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Risk Analysis in the Rigging and Lifting Process Using the HIRARC Method in the Indonesian Production Platform Module Erection Area

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Abstract

PT. McDermott Indonesia is an offshore construction company where workplace accidents frequently occur due to poor weather conditions, inadequate work locations, equipment failures, and human factors. This study aims to assess risk levels in rigging and lifting processes using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method to achieve zero accidents in the Production Platform Module Erection Area. The research employs a concurrent embedded mixed-methods design, where qualitative data collection serves as the primary method supplemented by quantitative methods for data enrichment. Five informants were selected through purposive sampling: a rigging superintendent, HSE specialist, rigger, crane operator, and mechanic foreman. Data collection was conducted from 2023 to 2024 through observations, structured interviews, and documentation analysis using interview guidelines and risk assessment matrices. Results identified 21 potential hazards across 4 work stages and 10 work processes, categorized into 6 low-risk, 8 medium-risk, 11 high-risk, and 4 extreme-risk scenarios. Comparative analysis demonstrates HIRARC's superior capabilities over the existing Task Risk Assessment (TRA) method, identifying 21 hazards across 10 work processes compared to TRA's 16 hazards across 6 work processes. Risk control measures follow the hierarchy of controls, emphasizing elimination and substitution strategies. The study concludes that regular risk assessment updates are necessary, recommending enhanced employee HSE awareness, consistent PPE usage, and HIRARC adoption for comprehensive offshore construction risk management.

Keywords: Risk Management, HIRARC, Rigging and Lifting, Offshore Construction

1. Introduction

PT McDermott Indonesia employees understand the importance of Occupational Safety and Health (OSH), as they play a vital role in ensuring project success. It is a crucial element in the assessment of remuneration schemes, promoting ethical conduct and employee welfare (E. Beck-Krala, 2016). By implementing Occupational Safety and Health (OSH), the company can prevent and control potential workplace accident risks.

However, according to data from the BPJS Ketenagakerjaan, the number of workplace accidents in Indonesia over the past six years, from 123,040 cases in 2017, has continued to increase annually, reaching 265,334 cases in 2022 (Pratiwi, 2023). This high number of workplace accidents each year indicates that the implementation of Occupational Safety and Health (OSH) in Indonesia is becoming increasingly prioritized. Workplace accidents will not occur if employees collectively work to prevent and control potential accident risks in the workplace. Sources of workplace accidents include environmental influences and human factors, where employee negligence can lead to accident (Novita, 2021).

The construction industry is the largest contributor to workplace accident cases each year, accounting for 32% of the total workplace accident cases in Indonesia (Mayandari & Inayah, 2023). Therefore, according to the Construction Services Law, Article 70, Paragraph

1, every construction worker employed in the field of Construction Services must have a work competency certification to prevent potential workplace accident risks.

One of the companies engaged in construction is PT. McDermott Indonesia, renowned as an offshore fabrication construction industry specializing in engineering, fabrication, offshore installation, material procurement, and project management. The Marjan Saudi Aramco project is one of its contracts, encompassing the design, procurement, fabrication, and installation for pre-commissioning of the TP-10 tie-in platform, six gas lift topside modules and associated pipeline and subsea cables (Breakbulk Events, 2019).

During its construction, employees frequently handle various equipment and work processes that increase the risk of workplace accidents. The rigging process, particularly loading and unloading, presents a high risk of occupational accidents due to various hazards such as falling, being struck by materials, and being squeezed (Pasaribu, 2020). These risks are further exacerbated by using lifting equipment, which can lead to injury and health problems (Douwes, 2021). Therefore, preventive measures are necessary by analysing potential hazards and risks and taking accurate actions in risk control during the rigging process at Production Platform Module Erection Area.

Based on workplace accident data in the rigging process at the Production Platform Module Erection Area of PT. McDermott Indonesia from 2022 to 2024, there was one property damage case in March 2022, four near-miss cases (two of which occurred in November and December 2023), and two workplace incident cases, one of which occurred in January 2024. Accident investigation data and interview results indicate that these accidents occurred due to employees' lack of discipline in implementing hazard identification procedures and lifting procedures, directly impacting employees with various potential hazards.

To prevent the risk of work accidents PT. McDermott Indonesia utilizes Task Risk Assessment (TRA) to pinpoint dangers and evaluate their likelihood during work procedures, with the goal of minimizing workplace incidents and managing risks. Even though TRA is proficient in concentrating on particular duties and offering thorough examinations, its scope is restricted and it heavily depends on precise data. In general, TRA is efficient for managing certain risks but needs extra steps to adequately handle overall workplace risks.

