Job Safety Analysis of Watchkeeping Constraints during Cargo Handling Operations on MV Kartini Baruna

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Maritime safety during cargo handling operations is highly influenced by technical failures and human error. This study analyzes constraints in watchkeeping activities and evaluates the effectiveness of the Job Safety Analysis (JSA) method in improving safety performance. A qualitative case study was conducted onboard MV Kartini Baruna using observation, interviews, and documentation. The results indicate that identified hazards are dominated by high-risk categories, with technical and human factors contributing equally. The implementation of JSA improves hazard identification, maintenance practices, procedural compliance, and near miss reporting, aligning with standards from the International Maritime Organization and the Standards of Training, Certification and Watchkeeping for Seafarers (STCW). This study confirms that JSA is an effective approach to reducing operational risks and enhancing watchkeeping performance.

Keyword: *Job Safety Analysis, Watchkeeping, Maritime Safety, Cargo Handling, Human Error, Risk Assessment*

1. INTRODUCTION

Maritime safety remains a critical concern in global shipping operations, particularly during port activities where vessels are engaged in cargo handling processes. The complexity of shipboard operations during loading and unloading increases the exposure to occupational hazards, making safety management an essential component of maritime operations [1]. The International Maritime Organization (IMO) has established comprehensive regulations through the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) convention to ensure that seafarers maintain adequate competence in watchkeeping, safety procedures, and operational responsibilities [2]. These regulations emphasize the importance of proper watchkeeping practices, particularly when vessels are berthed at ports.

Port watchkeeping, conducted by the Officer on Watch (OOW), plays a vital role in maintaining the safety of the ship, crew, cargo, and surrounding environment [3]. The OOW acts as the representative of the ship's master and is responsible for supervising cargo operations, coordinating with stevedores, and ensuring compliance

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with safety procedures [4]. Ineffective watchkeeping management during cargo operations may lead to severe consequences, including cargo damage, environmental pollution, and occupational accidents [5].

Despite the existence of international regulations and safety procedures, maritime accidents continue to occur at a significant rate. Previous studies indicate that maritime transportation accidents are predominantly caused by technical factors (approximately 59%) and human error (around 41%) [6]. However, it is widely acknowledged that technical failures are often linked to human factors [7], including inadequate supervision, lack of awareness, and non-compliance with safety procedures [8]. Unsafe actions and unsafe working conditions are frequently identified as the primary contributors to accidents during cargo handling operations [9].

In the context of shipboard cargo operations, human error is often associated with insufficient safety awareness [10], fatigue, lack of training, and ineffective communication among crew members [11]. Moreover, the absence of structured risk identification and hazard control mechanisms during watchkeeping activities further increases the likelihood of accidents [12]. Although Standard Operating Procedures (SOPs) are implemented onboard, their effectiveness largely depends on the consistency of execution and the awareness level of personnel involved [13].

To address these challenges, systematic approaches to hazard identification and risk control are required. One widely recognized method is Job Safety Analysis (JSA), which focuses on breaking down tasks into sequential steps, identifying potential hazards, and determining appropriate control measures [14]. JSA serves as a proactive safety management tool that enables the prevention of accidents before they occur by addressing risks at the task level [15]. Its application has been proven effective in various industrial sectors, including construction, manufacturing, and maritime operations [16].

However, the application of JSA in maritime watchkeeping, particularly during cargo handling operations at ports, remains relatively limited. Most existing studies focus on general ship safety management or accident analysis, with insufficient emphasis on task-specific hazard identification within watchkeeping duties [17]. This indicates a research gap in developing a structured and practical framework for analyzing safety constraints in port watchkeeping using JSA.

Therefore, this study aims to develop a systematic analysis of watchkeeping constraints during cargo handling operations using the Job Safety Analysis method. By identifying potential hazards, unsafe actions, and unsafe conditions, this research seeks to enhance the effectiveness of watchkeeping management and minimize occupational risks onboard. The findings are expected to contribute to improving maritime safety practices and provide practical recommendations for ship operators and maritime stakeholders.

