transportation system, which plays a crucial role in supporting the mobility of goods and passengers. Safe maritime transportation operations depend heavily on the implementation of safety procedures that minimize the risk of accidents during ship operations. If safety aspects are not optimally managed, the impacts will not only include ship damage and material losses, but can also result in loss of life and disrupt the overall smooth operation of maritime transportation (Haryono, 2024).

Various studies have shown that maritime accidents are still dominated by human factors, although ship technical factors and environmental conditions also influence the level of maritime safety. It is estimated that approximately 75% to 96% of maritime accidents are caused by human error, such as crew negligence, lack of competence, and non-compliance with applicable safety procedures (Wahyuni et al., 2020). This situation demonstrates that the implementation of risk management and discipline in implementing operational procedures play a crucial role in preventing occupational accidents on board ships.

One operational activity with a high level of risk is mooring and unmooring. Mooring is the process of attaching a ship to a dock using mooring lines to maintain stability while in port, while unmooring is the process of releasing the mooring lines when the ship is about to leave the dock. These activities involve the use of mooring lines under high tension, the operation of equipment such as mooring winches or capstans, and coordination between crew members on deck. Errors in these processes can lead to serious accidents, especially if the mooring lines break and cause a snap-back effect, potentially resulting in serious injury or even death to the crew (Zhao et al., 2023). In line with this, the Mooring Equipment Guidelines (MEG4) published by the OCIMF explain that accidents during mooring activities are generally caused by mooring line breaks due to excessive tension, the presence of crew members in the snap-back zone, and lack of communication during the mooring process (OCIMF, 2018).

Safety issues during mooring and unmooring activities are also reflected in various international maritime accident reports. According to the Annual Overview of Marine Casualties and Incidents 2023 published by the European Maritime Safety Agency (EMSA), between 2014 and 2022, 23,814 maritime accidents and incidents were recorded, or an average of around 2,646 incidents per year. The number of incidents decreased in 2020 due to reduced shipping activity during the COVID-19 pandemic, then increased again in 2021 and 2022 as shipping activity normalized. The report also showed that more than 51% of accidents occurred in internal waters or port areas, while 45.3% of accidents occurred during the arrival, departure, or berthing phases of a ship. These findings indicate that mooring and unmooring activities remain one of the operational stages with a high level of occupational accident risk.

Based on observations during on-board sea practice, mooring and unmooring activities are often carried out under conditions of high operational pressure, such as limited berthing time, changing weather conditions, and demands for rapid and precise coordination between crew members. These conditions have the potential to increase the risk of work accidents if not supported by systematic hazard identification and consistent implementation of work safety procedures. In addition, the crew's understanding of potential hazards, particularly regarding snap-back zones and the risks of using mooring equipment, still requires attention so that each stage of the work can be carried out safely.

Based on these conditions, this study aims to identify potential hazards, analyze the risk level of work accidents in mooring and unmooring activities using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method, and determine risk control measures that can be applied to minimize work accidents on board the MV. CTP Honour. This study is important because the results of risk identification and assessment are expected to be the basis for preparing more effective risk controls to improve the work safety of ship crews. The novelty of this study lies in the application of the HIRARC method which is focused on hazard identification, risk assessment, and risk control in mooring and unmooring activities on board the MV. CTP Honour based on operational conditions directly observed during sea practice.

II. METHOD

This study uses a descriptive quantitative approach with the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method. The quantitative approach was chosen because the study involves assigning numerical values to likelihood and severity parameters to determine the level of risk in mooring and unmooring activities. The study is descriptive because it aims to describe the risk conditions that occur in the field without testing the relationship between variables. This approach is in accordance with the research of Wandi et al. (2026) which states that descriptive quantitative research is used to analyze work risk conditions based on numerical data without hypothesis testing. In addition, Kabul (2022) explains that descriptive quantitative research aims to provide a systematic description of phenomena through measuring numerical data, especially in work safety analysis using the HIRARC method. The study was conducted during marine work practice on board the MV. CTP Honor owned by PT. Caraka Tirta Perkasa Lines from June 13, 2024, to June 30, 2025.