According to OHSAS 18001:2007, it is important to reduce the risk of workplace accidents by using risk assessment and risk management (Boariu & Armean, 2020). This allows the company to determine the risk levels in work processes and identify appropriate control measures based on these risk levels.

Therefore, to minimize the potential for workplace accidents, it is necessary to implement risk analysis using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method to identify potential hazards and risks in each work process, thereby reducing, protecting against, and eliminating risks (zero accidents).

2. Theoretical Review

Occupational Safety and Health (OSH)

OSH is a practical effort to ensure safety and improve employee health by preventing work-related accidents and diseases, as well as controlling workplace hazards (Meirinawati & Prabawati, 2017). Supporting worker health is one of the Millennium Development Goals, and occupational safety and health is a multidisciplinary discipline that includes identifying, preventing, and controlling workplace hazards (Salvador & Thinh, 2016).

Rigging and Lifting

Rigging is the process of transporting and moving materials in the fabrication area using heavy transport equipment such as forklifts, cranes, and supporting equipment like hooks, slings, wire ropes, shackles, sockets, and chains, while lifting is the process of hoisting equipment, loads, or materials using lifting devices (Hutari, 2022). Rigging typically includes binding, securing, and preparing the weight for the loads, while lifting the load against gravity is known as lifting. (Mishra, et al., 2022).

Risk Management

Risk management is a system that supports and enhances the quality of a company by identifying and controlling risk levels in the workplace. Risk management consists of a series of actions to list out all possible risks, evaluate their influences, and reduce or avoid losses (Y. Hayashi, 2020)

HIRARC (Hazard Identification, Risk Assessment, and Risk Control)

HIRARC is the activity of risk identification in all situations, conducting risk assessments by categorizing the levels of risk hazards, and implementing risk control measures aimed at managing and minimizing the hazard levels and the occurrence of accidents in the workplace (Fitri Damayanti & Mahbubah, 2021).

Hazard Identification

According to Fitri Damayanti & Mahbubah (2021), this stage involves examining each area and identifying potential hazards or risks in every work activity, as well as the work systems that could lead to accidents. The company's considerations for determining risks or hazards are as follows (Urrohmah & Riandadari, 2019):

a. Abnormal operating conditions (A): Work outside standard procedures.

b. Normal operating conditions (N): Routine work and procedures.
c. Emergency conditions (E): Situations that are difficult to control.

Risk Assessment

According to Hutari (2022), risk assessment is a set of rules used to control and ensure that worker health and safety are not affected by risks in the workplace. There are two assessments: Likelihood and Severity. Likelihood (see Table 1) identifies the probability of a workplace accident occurring, while Severity (see Table 2) assesses the level of severity of the consequences of such an accident. The values of likelihood and severity are used to determine the assessed risk level.

Risk rating (see Table 3) is a value indicating whether the risk level is low, medium, high, or extreme. Low (L) with risk value 2-4, Moderate (M) with risk value 5-8, High (H) with risk value 9-15, and Extreme (E) with risk value 16-20.

TABLE 1 LEVELS OF LIKELIHOOD

Level	Description	Explanation
5	Almost Certain	There is ≥ 1 occurrence per shift
4	Unlikely	There is ≥ 1 occurrence per day
3	Possible	There is ≥ 1 occurrence per week
2	Unlikely	There is ≥ 1 occurrence per month
1	Rare	There is ≥ 1 occurrence per year or longer

(Source: AS/NZS 4360:2004)

TABLE 2 LEVELS OF SEVERITY

Level	Description	Explanation
1	Insignificant	No injury, minimal financial loss
2	Minor	Minor injury, minimal financial loss
3	Moderate	Moderate injury, requires medical treatment, moderate financial loss
4	Major	Serious injury ≥ 1 persons, significant financial loss, disrupts production process
5	Catastrophic	Fatality ≥ 1 person, very significant financial loss, extensive impact, results in complete halt of all activities

(Source: AS/NZS 4360:2004)

TABLE 3 RISK RATING

Frequency of Risk	Impact of Risk				
	1	2	3	4	5
5	H	H	E	E	E
4	M	H	E	E	E
3	L	M	H	E	E
2	L	L	M	H	E
1	L	L	M	H	H

(Source: AS/NZS 4360:2004)

Risk Control

Risk control is a useful procedure for identifying and managing all potential risks or hazards that occur in the workplace (Indragiri & Yuttya, 2018). The first step in risk control is to determine the priority scale, making it easier to select risk control measures, also known as the hierarchy of controls (Wibowo, 2016). There are 5 stages in the Hierarchy of Risk Control (see Figure 1) namely elimination, substitution, engineering control, administrative control, and PPE (Dhaifullah, 2022).

