



## Occupational Safety and Health Evaluation of Scaffolding Systems in Offshore Deck Areas

Doni Suseno<sup>1\*</sup>, Khairul<sup>2</sup>

<sup>1,2</sup> Department of Mechanical Engineering, Sekolah Tinggi Teknologi Bina Tunggal

### Article History

Received : April 27, 2026

Revised : May 20, 2026

Accepted : May 26, 2026

Published : May 26, 2026

### Corresponding author\*:

[doni.suseno.directional@gmail.com](mailto:doni.suseno.directional@gmail.com)

### Cite This Article:

Suseno, D., & Khairul, K. (2026). Occupational Safety and Health Evaluation of Scaffolding Systems in Offshore Deck Areas. *Jurnal Ilmiah Teknik*, 5(2), 384–396.

### DOI:

<https://doi.org/10.56127/juit.v5i2.2703>

**Abstract:** Offshore scaffolding activities involve high-risk work, especially in deck areas where workers operate at height and near emergency evacuation facilities. Improper scaffolding installation and use may cause structural hazards, workplace accidents, and disruption of liferaft systems. **Objective:** This study aims to analyze scaffolding implementation in offshore deck areas from the perspective of occupational safety and health. **Method:** A qualitative descriptive method was used through direct field observation and documentation at the Natuna Forel offshore platform. Data were analyzed by identifying scaffolding components, safety procedures, inspection practices, and potential hazards based on relevant OSH standards and scaffolding guidelines. **Findings:** The results show that scaffolding implementation generally complied with OSH requirements, particularly in terms of pipe connection, joint position, access system, guardrail installation, PPE use, and inspection procedures. However, a potential hazard was identified in scaffolding installed near the liferaft area, where several pipe ends were not equipped with protective plastic tube end caps. This condition may damage emergency evacuation equipment and reduce emergency response effectiveness. **Implications:** The findings suggest that offshore scaffolding safety assessment should not only focus on structural stability and worker access but also consider the interaction between temporary structures and emergency facilities. **Originality:** This study offers a specific contribution by highlighting scaffolding safety in offshore deck areas, particularly its potential impact on liferaft emergency systems, which is rarely discussed in onshore-focused scaffolding studies.

Keywords: offshore scaffolding; occupational safety and health; offshore deck area; liferaft; hazard identification.

## INTRODUCTION

Construction, maintenance, and inspection activities in the offshore oil and gas industry are classified as high-risk occupations due to their complex and hazardous working environments. Offshore working areas are characterized by limited workspaces, dynamic operational activities, extreme weather exposure, work at height, and the use of heavy equipment and temporary structures. One of the most essential supporting facilities in offshore operations is scaffolding, which functions as a temporary structure to support workers, materials, and equipment during maintenance and construction activities on offshore deck areas. However, improper scaffolding design, installation, usage, and dismantling may result in serious accidents such as falls from height, falling materials,

structural collapse, and obstruction of emergency evacuation systems. The International Labour Organization (ILO) reported that falls from height remain one of the leading causes of fatalities in the construction and heavy industrial sectors ([International Labour, 2021](#)). In addition, the Occupational Safety and Health Administration (OSHA) emphasized that scaffolding accidents frequently occur due to non-compliance with safety standards and improper working procedures ([Occupational & Health, 1996](#)). Therefore, the implementation of occupational safety and health (OSH) in offshore scaffolding activities is critically important to reduce workplace accidents, maintain operational continuity, and ensure worker protection as mandated by Law No. 1 of 1970 concerning Occupational Safety ([Indonesia, 1970](#)).

Previous studies regarding scaffolding have primarily focused on technical and structural aspects. Ratay (1996) explained that temporary structures such as scaffolding must be designed by considering structural strength, stability, loading capacity, and environmental conditions to ensure worker safety. Furthermore, international standards such as AS/NZS 4576:1995 provide detailed guidelines regarding scaffolding erection, inspection, maintenance, use, and dismantling procedures ([Standards & Standards New, 1995](#)). Several studies also reported that scaffolding failures are generally caused by material defects, improper installation, inadequate supervision, and insufficient structural evaluation during operation ([Halperin & McCann, 2004](#); [Lingard & Rowlinson, 2005](#)). These findings indicate that structural integrity and material quality are essential factors in maintaining scaffolding safety during offshore operational activities.