The research population was all work activities related to the mooring and unmooring process on board the MV. CTP Honor and the crew involved in its implementation. The research sample focused on the crew's work activities in the deck area during the mooring and unmooring process, including the use of mooring lines, winch operation, and working conditions that have the potential to cause accidents. The data used consisted of primary and secondary data. Primary data was obtained through direct observation of mooring and unmooring activities, interviews with crew members to obtain information on the level of likelihood and severity, and documentation in the form of photographs of activities, equipment conditions, and the work environment. The use of primary data is in line with Ihsan et al. (2025) and Ummarah et al. (2025) who stated that observation and interviews are the basis for hazard identification and risk assessment based on real conditions in the field. Secondary data was obtained from books, scientific journals, the ISO 45001:2018 standard, Government Regulation Number 50 of 2012, maritime safety guidelines from the IMO and OCIMF, and ship documents such as operational procedures, activity reports, and incident records

related to mooring and unmooring activities. Secondary data serves as a theoretical basis and supports the analysis, as proposed by Indrayani and Sastradiharja (2021) and Fauzan and Kusnadi (2022).

Data collection instruments in this study included observation sheets, interview guidelines, and documentation. Direct observations were conducted to identify potential hazards during mooring and unmooring activities, while interviews were used to assess the frequency of hazard occurrence (likelihood) and the level of impact (severity) based on crew members' experiences. Documentation was used as empirical evidence to support the results of observations and interviews (Ihsan et al., 2025; Ummarah et al., 2025; Fauzan & Kusnadi, 2022). Data analysis was conducted using the HIRARC method, which consists of three stages: hazard identification, risk assessment, and risk control (Zaman et al., 2023). The hazard identification stage was carried out by identifying all potential hazards during mooring and unmooring activities based on observations, interviews, and documentation. Next, a risk assessment was conducted by determining likelihood and severity values obtained from observations, interviews, and supported by literature studies. The risk value is calculated using the equation R = L × S, then classified based on the Australian/New Zealand risk matrix 4360:2004 and the risk categories according to Sukwika and Pranata (2022). The final stage is determining risk control by referring to the control hierarchy which includes elimination, substitution, engineering, administrative control, and the use of personal protective equipment according to the level of risk obtained (Fauzan & Kusnadi, 2022).

The research procedure began with data collection through observation, interviews, and documentation during mooring and unmooring activities on board the MV. CTP Honor. The data obtained was then used to identify all potential hazards present at each stage of the work. After potential hazards were identified, a risk assessment was conducted by assigning values to the likelihood and severity parameters to obtain the risk level for each activity. The assessment results were then classified based on the risk level to determine handling priorities. The final stage of the research was the preparation of risk control recommendations according to the HIRARC control hierarchy so that it is expected to be able to minimize the potential for work accidents during mooring and unmooring activities on board the ship.

III. RESULTS AND DISCUSSION

Data Presentation

1. Observation Results

Researchers observed the mooring and unmooring processes carried out by the deck crew on the MV. CTP Honor.

Fig. 1. SOP for Mooring and Unmooring on the MV.CTP Honour Ship
Source: Ship Documents (2025)

The following is an SOP issued by the company PT. Caraka Tirta Perkasa which is intended for owned vessels, as follows:

A. *Mooring SOP*(Ship Mooring)

a) Preparation:Prepare mooring lines, winch, and ensure communication between the bridge, bow and stern.

b) Approach:The ship approached the pier slowly, assisted by a tugboat if necessary.

c) Rope Delivery:The heaving line is sent ashore, followed by the main mooring line.

d) Binding:Mooring ropes are installed on bollards on the pier according to the mooring plan.

e) Tightening:Use the winch to tighten the rope until the boat is stable.
f) Solution:Make sure all ropes are tied securely and any excess rope is tidied up.
B. *SOUP*Unmooring (Removing Mooring)
a) Preparation:Remove additional equipment and prepare the ship's engine.
b) Relaxation:The mooring lines are gradually loosened on command from the bridge.
c) Release:The shore team removed the rope from the bollard and hoisted it onto the ship.
d) Storage:The mooring rope is pulled and stored back in the storage area (mooring store) or covered with a tarpaulin.
e) Dock Remains:The ship moved safely away from the dock.
C. Mooring and Unmooring Safety
a) Use complete PPE: helmet, gloves, safety shoes, and life jacket.
b) Avoid standing in the snap-back zone (danger zone where the rope breaks).
c) Operators must understand danger signs and emergency procedures.