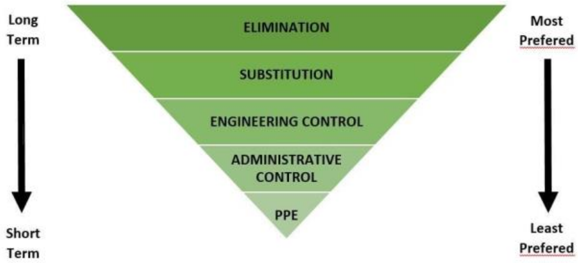

Figure 1: Hierarchy of Risk Control

(Source: AS/NZS 4360:2004)

Task Risk Assessment (TRA)

Task risk assessment (TRA) is a hazard identification activity to find out how much potential hazard occurs during the work process as a way to reduce work accidents and control these hazards (Sobah & Maulitana, 2019). According to Sobah & Maulitana (2019) 6 steps in making a Task Risk Assessment (TRA):

1. Determine the type of work to be analysed.
2. Identify the activities, materials, equipment, or work procedures used.
3. Analyse the potential hazards of each job task and their consequences.
4. Determine the risk level for each task.
5. Determine the safeguards required.
6. Determine the residual risk

Research Framework

Based on Figure 2, the research framework illustrates a systematic approach to risk analysis in rigging and lifting operations using the HIRARC methodology. The framework begins with the identification of the research problem, specifically focusing on workplace accidents and safety concerns in rigging and lifting processes at PT. McDermott Indonesia's Production Platform Module Erection Area. The study employs a mixed-methods research approach, combining both qualitative and quantitative data collection techniques to ensure comprehensive analysis. The framework then proceeds through the three core components of HIRARC: Hazard Identification, where potential risks in rigging operations are systematically identified; Risk Assessment, which evaluates the likelihood and severity of identified hazards using established risk matrices; and Risk Control, which develops appropriate mitigation strategies following the hierarchy of controls.

Throughout the process, data is collected through interviews with key personnel including rigging superintendents, HSE specialists, riggers, crane operators, and mechanic foremen, as well as direct field observations. The framework culminates in the development of comprehensive risk control measures and recommendations aimed at achieving zero accidents in offshore construction operations, thereby providing a structured pathway from problem identification to practical safety solutions.

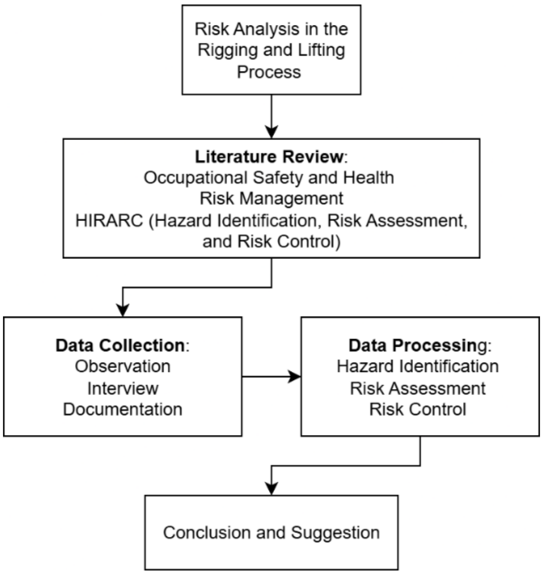

Figure 2: Research Framework

3. Research Methods

This study uses a mixed-methods approach, primarily featuring qualitative methodology enhanced by quantitative data. According to Sugiyono (2023), mixed-methods research constitutes a methodological framework that combines qualitative and quantitative research approaches within a single research endeavour, thereby yielding more comprehensive, valid, reliable, and objective data. This research uses a concurrent embedded approach, where qualitative data collection serves as the primary or dominant method, and quantitative methods are used as complementary methods to enrich the data or provide additional context (Creswell, 2014). This approach allows researchers to gain deeper insights through qualitative exploration while using quantitative data to validate findings and enhance the overall credibility and comprehensiveness of the research results.

Data collection was conducted from July 2023 to July 2024. The research was conducted at the Production Platform Module Erection Area of PT. McDermott Indonesia. The object of study in this research is Occupational Safety and Health (OSH) practices in the rigging and lifting processes at the Production Platform Module Erection Area of PT. McDermott Indonesia. Purposive sampling was employed as the informant selection technique in this research, whereby the researcher determines the identity of informants based on the research objectives (Lenaini, 2021). Three types of informants were identified in this research, as follows (Socrates, 2013):

- Main informants: Rigging Superintendent, Rigger, and Crane Operator.
- Key informant: HSE Specialist.
- Supporting informant: Mechanic Foreman.