Another group of studies has emphasized occupational safety and health aspects in construction and work-at-height activities. Regulation of the Minister of Manpower No. 9 of 2016 states that work at height activities must comply with occupational safety requirements, including work planning, safe work procedures, personal protective equipment (PPE), competent workers, and hazard area control ([Indonesia, 2016](#)). Charehzehi and Ahankoob found that most scaffolding accidents are associated with human error, poor supervision, weak safety culture, and non-compliance with PPE usage ([Charehzehi & Ahankoob, 2012](#)). Similarly, Cooper ([Cooper, 2000](#)) and Hinze ([Hinze, 1997](#)) explained that effective safety culture implementation significantly reduces workplace accidents in construction and industrial sectors. In Indonesia, occupational safety regulations such as Regulation of the Minister of Manpower No. 01/MEN/1980 and the Joint Decree of the Minister of Manpower and Minister of Public Works No. KEP-

174/MEN/1986 also emphasize the importance of safe scaffolding systems and work-at-height procedures (Indonesia, 1980a, 1980b, 1986). These studies and regulations demonstrate that occupational safety implementation plays a significant role in minimizing workplace hazards during scaffolding activities.

Other studies have mainly discussed scaffolding implementation in onshore construction projects and general building activities. Most previous research focused on installation procedures, general hazard identification, and compliance with construction safety standards. However, studies specifically discussing scaffolding implementation in offshore deck areas remain limited, particularly those related to scaffolding located near emergency evacuation facilities such as liferafts. Offshore platforms have different characteristics compared to onshore construction sites because they are influenced by marine environmental conditions, operational vibrations, limited working areas, and strict emergency evacuation requirements. OSHA stated that damaged or non-compliant scaffolding components must be repaired or replaced immediately to prevent workplace accidents and operational hazards (Occupational & Health, 1996). Nevertheless, previous studies have not comprehensively evaluated the occupational safety and health aspects of offshore scaffolding systems, especially regarding potential hazards affecting emergency evacuation systems. Therefore, a research gap still exists concerning the comprehensive evaluation of scaffolding implementation in offshore deck areas based on occupational safety and health perspectives.

Based on these research gaps, this study aims to analyze the implementation of scaffolding in offshore deck areas from the perspective of occupational safety and health. This study was conducted using a descriptive method through direct field observation and documentation in the offshore platform area at Natuna Forel. The research focuses on evaluating scaffolding materials, installation and dismantling procedures, personal protective equipment usage, scaffolding inspections, and potential hazards in offshore working areas. In addition, this study aims to identify non-conformities in scaffolding implementation based on applicable occupational safety standards and evaluate mitigation efforts applied during offshore scaffolding activities.

This study argues that scaffolding implementation that complies with occupational safety and health standards can improve workplace safety and minimize accident risks in offshore deck areas. Conversely, non-compliance in scaffolding installation, material usage, and work area control may create hazards that disrupt operational activities and

emergency evacuation processes. Therefore, the implementation of occupational safety standards, periodic inspections, proper PPE usage, and comprehensive hazard identification are essential factors in establishing a safe, effective, and regulation-compliant offshore scaffolding system.

## RESEARCH METHOD

The unit of analysis in this study was the implementation of scaffolding systems in offshore deck areas, particularly those used to support maintenance and operational activities on offshore oil and gas platforms. The study focused on scaffolding components, installation procedures, dismantling procedures, worker access systems, occupational safety facilities, and potential hazards associated with scaffolding activities. In addition, this study also examined the conformity of scaffolding implementation with occupational safety and health (OSH) standards and regulations applicable to offshore working environments. The research object was located in the offshore platform area of Natuna Forel, where scaffolding was used as temporary access for workers performing operational and maintenance tasks.

This study employed a qualitative descriptive research design to provide a comprehensive understanding of scaffolding implementation from the occupational safety and health perspective. A descriptive approach was selected because the study aimed to systematically describe the actual conditions, work procedures, safety practices, and potential hazards found in offshore scaffolding activities without manipulating the observed variables. The qualitative descriptive method was considered appropriate because it enabled the researcher to directly observe the scaffolding system, identify non-conformities, and evaluate safety practices implemented in the field. Furthermore, this approach allowed the researcher to analyze scaffolding implementation based on applicable occupational safety regulations and international scaffolding standards.