2. METHODOLOGY

This study employs a qualitative-descriptive research design combined with a structured risk assessment approach to analyze safety constraints in watchkeeping during cargo handling operations. The research utilizes the Job Safety Analysis (JSA) method as the primary analytical framework to systematically identify hazards, assess risks, and determine appropriate control measures. A case study approach is adopted to

provide an in-depth analysis of real operational conditions onboard MV Kartini Baruna, particularly during port activities involving loading and unloading processes.

The scope of this research is limited to watchkeeping duties performed by the Officer on Watch (OOW) during cargo handling operations while the vessel is berthed at the port. The study focuses on interactions between ship crews and stevedores, the implementation of safety procedures, and the identification of unsafe actions and unsafe conditions that may lead to occupational accidents. Navigation-related watchkeeping activities are excluded to maintain a specific focus on port operations.

Data collection was carried out using multiple methods to ensure the validity and comprehensiveness of the findings. Direct observations were conducted during cargo operations to capture actual working conditions, task sequences, and potential hazards. In addition, semi-structured interviews were carried out with officers and crew members to obtain insights into operational challenges, safety awareness, and compliance with procedures. Supporting data were also collected through documentation studies, including Standard Operating Procedures (SOP), safety manuals, logbooks, and incident reports. Field notes were recorded throughout the observation process to document real-time events and operational constraints.

The implementation of JSA in this study follows several systematic steps. First, each watchkeeping activity is broken down into a sequence of specific tasks. Second, potential hazards associated with each task are identified, including physical, environmental, and human-related risks. Third, risk analysis is conducted by evaluating the likelihood and severity of each identified hazard. Based on this assessment, appropriate control measures are proposed to minimize or eliminate risks, including engineering controls, administrative controls, and the use of personal protective equipment. Finally, an evaluation is conducted to assess the effectiveness of existing safety practices and to formulate recommendations for improvement.

Risk levels are determined using a risk matrix that combines the likelihood of occurrence and the severity of consequences. The identified risks are categorized into three levels, namely low, medium, and high risk, which serve as a basis for prioritizing corrective actions. This classification enables a more systematic and effective approach to managing safety risks during watchkeeping activities.

The data analysis process involves several stages, including data reduction, data presentation, and conclusion drawing. Relevant data related to safety issues and watchkeeping constraints are filtered and organized into structured formats such as JSA tables and risk matrices. The results are then analyzed by comparing actual onboard practices with established safety standards set by the International Maritime Organization and the Standards of Training, Certification and Watchkeeping for Seafarers (STCW). This comparison is intended to identify gaps between practice and regulation.

To ensure the validity and reliability of the research findings, triangulation techniques are applied by integrating data obtained from observations, interviews, and documentation. Cross-validation is also conducted by aligning field findings with international maritime safety standards. Furthermore, consistency checks are performed throughout the analysis process to ensure that the identified hazards and risk evaluations are reliable and accurately reflect actual operational conditions. Through this methodological approach, the study aims to provide a comprehensive and

systematic analysis of safety constraints in watchkeeping during cargo handling operations.

Figure 1. Flowchart

3. DISCUSSION

The findings of this study indicate that the implementation of watchkeeping procedures during cargo handling operations onboard MV Kartini Baruna has not been fully executed in a consistent and sustainable manner. Although Standard Operating Procedures (SOP) and checklists have been established as control instruments, their application in practice remains partial and inconsistent. This condition creates operational vulnerabilities that may lead to safety risks and inefficiencies during cargo operations.

The absence of systematic adherence to procedures is particularly evident in critical watchkeeping tasks such as monitoring mooring lines, supervising cargo operations, and controlling auxiliary activities (e.g., freshwater transfer). These tasks are essential components of watchkeeping responsibilities as outlined by the Standards of Training, Certification and Watchkeeping for Seafarers (STCW), which emphasizes continuous monitoring and situational awareness during port operations. Failure to comply with these requirements increases the likelihood of unsafe actions and operational disruptions.