The data collection techniques used in this research include observation of operational activities related to potential hazards in the rigging and lifting process at the Production Platform Module Erection Area of PT. McDermott Indonesia. Additionally, interviews were conducted with parties related to the research problem using interview guidelines. Furthermore, documentation was also utilized, which includes images, recordings, and minutes that have covered activities throughout the research process.

The data analysis technique in this research uses the Miles and Huberman Model, which is an interactive data analysis process that continues consistently until saturation is reached (Sugiyono, 2013). The stages in data analysis based on the Miles and Huberman Model are as follows.

1. Data Collection.
   Primary data sources are recorded from interview responses of informants and observed actions of employees in the field. Meanwhile, secondary data sources are recorded from books, scientific journals, personal documents, and official documents (Rijali, 2019).
2. Data Reduction.
   According to Rijali (2019), data reduction is carried out by summarizing data, strict data selection, and categorizing it into broader patterns.
3. Data Presentation.
   In qualitative research, data presentation can be in the form of narrative texts. Besides narrative texts, data presentation in qualitative research can also be in matrices, graphs, and charts.
4. Drawing Conclusions.
   Various conclusions should be approached openly, and sceptically. Even though unclear, they will become more detailed over time.

4. Results & Discussion

There are 3 steps in processing data collection in the rigging and lifting process at the Production Platform Module Erection Area of PT. McDermott Indonesia, using the HIRARC method (Hazard Identification, Risk Assessment, and Risk Control) and gap analysis between PT McDermott Indonesia's Task Risk Assessment (TRA) method and the Hazard

Identification, Risk Assessment, and Risk Control (HIRARC) method.

Hazard Identification

To identify a number of work stages that have the potential to cause hazards and workplace accidents in the rigging and lifting process at the Production Platform Module Erection Area, to achieve zero accidents. Data were collected through direct observation and interviews with relevant employees. Through interviews with participants and hazard identification analysis, it can be identified 4 work stages containing 10 work processes and 21 potential hazards (see Table 4). Among the 21 potential hazards found, there are 10 Normal working conditions (N), 8 Abnormal working conditions (A), and 13 emergency working conditions (E) in the rigging and lifting process at the Production Platform Module Erection Area of PT McDermott Indonesia.

TABLE 4 HAZARD IDENTIFICATION RESULTS

No	Work Process		Hazard Identification	Risk	Condition (N/A/E)
1	Preparation Stage	Conducting Lifting Plan, Toolbox Talk, and Filling out HIT and TRA	Overload exceeding SWL	Property Damage, Personnel Injured	A
			Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E
		Inspecting Rigging Equipment	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E
			Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E
		Setting Up the Crane	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E
			Overload exceeding SWL	Property Damage, Personnel Injured	A
			Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	N
			Crane Stability Failure	Crane Tipping/Overturning	E
		Sterilizing the Work Area	Falling load outside the safety exclusion zone	Property Damage, Personnel Injured	E
			Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	N
2	Load Transportation Stage	Transporting Load from Workshop by Forklift/Truck Operator	Forklift/truck malfunction	Personnel Injured, Crushed by Load	A
			Load Rolling Off Truck	Hitting Personnel, Personnel Injured, Crushed by Load	E
			Heavy Traffic	Hitting Personnel, Personnel Injured	A
		Forklift/truck operator placing the load in the Production Platform Erection Area	Blindspot	Hitting Personnel, Personnel Injured	N
			Load Falling in the Wrong Spot	Property Damage, Personnel Injured	A
3	Lifting Stage	Crane operator rechecking load suitability based on Safe Working Load (SWL)	Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	N
			Crane Stability Failure	Crane Tipping/Overturning	E
		Rigger securing the load	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E
			Securing Material at Height	Pinched, Personnel Falling	N
			Load Falling from Height	Property Damage, Personnel Injured, Crushed by Load	E
			Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E
		Signalman directing the crane operator during the lifting process	Blindspot	Hitting Personnel, Personnel Injured	N
			Load shifting unexpectedly	Hitting Personnel, Personnel Injured, Property Damage	A
			Head room problems	Property Damage	N
			Loss of radio communication	Personnel Confusion	N
			Loss of control	Hitting Personnel	A
			Adverse weather	Property Damage	A
4	Load Lowering Stage	Crane releasing rigging equipment	Blindspot	Hitting Personnel, Personnel Injured	N
			Falling load outside the safety exclusion zone	Property Damage, Personnel Injured	E
			Falling from height	Personnel Injured	E
			Pinch Point	Personnel Injured	N

Risk Assessment

Risk assessment is conducted by determining the level of likelihood and severity using the risk rating matrix based on AS/NZS 4360:2004. Risk rating indicates the level of risk as low, medium, high, or extreme. The risks present in the rigging and lifting process mostly have significant impacts, which can result in fatalities and require immediate action (Kartika, et al., 2022).