The sources of data used in this study consisted of both primary and secondary data. Primary data were obtained directly from field observations of scaffolding activities in the offshore deck area, including scaffolding installation, usage, dismantling processes, material conditions, worker practices, and safety facilities. Secondary data were obtained from occupational safety regulations, scaffolding guidelines, technical standards, inspection procedures, and supporting literature related to offshore safety and scaffolding systems. The regulations and standards used as references in this study included Law No.

1 of 1970 concerning Occupational Safety, Regulation of the Minister of Manpower No. 9 of 2016 concerning Occupational Safety and Health in Working at Height, OSHA scaffolding regulations, and AS/NZS 4576:1995 Guidelines for Scaffolding.

Data collection was conducted through direct observation and documentation techniques. Field observations were carried out by observing scaffolding erection, inspection, usage, and dismantling activities in the offshore deck area. The observation process focused on scaffolding materials, structural conditions, worker access, use of personal protective equipment (PPE), safety signs, and potential hazards surrounding the scaffolding area. Documentation techniques were also used to collect supporting visual data, including photographs of scaffolding structures, work activities, and identified non-conformities. During the observation process, the researcher used observation guidelines based on occupational safety standards and scaffolding inspection criteria to ensure systematic data collection.

The collected data were analyzed using descriptive qualitative analysis techniques. The analysis process began with data reduction by identifying and classifying relevant findings related to scaffolding safety implementation. The data were then organized into several categories, including scaffolding materials, installation procedures, dismantling procedures, occupational safety practices, and potential hazard findings. After categorization, the observed conditions were compared with applicable occupational safety regulations and scaffolding standards to evaluate the conformity of scaffolding implementation. Finally, the results were interpreted to identify potential risks, determine non-conformities, and formulate recommendations for improving occupational safety and health implementation in offshore scaffolding activities.

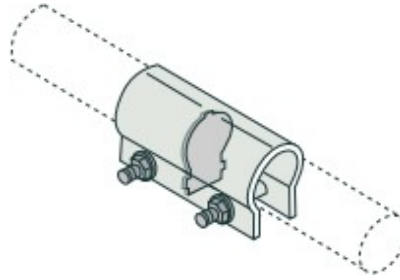
## **RESULT**

### **Scaffolding Material and Structural Condition**

Field observations showed that the scaffolding system in the offshore deck area consisted of several main components, including baseplates, standards, ledgers, transoms, braces, platforms, guardrails, ladders, and pipe connections. The pipe connection is an important element because it determines the stability and rigidity of the scaffolding structure during use.

Before showing the pipe connection, it is important to note that the strength of scaffolding does not only depend on the pipe material, but also on how each pipe is

connected and locked. Improper pipe connection may reduce structural stability and increase the risk of collapse.



**Figure 1.** Pipe Connection

Figure 1 shows the pipe connection used in the scaffolding structure. The connection functions to join scaffolding pipes so that the structure remains stable and can distribute loads properly. The use of proper clamps and couplers is necessary to ensure that the connected pipes do not shift, loosen, or fail during operational activities.

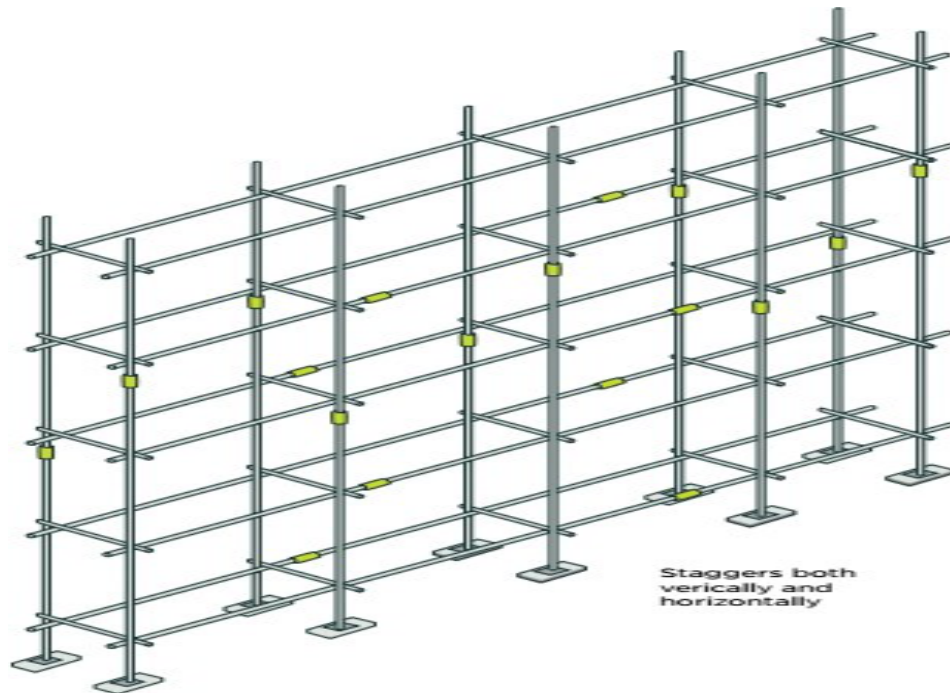
The data indicate several important patterns. First, pipe connections are central to the overall structural integrity of scaffolding. Second, connection quality affects the ability of scaffolding to withstand worker loads, material loads, and operational vibrations. Third, pipe connections must be inspected before use to ensure that all clamps and couplers are firmly attached. Fourth, improper pipe connections may create hidden hazards even when the scaffolding structure appears visually complete.