In addition to the work steps, the SOP also outlines safety procedures for mooring and unmooring, including the use of complete PPE, including helmets, gloves, and safety shoes. Crew are also required to avoid snap-back zones and understand hazard signs and applicable emergency procedures.

However, based on the results of observations carried out during the research, several discrepancies were still found between the SOP and conditions in the field, such as the use ofPPEIncomplete monitoring, ineffective communication, and crew members still in the snap-back zone. Therefore, further observations were conducted to obtain research data. The researchers conducted direct observations of mooring and unmooring activities on the MV CTP Honor during 30 voyages. Observations were conducted using an observation sheet containing occupational safety aspects based on the company's SOP and mooring and unmooring safety procedures. The observation data were used to determine the level of occupational safety implementation and to identify potential hazards that occurred during the activity. The observation results were then presented in the following table:

Observer Name : Riko Efendi Jaya Ramadhani
Date : January 8, 2025
Ship Name : MV CTP Honor
Voyage : 002E/MKS-JKT/I/2025
Time : 15.54 LT
Location : Makassar Port

Table 1. Mooring and Unmooring Observation Sheet (Unmooring Activities)

No	Observed Aspects	Yes	No	Information
1	Is a safety meeting held before the unmooring activity?		✔	No safety meeting was held so the crew did not receive a briefing regarding the division of tasks and potential hazards.
2	Is the crew's use of PPE complete according to standards?		✔	Some of the crew did not use complete PPE such as gloves and safety helmets.
3	Is the mooring line in good condition for use?		✔	The mooring rope looks worn and is under high tension so it has the potential to break.
4	Is the work area free from hazards (snap-back zone observed)?		✔	The crew was in the snap-back area without observing the safety zone.
5	Is communication between the crew going well?		✔	Instructions were not heard clearly resulting in miscommunication between the crew.
6	Is the deck condition safe (not slippery)?		✔	*Deck*in wet conditions due to sea water so it is very slippery
7	Is the rope pulling process carried out safely?		✔	The withdrawal process is uncontrolled and high risk.
8	Is there supervision from officers?		✔	There is no direct supervision from officers
9	Is the process running according		✔	Activities are not carried out according to

	to SOP?		applicable procedures
10	Is there no potential danger?	✔	The potential for accidents is very high, especially due to snap-back and slipping.

Source: Researcher Data (2025)

Based on observations during the unmooring activity on January 8, 2025, at Makassar Port, it was found that occupational safety practices were not optimal. A safety meeting was not held before the activity began, resulting in the crew immediately getting to work without a preliminary briefing on the division of tasks and potential hazards that could occur during the unmooring process.

Furthermore, the use of Personal Protective Equipment (PPE) was not fully implemented. Some crew members were seen not wearing gloves or safety helmets when handling the mooring lines. The tension in the mooring lines due to currents and ship movement also increased the risk of danger, especially as some crew members were still in the snap-back zone during the release of the lines.

From a communication and supervision perspective, instructions between crew members were not clearly audible due to the noisy working conditions. Direct supervision from officers was also not optimal during the activity. Furthermore, the wet deck due to seawater made the work area slippery, posing a potential slippery risk. Overall, observations indicated that unsafe actions and unsafe conditions persisted during the unmooring activity.

Observer Name : Riko Efendi Jaya Ramadhani
Date : January 21, 2025
Ship Name : MV CTP Honor
Voyage : 005W/JKT-MKS/I/2025
Time : 07.30 LT
Location : Tanjung Priok Port

Table 2. Mooring and Unmooring Observation Sheet (Mooring Activities)

No	Observed Aspects	Yes	No	Information
1	Is a safety meeting held before mooring activities?	✔		Done before the activity starts
2	Is the crew's use of PPE complete according to standards?	✔		The crew uses complete PPE according to standards.
3	Is the mooring line in good condition for use?	✔		The rope is in good condition and suitable for use.
4	Is the work area free from hazards (snap-back zone observed)?		✔	The crew is still standing in the area near the ropeway.
5	Is communication between the crew going well?		✔	Miscommunication occurred due to unclear instructions.
6	Is the deck condition safe (not slippery)?	✔		Deck in dry condition
7	Is the rope pulling process carried out safely?	✔		The process is running according to procedure
8	Is there supervision from officers?	✔		Supervision is carried out by officers
9	Is the process running according to SOP?	✔		Implemented according to SOP
10	Is there no potential danger?		✔	Potential dangers due to coordination errors