The results of this risk assessment are based on interviews with HSE specialists from PT. McDermott Indonesia, stating that if hazard identification does not cover all aspects, the next step is to use TRA (Task Risk Assessment). For example, when working at height with the risk of falling. If the value is still high, additional controls will be implemented until the value becomes low, where there are high, medium, and low categories. Activities can only be conducted under low conditions. If it remains medium, controls will be implemented for both workplace protection and personnel.

The results of the risk assessment in Table 5, shows that there are 8 potential hazards categorised as low risk, 8 potential hazards categorised as medium risk, 11 potential hazards categorised as high risk, and 4 potential hazards categorised as extreme risk.

TABLE 5 RISK ASSESSMENT RESULTS

Work Process		Hazard Identification	Risk	Condition (N/A/E)	Likelihood	Severity	Risk Rating
Preparation Stage	Conducting Lifting Plan, Toolbox Talk, and Filling out HIT and TRA	Overload exceeding SWL	Property Damage, Personnel Injured	A	3	4	8
		Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	3	4	12
	Inspecting Rigging Equipment	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	3	4	12
		Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E	2	4	8
	Setting Up the Crane	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	3	4	12
		Overload exceeding SWL	Property Damage, Personnel Injured	A	2	4	8
		Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	N	1	3	3
		Crane Stability Failure	Crane Tipping/Overturning	E	3	4	12
	Sterilizing the Work Area	Falling load outside the safety exclusion zone	Property Damage, Personnel Injured	E	2	4	8
		Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	N	1	3	3
Load Transportation Stage	Transporting Load from Workshop by Forklift/Truck Operator	Forklift/truck malfunction	Personnel Injured, Crushed by Load	2	3	2	6
		Load Rolling Off Truck	Hitting Personnel, Personnel Injured, Crushed by Load	E	4	4	16
		Heavy Traffic	Hitting Personnel, Personnel Injured	A	2	4	8
	Forklift/truck operator placing the load in the Production Platform Erection Area	Blindspot	Hitting Personnel, Personnel Injured	N	3	4	12
		Load Falling in the Wrong Spot	Property Damage, Personnel Injured	A	1	4	4
Lifting Stage	Crane operator rechecking load suitability based on Safe Working Load (SWL)	Uneven/Soft Ground	Crane Tipping/Overturning, Tripping, Falling Load, Slipping	3	1	3	3
		Crane Stability Failure	Crane Tipping/Overturning	E	3	4	12
	Rigger securing the load	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	3	4	12
		Securing Material at Height	Pinched, Personnel Falling	N	2	4	8
		Load Falling from Height	Property Damage, Personnel Injured, Crushed by Load	E	4	5	20

		Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E	2	4	8
	Signalman directing the crane operator during the lifting process	Blindspot	Hitting Personnel, Personnel Injured	N	3	4	12
		Load shifting unexpectedly	Hitting Personnel, Personnel Injured, Property Damage	A	4	4	16
		Head room problems	Property Damage	N	2	2	4
		Loss of radio communication	Personnel Confusion	N	1	2	2
		Loss of control	Hitting Personnel	A	2	2	4
		Adverse weather	Property Damage	A	2	3	6
Load Lowering Stage	Crane releasing rigging equipment	Blindspot	Hitting Personnel, Personnel Injured	4	3	4	12
		Falling load outside the safety exclusion zone	Property Damage, Personnel Injured	E	3	4	12
		Falling from height	Personnel Injured	E	4	5	20
		Pinch Point	Personnel Injured	N	2	4	8

Risk Control Results

At this stage, risk control is implemented to prevent unsafe actions and eliminate unsafe conditions in order to achieve zero accidents. The risk control results shown in Table 6 reveal a risk rating matrix where the low category received control measures consisting of 6 Administrative Controls, 4 PPE measures, and 2 Elimination controls. Since this category involves low hazard potential, it is not considered a primary priority for risk control intervention. The medium risk category received control measures comprising 6 Administrative Controls, 4 PPE measures, 1 Engineering Control, 1 Substitution measure, and 1 Elimination control. This category presents moderate hazard potential; therefore, continuous monitoring is required to determine whether additional control measures are necessary. On the other hand, high risk category received control measures including 3 Administrative Controls, 6 PPE measures, 2 Engineering Controls, 4 Substitution measures, and 2 Elimination controls. Meanwhile, the extreme risk category received control measures consisting of 2 Administrative Controls, 2 PPE measures, 4 Engineering Controls, and 2 Elimination controls.