These findings suggest that pipe connection quality is one of the key indicators of scaffolding safety in offshore deck areas. Proper connection systems contribute to structural stability and reduce the risk of workplace accidents.

### **Joint Position and Work Access Safety**

Another important finding was related to the position of scaffolding joints. Joint position determines whether the scaffolding structure can maintain balance, distribute loads evenly, and provide safe access for workers. In offshore deck areas, joint placement must be carefully arranged because the working space is limited and the scaffolding structure may be exposed to environmental and operational loads.

Before presenting the joint position, it is necessary to explain that incorrect joint placement can weaken the scaffolding frame. Therefore, joint position must follow technical standards and installation procedures to ensure that the scaffolding remains stable during use.



**Figure 2. Joint Position**

Figure 2 shows the joint position in the scaffolding structure. The joint position indicates the connection points between vertical and horizontal members, such as standards, ledgers, and transoms. These points play an important role in maintaining structural alignment and preventing displacement during work activities.

From the observation, several patterns can be identified. First, joints must be positioned at structurally appropriate points to maintain the strength of the scaffolding frame. Second, joint placement influences the distribution of loads from the working platform to the main supports. Third, improper joint position may reduce the effectiveness of bracing and increase the risk of instability. Fourth, joint inspection is necessary before scaffolding is declared safe for use.

These findings indicate that joint position is not merely a technical detail but an essential safety factor in scaffolding implementation. Correct joint positioning supports safe work access and improves the reliability of scaffolding structures in offshore deck environments.

### **Stair Access and Emergency Hazard Identification**

The third finding concerns stair access and hazard identification around emergency facilities. Safe stair access is essential because workers use stairs to move between scaffolding levels. In scaffolding activities, workers are required to follow the three-point contact rule, meaning that three of four limbs must remain in contact with the ladder or stair structure when climbing or descending.

Before presenting the stair access figure, it is important to explain that many accidents in scaffolding work occur during vertical movement. Therefore, safe stair use, correct hand and foot positioning, and stable ladder installation are necessary to reduce fall hazards.