Source: Researcher Data 2025

Based on observations of the mooring activity on January 21, 2025, at Tanjung Priok Port, occupational safety implementation has been better than previous observations. A safety meeting was held before the activity began so that the crew received guidance on task allocation, work procedures, and potential hazards that may occur during the mooring process. Furthermore, most crew members used complete Personal Protective Equipment (PPE) in accordance with occupational safety regulations.

During the mooring process, the mooring lines were in good condition, and the rope pulling process was carried out according to procedure. Communication between the crew was also quite good, allowing the

Chief Officer's instructions to be clearly received by the crew in the work area. Direct supervision from the officer during the activity helped the crew work more orderly and in accordance with the ship's SOPs.

Although conditions for the operation have improved, several potential hazards remain in the work area. The wet deck, caused by seawater, made the work surface slippery, and several crew members were still standing near the mooring lines. This demonstrates that, despite the good implementation of occupational safety measures, increased vigilance and supervision are still needed to minimize the risk of workplace accidents during mooring operations.

To simplify data presentation and avoid lengthy discussions, the researchers present only two examples of observation sheets deemed representative of mooring and unmooring conditions on the MV CTP Honor. These two observation sheets were selected based on differences in occupational safety implementation conditions: one with less than optimal safety implementation and the other with better safety implementation.

Meanwhile, all 30 pieces of observation data are still used as research data and are attached in the attachment section. This data supports the risk analysis process using the HIRARC method and strengthens the results of research that has been carried out.

2. Interview Results

On this occasion, the source of information that the researcher observed was obtained from the results of interviews with the Chief Officer, Second Officer, Third Officer, Boatswain, Able 1, Able 2, and Able 3. The following interview results were carried out when the researcher was carrying out sea practice on the MV. CTP Honor. The following are the results of the interviews.

A. The results of the information obtained from the answers of source 1 (Chief Officer) as contained in the attachment:

Based on an interview with the Chief Officer of the MV CTP Honor, it was discovered that the mooring and unmooring activities had essentially followed company-established procedures. However, several obstacles were encountered in the field that could impact crew safety. One of the main obstacles was the lack of effective coordination and communication between crew members, particularly during busy and noisy working conditions. Furthermore, time pressures during docking and undocking caused the crew to work in a rush, resulting in several safety procedures not being fully implemented.

*Chief Officer*He also explained that the most common risk factor during mooring and unmooring activities is the risk of snapback due to high tension on the mooring lines. In addition, other risks, such as hands getting caught in the lines, unsafe working positions, and slippery deck conditions due to seawater, are also frequently encountered during the activities. According to him, human factors such as lack of focus, fatigue, and work habits that do not pay attention to safety are among the causes of potential hazards in the field.

The interview also revealed that the use of Personal Protective Equipment (PPE) has actually been mandated by the company, but in practice, there are still crew members who do not use complete PPE, especially gloves. Furthermore, supervision by officers has not been optimal across the entire work area due to the vastness of the mooring area and the limited number of officers in the field. Therefore, the Chief Officer conveyed the need for improvements in the quality of safety meetings, reinforcement of PPE use, increased communication between crew members, and regular work safety training to improve work safety during mooring and unmooring activities on the MV CTP Honor.

B. The results of the information obtained from the answers of source 2 (Second Officer) as contained in the attachment:

Based on an interview with the Second Officer of the MV CTP Honor, it was discovered that the mooring and unmooring activities had essentially followed the company's established procedures. However, several obstacles were encountered in the field, particularly in terms of coordination and the delivery of instructions between crew members. According to the Second Officer, the busy and noisy working conditions often meant that instructions from officers could not be heard clearly, leading to miscommunication during the activities. Furthermore, time pressures during docking and undocking also forced the crew to work faster and pay less attention to safety procedures.