TABLE 6 RISK CONTROL RESULTS

Work Process		Hazard Identification	Risk	Condition (N/A/E)	Risk Rating	Risk Control	Risk Hierarchy Control
Preparation Stage	Conducting Lifting Plan, Toolbox Talk, and Filling out HIT and TRA	Overload exceeding SWL	Property Damage, Personnel Injured	A	8	The rigging supervisor must ensure that the crane operator is certified, verify the weight of the load being lifted, and ensure the crane is within the correct radius.	Administrative Control, Substitution
		Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	12	A HIT and TBT briefing must be conducted before starting the lift, personnel should be trained, complete PPE must be used, and a visual inspection of the rigging equipment must be carried out before use, with any damaged rigging equipment being quarantined.	Administrative Control, Substitution, PPE
	Inspecting Rigging Equipment	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	12	A visual inspection of the rigging equipment must be carried out before use, with any damaged rigging equipment being quarantined.	Substitution, PPE
		Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E	8	The rigging department must ensure that all slings and other lifting gear have been inspected and certified.	Substitution, PPE
	Setting Up the Crane	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	12	A visual inspection of the rigging equipment must be carried out before use, and any damaged rigging equipment must be quarantined.	Substitution, PPE

		Overload exceeding SWL	Property Damage, Personnel Injured	A	8	The weight of the load being lifted must be verified and the crane must be within the correct radius.	Administrative Control, Substitution
		Uneven/Soft Ground	Crane Tipping/Over turning, Tripping, Falling Load, Slipping	N	3	The lifting area must be free of debris and tripping hazards, cleanliness must be maintained, and proper cable management must be ensured.	Administrative Control, PPE
		Crane Stability Failure	Crane Tipping/Over turning	E	12	The crane operator must perform daily inspections and report any issues to the rigging and mechanical superintendent, and must know, understand using the crane load chart correctly.	Engineering Control
	Sterilizing the Work Area	Falling load outside the safety exclusion zone	Property Damage, Personnel Injured	E	8	Barricade and signs must be installed.	Administrative Control
		Uneven/Soft Ground	Crane Tipping/Over turning, Tripping, Falling Load, Slipping	N	3	The lifting area must be free of debris and tripping hazards, cleanliness must be maintained, and proper cable management must be ensured.	Administrative Control, PPE
Load Transportation Stage	Transporting Load from Workshop by Forklift/Truck Operator	Forklift/truck malfunction	Personnel Injured, Crushed by Load	2	6	Perform routine maintenance on the forklift machine before use.	Administrative Control
		Load Rolling Off Truck	Hitting Personnel, Personnel Injured, Crushed by Load	E	16	Ensure that the weight of the load lifted by the forklift is appropriate.	Engineering Control
		Heavy Traffic	Hitting Personnel, Personnel Injured	A	8	Ensure there are safe and adequate entry and exit routes.	Administrative Control, PPE
	Forklift/truck operator placing the load in the Production Platform Erection Area	Blindspot	Hitting Personnel, Personnel Injured	N	12	Clear communication must be conveyed by the signalman.	Administrative Control
		Load Falling in the Wrong Spot	Property Damage, Personnel Injured	A	4	Maintain distance and stay away from the load being lifted unless given specific instructions by the signalman.	Engineering Control, PPE
Lifting Stage	Crane operator rechecking load suitability based on Safe Working Load (SWL)	Uneven/Soft Ground	Crane Tipping/Over turning, Tripping, Falling Load, Slipping	3	3	The lifting area must be free of debris and tripping hazards, cleanliness must be maintained, and proper cable management must be ensured.	Administrative Control, PPE
		Crane Stability Failure	Crane Tipping/Over turning	E	12	The crane operator must perform daily inspections and report any issues to the rigging and mechanical superintendent, and must know, understand using the crane load chart correctly.	Engineering Control
	Rigger securing the load	Failure in Rigging and Lifting Gear	Property Damage, Personnel Injured, Crushed by Load	E	12	A visual inspection of the rigging equipment must be carried out before use, and any damaged rigging equipment must be quarantined.	Substitution, PPE
		Securing Material at Height	Pinched, Personnel Falling	N	8	Only experienced, certified, and competent personnel who have undergone at least stage 2 rigging training and possess valid K3 rigger permits are allowed to	Administrative Control, Elimination, Substitution, PPE