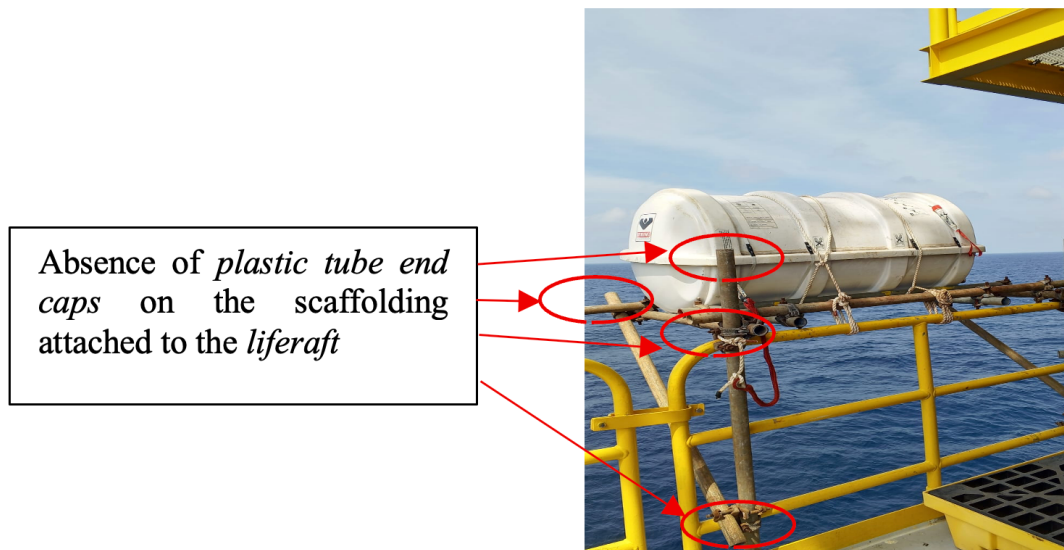


**Figure 3.** Three Point Contact for the Use of Stairs

Figure 3 illustrates the three-point contact rule for stair or ladder use. This principle requires workers to maintain stable body contact with the ladder or stair structure while moving up or down. The application of this rule helps prevent slips, loss of balance, and falls from height.

The observation shows several important patterns. First, stair access must be stable and securely connected to the scaffolding structure. Second, workers must maintain three-point contact during climbing and descending activities. Third, the use of PPE, especially body harnesses, remains important during work-at-height activities. Fourth, stair access must be free from obstacles, slippery surfaces, and loose materials.

In addition to stair access, field observations also identified a potential hazard related to scaffolding installed near the liferaft area. The liferaft is a critical emergency evacuation facility; therefore, any scaffolding structure placed near it must not obstruct access or damage the emergency equipment.



**Figure 4.** Scaffolding on Liferaft

Figure 4 shows scaffolding located near the liferaft area. The observation identified a non-conformity in the form of scaffolding pipe ends without plastic tube end caps. This condition may create a hazard because direct contact between metal pipe edges and the inflatable liferaft can damage emergency evacuation equipment.

Several patterns can be identified from this finding. First, scaffolding located near emergency facilities requires stricter hazard control. Second, missing protective pipe end caps may appear minor but can create serious risks during emergency situations. Third, emergency evacuation equipment must remain protected from sharp edges, obstruction, or mechanical contact. Fourth, scaffolding inspection must include not only structural stability but also the potential impact on nearby safety equipment.

These findings indicate that offshore scaffolding safety must be evaluated not only from structural and worker access aspects but also from its interaction with emergency evacuation systems. Therefore, protective covers, safe clearance, and detailed inspection are necessary to ensure that scaffolding does not compromise offshore emergency preparedness.

## DISCUSSION

The results of this study indicate that the implementation of scaffolding systems in the offshore deck area generally complied with occupational safety and health (OSH) standards related to structural stability, worker access, inspection procedures, and the use of personal

protective equipment. The observed scaffolding structures used appropriate steel materials, stable pipe connections, properly positioned joints, secured work platforms, and access ladders equipped with safety procedures such as the three-point contact rule. In addition, scaffolding inspection systems and safety tagging procedures had been implemented to ensure that the structures were safe before operational use. However, despite the overall compliance with safety standards, the study also identified a non-conformity related to scaffolding located near the liferaft emergency evacuation system, particularly the absence of protective plastic end caps on several scaffolding pipe edges.

The findings occurred because offshore scaffolding activities require a balance between operational efficiency and strict safety implementation. The use of proper scaffolding materials, standardized installation procedures, and periodic inspections contributed to maintaining structural integrity and worker protection during offshore operational activities. The implementation of guardrails, toe boards, braces, and PPE requirements reduced the possibility of falls from height and structural instability. Furthermore, the application of inspection systems and safety tags helped workers and supervisors identify whether scaffolding structures were safe for operational use. However, the identified hazard near the liferaft area demonstrates that offshore safety management is not limited to structural stability alone. Small technical details, such as missing protective pipe end caps, may create additional operational risks because offshore working environments involve close interaction between scaffolding systems and emergency evacuation facilities.

The findings of this study are consistent with previous studies emphasizing the importance of structural stability and safety management in scaffolding implementation. Ratay explained that scaffolding safety depends on proper structural configuration (Ratay, 1996), load distribution, and connection systems. Similarly, Halperin and McCann reported that scaffolding failures are often associated with improper installation and inadequate inspection systems (Halperin & McCann, 2004). The present study also supports the findings of Charehzehi and Ahankoob, who stated that occupational accidents in scaffolding activities are strongly influenced by worker compliance, supervision quality, and safety procedures (Charehzehi & Ahankoob, 2012). However, this study provides a different contribution because it specifically examines scaffolding implementation in offshore deck areas where scaffolding structures are located close to emergency evacuation systems such as liferafts. Previous studies generally focused on onshore construction

environments, whereas this study highlights the interaction between scaffolding structures and offshore emergency safety facilities. Therefore, the novelty of this study lies in its identification of operational safety risks associated with scaffolding placement near offshore emergency evacuation equipment.