Furthermore, the study highlights the ineffective implementation of near miss reporting as a key weakness in safety management. The discontinuation of near miss reporting over several years has resulted in the loss of valuable safety data, limiting the ability of crew members—particularly newly assigned officers—to learn from previous incidents. In modern safety management systems, near miss reporting is a critical tool for proactive risk identification and continuous improvement. Its absence indicates a gap in safety culture and organizational learning onboard.

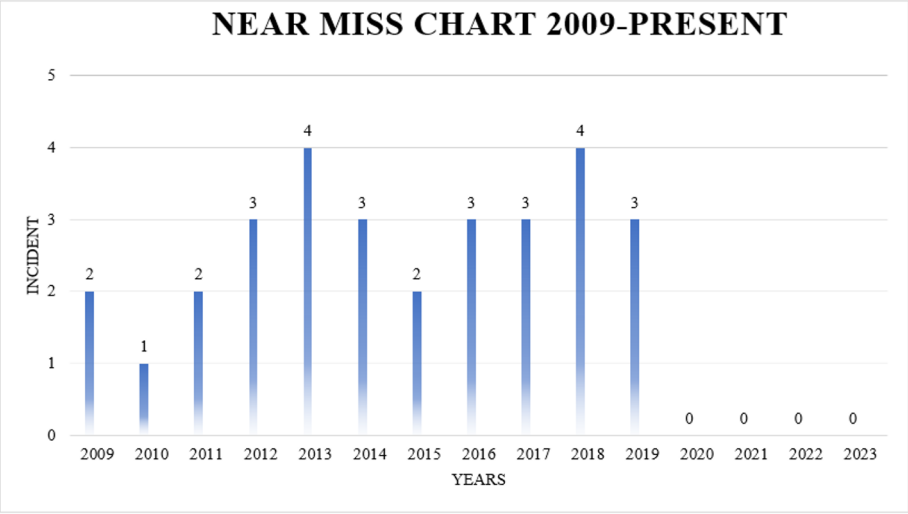

Figure 2. Near miss chart

The application of Job Safety Analysis (JSA) in this study reveals that safety constraints during cargo watchkeeping operations are primarily influenced by two dominant factors: technical failures and human error. These findings are consistent with previous studies in maritime safety, which identify human and technical factors as the main contributors to operational accidents.

From a technical perspective, the identified issues—such as damaged Australian ladder steps and broken hatch cover wheels—indicate inadequate maintenance management. The absence of a structured maintenance plan and insufficient preventive maintenance practices lead to equipment degradation, increasing the risk of operational failure. For instance, the failure of hatch cover wheels due to corrosion and lack of lubrication demonstrates a clear deviation from standard maintenance procedures. Such conditions not only disrupt cargo operations but also pose significant safety hazards, including the risk of equipment collapse and injury.

In contrast, human error is identified as a critical factor contributing to operational risks. Incidents such as the failure to monitor mooring line tension and the negligence in supervising freshwater transfer reflect a lack of situational awareness and task prioritization among crew members. These behaviors are categorized as unsafe actions, which are often influenced by factors such as fatigue, workload, lack of supervision, and insufficient safety awareness. The failure to perform routine checks, despite being

part of established job descriptions, indicates a gap between procedural knowledge and practical implementation.

Table 1. Classification of Identified Hazards Based on JSA Analysis

No	Factor Type	Identified Issue	Root Cause	Risk Level
1	Technical	Damaged Australian ladder	Lack of maintenance	High
2	Technical	Broken hatch cover wheel	Corrosion & no lubrication	Urgent
3	Human Error	Mooring line failure	monitoring & negligence	High
4	Human Error	Freshwater overflow	Lack of supervision	Low

The JSA results further classify these hazards into varying risk levels, with most incidents categorized as high risk due to their potential impact on operational continuity and safety. For example, the breakage of mooring lines presents a serious hazard that could lead to vessel instability, injury to personnel, or damage to port infrastructure. Similarly, technical failures in cargo handling equipment may result in operational delays and increased costs.