*Second Officer*also explained that the most common risk factor in mooring and unmooring activities is the condition of the mooring lines that are tense and have the potential to cause snap-back, especially when the vessel is affected by strong currents and winds. Furthermore, wet and slippery deck conditions due to seawater are also often the cause of crew nearly slipping while working. Other risks come from human factors (human error), such as crew standing too close to the rope path and a lack of attention to dangerous areas during the activity.

The interview also revealed that the use of Personal Protective Equipment (PPE) on the ship has actually been implemented, but crew members were still found not using complete PPE, especially gloves. According to the Second Officer, this occurred because some crew felt that the work was routine and therefore paid less attention to work safety. In addition, supervision carried out by officers was not able to cover the entire work area optimally due to the large size of the mooring area and the limited number of officers. Therefore, the Second Officer stated that it was necessary to improve the quality of safety meetings, emphasize the use of PPE, improve communication between crew members, and implement regular work safety training to increase crew awareness of potential hazards in mooring and unmooring activities.

C. The results of the information obtained from the answers of source 3 (Third Officer) as contained in the attachment:

Based on the results of an interview with the Third Officer of MV CTP Honor, it was found that the implementation of mooring and unmooring activities on board the ship had followed applicable safety procedures, however, in the implementation there were still several obstacles encountered in the field. According to the Third Officer, one of the problems that often occurred was the crew's lack of attention to the use of work safety equipment, especially when the activity took place in busy and rushed conditions. Some crew sometimes considered mooring work as routine work so they paid less attention to potential hazards around the work area.

*Third Officer*He also explained that the most common risk encountered during mooring and unmooring activities is the risk of snapback from taut mooring lines. Furthermore, slippery deck conditions due to seawater and crew being too close to the rope lines also increase the risk of work accidents. According to him, these conditions often occur, especially during unfavorable weather or when the ship is affected by strong currents and winds.

As the officer responsible for safety equipment on board, the Third Officer stated that the use of Personal Protective Equipment (PPE) is actually mandatory and that safety equipment is well-stocked on board. However, crew awareness of the need to use complete PPE still needs to be improved. Therefore, the Third Officer believes that stricter supervision, increased safety meetings before activities begin, and regular work safety training are needed so that crews better understand the risks and the importance of working according to safety procedures during mooring and unmooring activities.

To simplify data presentation and avoid lengthy discussions, the researchers only present the interview results from three informants deemed representative of all respondents in this study: the Chief Officer, Second Officer, and Third Officer. These three informants were selected because they played a crucial role in implementing and overseeing mooring and unmooring activities on the MV CTP Honor.

Meanwhile, interview results from other respondents, such as Bosun, AB1, AB2, and AB3, were still used as supporting data in the study and are presented in full in the appendix. All interview data was used to strengthen the observations and support the risk analysis process using the HIRARC method in this study.

3. Documentation Results

Fig. 2. Mooring Activities

Source : Researcher Documentation

The image shows mooring activity on the forecastle deck of the MV CTP Honor while the ship is in port. The image shows a crew member near the taut mooring line while using a mobile phone. This is considered an unsafe act because the crew member is near the rope path, which could potentially snap back if the line breaks or is suddenly released.

Furthermore, using mobile phones during mooring operations can reduce the crew's concentration on the surrounding conditions and work instructions. According to mooring safety procedures, the crew should remain focused on operational activities and avoid hazardous areas while the rope is taut.

The documentation reveals that work behaviors still lack attention to safety during mooring activities on the MV CTP Honor. This situation highlights the need for increased crew supervision and discipline to minimize the risk of workplace accidents during the mooring process.

Data analysis

The main objective of data analysis in this study was to process and simplify the data from observations, interviews, and documentation so that they are easier to understand and can be used to answer the research problem formulation. The data obtained were analyzed descriptively quantitatively using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method to identify potential hazards, assess the level of risk of work accidents, and determine risk control measures in mooring and unmooring activities on board the MV CTP Honor as follows:

1. Hazard identification

Table 3. Hazard Identification

No	Activity Stages	Potential Danger	Risk / Impact of Accidents
1	Mooring and unmooring preparation	*Safety meeting*are not done	Crew lacks understanding of division of tasks and potential work hazards
2	Work preparation	Incomplete use of PPE	Head, hand and foot injuries
3	Work area preparation	*Deck*wet and slippery	The crew slipped and fell
4	Mooring rope preparation	The rope is in a taut condition	Risk of snap-back and serious injury
5	Mooring line pulling	Crew standing in snap-back zone	Serious injury to death
6	Winch operation	Hand caught in winch or rope	Hand injury
7	Mooring line pulling	The rope broke due to high tension	Crew hit by rope jerk
8	Mooring line release	The rope came loose suddenly	bodily injury
9	Mooring and unmooring process	Communication between crew is ineffective	Miscommunication and work errors
10	Work supervision	Lack of officer supervision	*Unsafe action*by the crew
11	Activities in the deck area	Crew using mobile phones while working	Loss of concentration at work
12	Handling of mooring lines	Crew working position is unsafe	Injury from being hit by a rope
13	Work process during bad weather	*Deck*increasingly slippery due to rain or sea water	The risk of slipping increases
14	Mooring and unmooring activities	The crew worked in a hurry	*Human error*and work accidents
15	Area around the winch	Crew too close to winch	Injuries caused by being caught in a tool
16	Heaving line withdrawal	*Heaving line*regarding the crew's body	Wounds on the body or head
17	Placement of rope on bollard	The rope is not attached properly	The rope came loose when the ship was moving
18	Tightening of mooring lines	The rope tension is unstable	Risk of rope breaking
19	Evening activities	Inadequate lighting	Crew had difficulty seeing the work area
20	Unmooring process	The crew lacked focus when releasing the rope.	Rope removal errors and work injuries

Source: Researcher Data (2025)

Based on the hazard identification table above, it can be seen that mooring and unmooring activities on board the MV CTP Honor have various potential hazards that can cause work accidents to the ship's crew. These potential hazards are found at every stage of work activities, starting from work preparation, handling mooring lines, operating the winch, to the process of releasing the mooring lines. The most dominant hazards found are the risk of snap-back due to tensioned mooring lines, slippery deck conditions, the use of incomplete PPE, and unsafe crew working positions around the mooring area. In addition, ineffective communication factors, lack of officer supervision, and unsafe actions such as using cell phones while working also contribute to the increased risk of work accidents. From the identification results, it can be seen that the potential for work accidents in mooring and unmooring activities originates from unsafe conditions and unsafe actions that can cause minor injuries to fatal accidents if not properly controlled.

2. Risk Assessment

Table 4. Risk Assessment

No	Activity Stages	Potential Danger	Risk / Impact of Accidents	L	S	RR	Category
1	Mooring and unmooring preparation	Safety meeting was not held	Crew lacks understanding of division of tasks and potential work hazards	3	3	9	Medium
2	Work preparation	Incomplete use of PPE	Head, hand and foot injuries	3	3	9	Medium
3	Work area preparation	Wet and slippery deck	The crew slipped and fell	4	3	12	High
4	Mooring rope preparation	The rope is in a taut condition	Risk of snap-back and serious injury	4	5	20	Extreme
5	Mooring line pulling	Crew standing in snap-back zone	Serious injury to death	4	5	20	Extreme
6	Winch operation	Hand caught in winch or rope	Hand injury	3	4	12	High
7	Mooring line pulling	The rope broke due to high tension	Crew hit by rope jerk	4	5	20	Extreme
8	Mooring line release	The rope came loose suddenly	bodily injury	3	4	12	High
9	Mooring and unmooring process	Communication between crew is ineffective	Miscommunication and work errors	3	4	12	High
10	Work supervision	Lack of officer supervision	Unsafe action by the crew	3	4	12	High
11	Activities in the deck area	Crew using mobile phones while working	Loss of concentration at work	3	3	9	Medium
12	Handling of mooring lines	Crew working position is unsafe	Injury from being hit by a rope	3	4	12	High
13	Work process during bad weather	The deck becomes increasingly slippery due to rain or sea water	The risk of slipping increases	4	3	12	High
14	Mooring and unmooring activities	The crew worked in a hurry	Human error and work accidents	3	4	12	High
15	Area around the winch	Crew too close to winch	Injuries caused by being caught in a tool	3	4	12	High
16	Heaving line withdrawal	Heaving line hits the crew's bodies	Wounds on the body or head	3	3	9	Medium
17	Placement of rope on bollard	The rope is not attached properly	The rope came loose when the ship was moving	3	4	12	High
18	Tightening of mooring lines	The rope tension is unstable	Risk of rope breaking	4	5	20	Extreme
19	Evening activities	Inadequate lighting	Crew had difficulty seeing the work area	2	3	6	Medium