The results of this study provide important implications for offshore occupational safety management. The findings demonstrate that scaffolding safety should not only be evaluated based on structural strength and worker access systems but also based on its interaction with surrounding operational and emergency facilities. The identification of hazards near the liferaft system indicates that offshore scaffolding activities require more comprehensive hazard assessments, including the evaluation of potential impacts on emergency evacuation systems. In a broader context, the study contributes to the understanding that occupational safety implementation in offshore environments must integrate structural safety, operational procedures, emergency preparedness, and environmental awareness simultaneously.

From a practical perspective, the implementation of scaffolding safety systems provides several positive functions, such as improving worker protection, supporting operational effectiveness, and reducing workplace accident risks. The use of PPE, inspection systems, and standardized installation procedures contributes positively to offshore operational safety performance. Nevertheless, the study also reveals potential dysfunctions when detailed safety elements are overlooked. Minor non-conformities, such as the absence of protective end caps, may not directly affect structural stability but can create significant risks during emergency evacuation situations. This finding suggests that safety management systems should not focus solely on major structural hazards but also on small operational details that may influence emergency preparedness and worker safety.

Based on these findings, several policy and operational actions are recommended to improve offshore scaffolding safety implementation. First, companies should strengthen scaffolding inspection procedures by including detailed evaluations of nearby emergency evacuation systems and operational hazards. Second, all scaffolding pipe ends located near sensitive equipment or emergency facilities should be equipped with protective plastic tube end caps to minimize the risk of equipment damage. Third, periodic safety audits and hazard identification programs should be conducted to ensure continuous compliance with occupational safety standards. Fourth, additional training regarding offshore emergency preparedness and scaffolding hazard awareness should be provided to scaffolding workers

and supervisors. Finally, offshore companies should integrate scaffolding safety management with emergency evacuation planning to ensure that temporary structures do not interfere with emergency response systems during critical situations.

## CONCLUSION

This study concludes that the implementation of scaffolding systems in the offshore deck area generally complied with occupational safety and health (OSH) standards related to structural stability, worker access systems, inspection procedures, and the use of personal protective equipment. The scaffolding structures observed during the study were equipped with appropriate materials, stable pipe connections, properly positioned joints, guardrails, toe boards, and safe access ladders that supported operational safety during offshore maintenance activities. In addition, the implementation of inspection systems and scaffolding safety tags contributed positively to maintaining scaffolding reliability and minimizing workplace accident risks. However, the study also identified a potential hazard related to scaffolding installed near the liferaft emergency evacuation area, particularly the absence of protective plastic tube end caps on several scaffolding pipe edges. Although the identified non-conformity appeared minor, it had the potential to damage emergency evacuation equipment and interfere with emergency response effectiveness in offshore operational environments.

The scientific contribution of this study lies in its comprehensive evaluation of scaffolding implementation in offshore deck areas from the occupational safety and health perspective. Unlike previous studies that mainly focused on structural safety or onshore construction environments, this study specifically highlights the interaction between offshore scaffolding systems and emergency evacuation facilities such as liferafts. The study also contributes additional practical insights regarding the importance of detailed hazard identification, not only in terms of structural stability but also in relation to surrounding operational and emergency safety systems. Therefore, this research expands the understanding of offshore scaffolding safety management by integrating structural safety, operational procedures, worker protection, and emergency preparedness into a single evaluation framework.

Nevertheless, this study has several limitations. First, the research was conducted using a qualitative descriptive approach limited to field observations in one offshore operational area, namely the Natuna Forel platform. Second, the study did not include quantitative risk

assessment methods or statistical measurements related to scaffolding failure probability and accident frequency. Third, the analysis focused primarily on operational safety observations without conducting engineering simulations or structural load testing. Consequently, the findings may not fully represent all offshore operational conditions or scaffolding configurations in different offshore environments. Future research is recommended to incorporate quantitative risk analysis methods, structural simulations, and broader comparative studies involving multiple offshore platforms to obtain more comprehensive findings regarding offshore scaffolding safety performance and hazard mitigation strategies.

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