						perform rigging and slinging work. Hook locks must be visually inspected and installed.	
		Load Falling from Height	Property Damage, Personnel Injured, Crushed by Load	E	20	Cranes or other lifting equipment to be used must be regularly inspected to ensure that potential falling parts are in good condition and primary safety measures are intact.	Administrative Control, Engineering Control, Elimination
		Chain Block & Sling Breakage	Personnel Injured, Crushed by Load	E	8	The rigging department must ensure that all slings and other lifting gear have been inspected and certified.	Substitution, PPE
	Signalman directing the crane operator during the lifting process	Blindspot	Hitting Personnel, Personnel Injured	N	12	Clear communication must be conveyed by the signalman.	Elimination, PPE
		Load shifting unexpectedly	Hitting Personnel, Personnel Injured, Property Damage	A	16	The signalman ensures that there are no obstacles on all sides, and the load to be lifted must be carefully inspected for potential objects that may become detached before lifting.	PPE
		Head room problems	Property Damage	N	4	The obligation to stop work must be implemented if an unsafe lift is observed.	Elimination
		Loss of radio communication	Personnel Confusion	N	2	Clear instructions must be maintained before starting work, paying attention to body position.	Administrative Control
		Loss of control	Hitting Personnel	A	4	T-magnetic/guide ropes must be used to control the load being lifted.	Engineering Control
		Adverse weather	*Property Damage*	A	6	The obligation to stop work must be implemented if an unsafe lift is observed.	Elimination
Load Lowering Stage	Crane releasing rigging equipment	*Blindspot*	Hitting Personnel, Personnel Injured	4	12	Clear communication must be conveyed by the signalman.	Elimination, PPE
		Falling load outside the safety exclusion zone	*Property Damage, Personnel Injured*	E	12	Barricade and signs must be installed.	Administrative Control
		Falling from height	*Personnel Injured*	E	20	Check the stability of a load before releasing rigging equipment, use mechanical lifting equipment to assist in releasing heavy slings and shackles, provide full-body harnesses for personnel who have undergone fall equipment training.	Administrative Control, Engineering Control, Elimination, PPE
		Pinch Point	*Personnel Injured*	N	8	Personnel must beware of pinch point hazards when attaching to a load and use appropriate safety gloves when handling rigging equipment.	Engineering Control, PPE

Comparison Analysis Between TRA & HIRARC

TABLE 7 COMPARISON ANALYSIS BETWEEN TRA & HIRARC

Method	TRA Method	HIRARC Method
Work Process	There are 6 work processes	There are 10 work processes
Hazard Potential	There are 16 hazard potentials	There are 21 hazard potentials
Risk Control	No hierarchy of risk control	Hierarchy of Risk Control
Adoption of Computerized System	Has not yet implemented a computerized system	HIRARC already has applications and software that assist in the process of hazard identification, risk assessment, and risk control.
Stakeholder	Limited to	Broader, involving

Involvement	feedback on task-related risks.	stakeholders for feedback, hazard identification, and risk control plans.
Risk Control Effectiveness	Risk control can be limited to specific tasks.	Risk control is designed to address systemic risks and provide more comprehensive solutions.
Approach	TRA is more reactive, conducted before certain tasks.	HIRARC is more proactive, involving preventive measures that cover the entire process and work environment.
Comprehensiveness	TRA does not always consider all aspects of hazards and risks present in the work environment.	HIRARC provides a more comprehensive assessment of all potential hazards and risks.

As explained in Table 7, HIRARC provides a broader, more systematic and comprehensive approach to risk management than the TRA implemented at PT. McDermott Indonesia. HIRARC covers 10 work processes, identifies 21 potential hazards and uses a systematic hierarchy of risk control. It supports digital implementation, such as e-HIRARC, which improves efficiency and accuracy. HIRARC also incorporates broader stakeholder feedback and is designed to address systemic risks with comprehensive solutions. In contrast, the TRA involves 6 work processes, identifies 16 potential hazards, lacks a risk control hierarchy, has not implemented a computerised system and has limited stakeholder involvement and a reactive approach.

Discussion

This study's findings show that the HIRARC method offers a thorough framework for managing risks in rigging and lifting operations at PT. McDermott Indonesia. The identification of 21 potential hazards across 4 work stages reveals the complexity of offshore construction operations, where multiple risk factors can simultaneously threaten worker safety and operational continuity. The risk categorization showing 4 extreme risks, 13 high risks, 8 medium risks, and 6 low risks indicates that the majority of identified hazards pose significant threats requiring immediate intervention. This distribution aligns with previous research by Kartika et al. (2022), who emphasized that rigging operations inherently carry substantial risks due to the combination of heavy equipment, height work, and environmental factors. The predominance of high and extreme risk categories underscores the critical importance of implementing robust safety management systems in offshore construction environments.