No	Activity Stages	Potential Danger	Risk / Impact of Accidents	L	S	RR	Category
20	Unmooring process	The crew lacked focus when releasing the rope.	Rope removal errors and work injuries	3	4	12	High

Source: Researcher Data (2025)

3. Risk Control

Table 5. Risk Control Hierarchy

Level of Control	Explanation
Elimination	Permanently eliminating the source of the hazard so that the risk no longer exists. This control is the most effective method.
Substitution	Replacing hazardous equipment, materials, or work methods with safer ones so that the level of risk can be reduced.
Engineering Control	Making modifications to equipment, facilities, or the work environment to reduce worker exposure to hazards.
Administrative Control	Controlling risks through work procedures, SOPs, safety meetings, training, supervision, and work system arrangements.
Personal Protective Equipment (PPE)	The use of safety equipment to protect workers from the impact of hazards that cannot be eliminated by other control methods.

Despite analyzing various work activities and their potential risks, workplace accidents still occur at the company. This demonstrates the need for a better and more structured occupational safety system. If the company is to achieve its zero accident target, implementing an effective risk control system in accordance with Law No. 36 of 2009 concerning occupational health in the workplace is crucial.

Table 6. Risk Control

No	Potential Danger	Risk Rating	Category	Risk Control	Types of Control
1	Safety meeting was not held	9	Medium	Conduct a toolbox meeting before mooring and unmooring activities to explain tasks, work procedures, and potential hazards.	Administrative Control
2	Incomplete use of PPE	9	Medium	Requires the use of safety helmets, gloves, safety shoes, and wearpacks during the activity.	PPE
3	Wet and slippery deck	12	High	Clean the work area, mark slippery areas, and ensure deck drainage is functioning properly.	Engineering + Administrative
4	The rope is in a taut condition	20	Extreme	Provide socialization of snap-back hazards and ensure crews are in a safe area.	Administrative
5	Crew standing in snap-back zone	20	Extreme	Provide marking or snap-back zone signs on the deck and prohibit crew from entering the area while operations are in progress.	Engineering + Administrative
6	Hand caught in winch or rope	12	High	Provide training on safe winch operation and use of safety gloves.	Administrative + PPE
7	The rope broke due to high tension	20	Extreme	Conduct routine inspections of rope condition and replace worn or damaged ropes.	Engineering
8	The rope came loose suddenly	12	High	The release of the rope is carried out in stages according to SOP and under the supervision of officers.	Administrative
9	Communication between crew is ineffective	12	High	Using HT (Handy Talky) and ensuring every instruction is received clearly	Administrative
10	Lack of officer supervision	12	High	Increase direct supervision by the Chief Officer during the activity	Administrative
11	Use of mobile phones while working	9	Medium	Prohibiting the use of mobile phones during mooring and unmooring operations	Administrative
12	Crew working position is unsafe	12	High	Provide a briefing on safe working positions before activities begin.	Administrative

No	Potential Danger	Risk Rating	Category	Risk Control	Types of Control
13	Slippery deck due to bad weather	12	High	Clean the deck regularly and wear non-slip shoes.	Engineering + PPE
14	The crew worked in a hurry	12	High	Arrange the division of tasks well and ensure that work is carried out according to SOP	Administrative
15	Crew too close to winch	12	High	Provide a safety perimeter around the winch area and install safety signs.	Engineering + Administrative
16	Heaving line hits the crew's bodies	9	Medium	Give a signal before throwing the heaving line and ensure the area is safe.	Administrative
17	The rope is not properly attached to the bollard.	12	High	Re-checking the rope installation by the duty officer	Administrative
18	The rope tension is unstable	20	Extreme	Monitor the rope tension condition periodically during the operation.	Administrative
19	Inadequate lighting	6	Medium	Adding lighting to the mooring area during night operations	Engineering
20	The crew lacked focus when releasing the rope.	12	High	Conduct a briefing before unmooring and ensure the crew is focused on their duties.	Administrative

Source: Researcher Data (2025)

IV. DISCUSSION

How is the identification of potential hazards (hazard identification) and the level of risk of work accidents in mooring and unmooring activities based on the HIRARC method of risk assessment analysis?