The implementation of JSA demonstrates a significant improvement in the management of watchkeeping activities during cargo operations. By systematically identifying hazards, assessing risks, and proposing control measures, JSA provides a structured approach to enhancing safety performance. The results show that after applying JSA-based recommendations, several improvements were observed, including the reactivation of near miss reporting, better maintenance practices, and increased compliance with watchkeeping procedures.

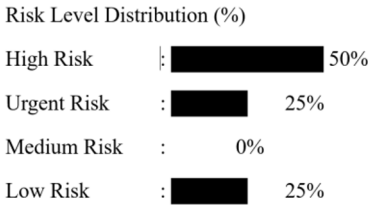

Figure 3. Risk level distribution

One of the key contributions of JSA is its ability to bridge the gap between theory and practice. Unlike conventional SOPs, which are often static, JSA provides a dynamic and task-specific analysis that directly addresses operational risks. This makes it more effective in identifying real-time hazards and implementing practical control measures. Additionally, JSA encourages active participation from crew members, thereby improving safety awareness and accountability.

The reduction of human error following the implementation of JSA indicates that structured risk analysis can positively influence crew behavior. By clearly defining

tasks, hazards, and control measures, JSA minimizes ambiguity and ensures that crew members understand their responsibilities. This aligns with the safety management principles promoted by the International Maritime Organization, which emphasize risk-based approaches and continuous improvement in maritime operations.

The findings of this study have important implications for improving maritime safety management, particularly in port operations. First, there is a need to strengthen the integration between SOP implementation and practical supervision. Procedures alone are insufficient without consistent enforcement and monitoring. Second, the reactivation and institutionalization of near miss reporting systems are essential for building a proactive safety culture and enabling continuous learning.

Third, maintenance management systems must be improved by incorporating planned maintenance schedules for critical equipment involved in cargo handling. Preventive maintenance should be prioritized to reduce the likelihood of technical failures. Finally, training programs should be enhanced to address human factors, including situational awareness, task prioritization, and safety compliance.

Overall, the integration of JSA into watchkeeping management provides a practical and effective framework for reducing risks and improving operational safety. This approach not only enhances compliance with international standards but also contributes to achieving the goal of zero accidents in maritime operations.

Table 2. Effectiveness of JSA Implementation

Aspect	Before JSA Implementation	After JSA Implementation
Near Miss Reporting	Not implemented	Actively implemented
Equipment Maintenance	Reactive	Preventive & scheduled
Mooring Monitoring	Inconsistent	Routine & controlled
Freshwater Monitoring	Neglected	Supervised & scheduled
Safety Awareness	Low	Improved significantly

4. CONCLUSION

This study demonstrates that the implementation of watchkeeping during cargo handling operations remains suboptimal, primarily due to inconsistencies in applying established procedures and weak safety management practices. The analysis using the Job Safety Analysis (JSA) method reveals that operational constraints are influenced equally by technical factors and human error, each contributing significantly to safety risks onboard. Technical issues, such as inadequate maintenance of critical equipment, lead to operational disruptions and high-risk conditions, while human errors—driven by low situational awareness, poor supervision, and lack of discipline—further exacerbate these risks. The majority of identified hazards fall into high and urgent risk categories, indicating a substantial threat to both operational continuity and occupational safety.

The application of JSA proves to be effective in systematically identifying hazards, evaluating risks, and formulating targeted control measures. Following its

implementation, notable improvements were observed, including the reactivation of near miss reporting, enhanced maintenance practices, and increased compliance with watchkeeping procedures. These findings highlight the importance of integrating proactive safety management approaches into daily ship operations. Furthermore, alignment with international standards established by the International Maritime Organization and the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) is essential to ensure sustainable safety performance. Therefore, this study concludes that the adoption of JSA as a structured safety framework can significantly improve watchkeeping effectiveness, reduce accident risks, and support the achievement of safer maritime cargo operations.

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