The comparative analysis between TRA and HIRARC methods reveals significant advantages of the HIRARC approach in terms of comprehensiveness and systematic risk management. While TRA identified 16 potential hazards across 6 work processes, HIRARC identified 21 potential hazards across 10 work processes, demonstrating its superior capability in hazard detection. The hierarchical risk control structure inherent in HIRARC provides a more systematic approach to risk mitigation compared to TRA's limited control measures. This finding supports the theoretical framework established by Fitri Damayanti & Mahbubah (2021), who argued that HIRARC's structured methodology enables more effective risk prioritization and control implementation. The integration of digital systems and broader stakeholder involvement in HIRARC also enhances its practical applicability in complex industrial environments, making it more suitable for achieving zero accident objectives.

The risk control measures identified through HIRARC implementation demonstrate the method's practical value in developing targeted safety interventions. The study's emphasis on administrative controls, engineering controls, and PPE usage reflects the hierarchical approach to risk management, prioritizing elimination and substitution over personal protective measures where possible. The requirement for certified crane operators, systematic equipment inspections, and proper load weight verification addresses the root causes of many identified hazards. These findings corroborate research by Wibowo (2016), who highlighted the importance of comprehensive risk control strategies in achieving zero accident goals. The integration of both proactive and reactive control measures ensures that safety management addresses not only immediate hazards but also systemic risks that could lead to cascading failures in complex rigging operations.

The study's results have significant implications for offshore construction industry safety management practices. The identification of extreme risks such as "falling from height" and "load shifting unexpectedly" highlights the need for enhanced safety protocols and continuous monitoring systems. The research demonstrates that traditional risk assessment methods may be insufficient for complex industrial operations, necessitating the adoption of more comprehensive approaches like HIRARC. The findings suggest that companies in similar industries should prioritize systematic hazard identification and implement hierarchical risk control measures to achieve sustainable safety performance. Furthermore, the study's emphasis on stakeholder involvement and digital system integration provides a roadmap for modernizing safety management practices in the offshore construction sector.

5. Conclusions & Suggestions

This research on rigging processes at PT. McDermott Indonesia's Production Platform Module Erection Area identified 21 potential hazards in rigging operations, including exceeding the Safe Working Load (S WL), failure of rigging and lifting gear, broken chain blocks and slings, uneven or soft ground, objects falling outside the safety exclusion zone, damaged forklifts/trucks, loads rolling off forklifts/trucks, congested traffic, blind spots, loads falling at wrong points, crane instability or tipping, material being hoisted at height, loads falling from height, unexpected shifting of loads, headroom problems, loss of radio communication, loss of control, unfavourable weather conditions, being struck by loads, pinch points, and being hit by loads.

Based on the risk assessment, risks in the rigging process were categorized as low (e.g., tripping, slipping, confusion among personnel, job delays, and property damage), medium (e.g., property damage, personnel injury, loads falling, falling, and pinching), high (e.g., being struck by loads, crane tipping, hitting personnel, severe injuries, being hit by loads, and falling from forklifts), and extreme (e.g., falling from height, being struck by loads, and fatalities).

Risk control measures include ensuring that crane operators are certified, inspecting and certifying all slings and lifting gear, ensuring proper load weight and crane positioning, placing wooden dunnage under crane outriggers for soft/muddy ground, and using appropriate safety gloves and full-body harnesses when handling rigging equipment.

Based on the results of the research and analysis conducted on the rigging process at the Production Platform Module Erection Area of PT. McDermott Indonesia, the following recommendations can be provided for the company are increase supervision to ensure employees always use Personal Protective Equipment (PPE) properly, implement measures to prevent loss of life, assets, and business continuity in extreme-risk situations, enhance supervision and provide short-term solutions to reduce hazards and risks in high-risk situations, monitor and improve every activity to ensure that risk control measures are implemented according to procedures based on priority.

This study acknowledges several limitations that may affect the generalizability and comprehensiveness of the findings. First, the research was conducted at a single facility (PT. McDermott Indonesia's Production Platform Module Erection Area) with a limited sample of 5 informants, which may not fully represent the diversity of offshore construction operations or capture all potential hazards present in different operational contexts. Second, the study's timeframe from July 2023 to July 2024 may not have captured seasonal variations or long-term operational changes that could influence risk profiles. Third, the qualitative nature of the research, while providing in-depth insights, may introduce subjective bias in hazard identification and risk assessment processes.

Future research should consider multi-site studies, larger sample sizes, and longitudinal designs to enhance the validity and applicability of findings across different offshore construction environments. It is suggested to use another method to protect and prevent financial losses and asset damage for the company, such as the Failure Mode and Effect Analysis (FMEA) method, to ensure more comprehensive results a detailed questionnaire can be included, and it is suggested to use FGD *(Focus Group Discussion)* to gather detailed insights from various stakeholders, including supervisors, rigging crew members, and safety officers.

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