Based on observations, interviews, and documentation of mooring and unmooring activities on board the MV. CTP Honor, 20 potential hazards were identified that could potentially cause workplace accidents. These potential hazards stem from unsafe working conditions and unsafe actions by workers. The most common hazards include slippery deck conditions, incomplete use of personal protective equipment (PPE), crew members in the snap-back zone, use of mobile phones while working, and the failure to hold safety meetings. Interviews with the Chief Officer, Second Officer, and Third Officer indicate that human factors remain the primary cause of potential workplace accidents.

The results of the risk assessment using the HIRARC method showed that of the 20 potential hazards identified, there were 4 hazards categorized as Extreme Risk, namely the rope is in a tense condition, the crew is in the snap-back zone area, the rope broke due to high tension, and unstable rope tension. In addition, there were 11 potential hazards categorized as High Risk, including slippery deck, hands caught in the winch, ineffective communication, lack of officer supervision, unsafe working positions, and the crew working in a hurry. A total of 5 other potential hazards were categorized as Medium Risk, namely the use of incomplete PPE, not holding a safety meeting, the use of mobile phones while working, the heaving line hitting the crew, and inadequate lighting.

The research results show that mooring and unmooring activities carry a relatively high level of risk, particularly those involving the handling of tensioned mooring lines. Therefore, hazard identification and risk assessment using the HIRARC method are necessary to systematically determine risk levels and thus serve as a basis for determining risk control priorities.

What risk control measures can be implemented to minimize work accidents during mooring and unmooring activities on ships?

Based on the results of hazard identification and risk assessment using the HIRARC method, risk control is carried out through administrative controls, engineering controls, and the use of personal protective equipment (PPE). Top priority is given to snap-back hazards that fall into the Extreme Risk category, through the installation of snap-back zone area signs, the implementation of safety meetings and briefings, and increased supervision of mooring rope handling activities.

Furthermore, the use of complete PPE must be mandatory and supervised by responsible officers. Control is also implemented by improving communication effectiveness using walkie-talkies (HT), providing clear commands, and ensuring each crew member understands their duties and responsibilities during the activity. Risks caused by work environment conditions, such as slippery decks, can be minimized by cleaning the work area, installing warning signs, and using appropriate safety shoes.

Improving crew competency through training on mooring and unmooring procedures, snap-back hazards, safe winch use, and emergency procedures is also an important part of risk management. With proper supervision, effective communication, adherence to standard operating procedures, consistent use of personal protective equipment (PPE), and increased safety awareness, the risk of workplace accidents during mooring and unmooring activities on board the MV CTP Honour can be minimized.

This summary retains all subchapters, main research findings, and discussion conclusions, but reduces repetition to better fit the discussion format of a scientific journal article.

V. CONCLUSION

This study shows that mooring and unmooring activities on board the MV. CTP Honor have a fairly high level of work accident risk based on analysis using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method. The identification results found 20 potential hazards originating from unsafe conditions and unsafe actions. The risk assessment shows that there are 4 potential hazards categorized as Extreme Risk, 11 potential hazards categorized as High Risk, and 5 potential hazards categorized as Medium Risk. The highest risks are found in activities related to mooring lines, especially the condition of the rope in a tense state, crews being in the snap-back zone area, ropes breaking due to high tension, and unstable rope tension. Recommended risk controls include increasing supervision, conducting safety meetings, using complete PPE, strengthening communication, implementing SOPs consistently, and occupational safety training to minimize accidents during mooring and unmooring activities.

This study has limitations because it was conducted on only one research object, namely the MV. CTP Honor, so the results cannot be generalized to all types of ships or shipping companies. In addition, the risk assessment is still based on the results of observations, interviews, and documentation during the research period, so it is strongly influenced by the observed operational conditions. Therefore, further research is recommended to involve more ships with different operational characteristics to obtain more comprehensive results. Practically, the results of this study are expected to be evaluation materials for shipping companies in improving their work safety management systems, strengthening safety culture, and developing more effective risk control programs for mooring and unmooring activities.

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