

Prevention of Work Accidents on the KMP Kalabia Ship During Cargo Handling in the Port

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ABSTRACT

Work accidents in the maritime sector, particularly during cargo handling in ports, remain a significant challenge to worker safety. Cargo handling involves heavy loads, lashing operations, and the use of ramp doors, exposing the crew and port workers to considerable risk. This study aims to analyze the factors causing work accidents on the KMP Kalabia during cargo handling and to identify preventive measures that can be implemented to reduce the accident rate. The study employed a descriptive qualitative method. Data were collected through in-depth interviews and field observations involving the ship's crew and port supervisors. The results indicate that the main causes of work accidents on the KMP Kalabia are low compliance with the use of Personal Protective Equipment (PPE), a lack of understanding of proper cargo lashing procedures, and inadequate supervision. Equipment failures, such as overloaded ramp doors, also contribute to accident risk. These findings show that accidents stem from a combination of human, procedural, and technical factors. This study recommends strengthening continuous safety training, enforcing stricter discipline in PPE usage, and implementing real-time monitoring technologies to improve supervision during cargo handling. These measures are expected to reduce accident rates and foster a stronger safety culture among the crew and port workers.



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1. INTRODUCTION

Occupational accidents in the maritime sector, particularly during loading and unloading operations at ports, represent a major challenge that threatens worker safety (Gonçalves et al., 2025; Xu et al., 2023). Loading and unloading activities involve heavy equipment, dynamic environmental conditions, and high accident risks, making ports and vessels high-risk workplaces. As maritime logistics and sea transportation activities continue to grow in Indonesia, improving occupational safety in ports and on passenger vessels has become increasingly urgent (Dewi et al., 2024). For example, KMP Kalabia, which operates on domestic routes, has been involved in several work-related incidents linked to inadequate supervision, insufficient training, and improper use of personal protective equipment.

Previous studies indicate that the maritime sector has a higher occupational accident rate than many other industries, with greater fatality levels. Data-driven analyses show that a large proportion of maritime occupational accidents are associated with human factors, often involving failure to follow safety procedures or lack of awareness of existing hazards (Yu et al., 2025). Environmental and vessel-related factors, including adverse weather, poorly maintained heavy equipment, and inadequate maintenance practices, further increase the likelihood of fatal incidents. For instance, damage to the ramp door disrupts loading and unloading on ro-ro vessels (Malindo et al., 2025), and accidents caused by ramp door overloading or vehicles falling into the sea are recurring incidents on vessels such as KMP Kalabia.

Continuous safety training is a key element in improving workers' awareness of surrounding hazards (Bęś & Strzałkowski, 2024; Purba et al., 2025). Regular training enhances workers' knowledge and skills regarding proper safety procedures, which in turn reduces accident rates. Although safety procedures have been introduced to workers, the persistently high accident rates on vessels and at Indonesian ports suggest that consistent and sustained implementation remains inadequate. Therefore, it is essential to reassess existing safety procedures and explore evidence-based solutions to improve current conditions.

Several studies have examined technological approaches to maritime safety. Real-time monitoring, communication, and tracking technologies have been developed for maritime operations and can provide early warnings of potential hazards (Bose et al., 2025; Spadon et al., 2024). In the Indonesian context, similar technologies have not been widely adopted, making it important to assess their potential application in domestic ports.

Human factors have also received significant attention in maritime safety research. Xi et al. (2025) demonstrated that safety culture on board vessels strongly influences the safety behavior of ship officers. In environments with weak safety culture, workers tend to neglect established safety procedures. Therefore, developing a strong safety culture among crew members is a critical component of accident prevention efforts.

Previous studies have further revealed that compliance with safety regulations in ports and on vessels remains low (Muhammad et al., 2025). Non-compliance with personal protective equipment requirements and failure to follow operational procedures are major contributors to accidents in ports and other high-risk workplaces (Ahmed, 2024; Yen et al., 2022). This reinforces the need for a more holistic approach to maritime safety, combining clear regulations with strict field-level implementation.

The urgency of this research is high given the significant number of occupational accidents in Indonesia's maritime sector, particularly during port loading and unloading activities. As a passenger vessel with high sailing frequency, KMP Kalabia faces operational safety risks related to ramp door incidents, vehicles falling into the sea, and non-compliance with safety procedures. These incidents not only endanger workers but also undermine overall operational safety. Therefore, this study aims to identify the factors contributing to occupational accidents on this vessel and to propose strategies to reduce their occurrence.

This research is expected to contribute to a deeper understanding of accident causation factors in Indonesia's maritime sector and to provide practical measures that can be implemented to reduce accidents. The study focuses on human factors, equipment conditions, environmental influences, and existing supervision systems, and aims to propose technology-based and training-oriented solutions to minimize accident risks. Through comprehensive data analysis, this research has the potential to lower occupational accident rates, improve port and vessel productivity, and enhance protection for workers involved in loading and unloading activities.

Moreover, although many studies have discussed occupational accidents in the maritime sector, few have focused specifically on passenger vessels in Indonesia, particularly in the context of loading and unloading. Therefore, this study is expected to make a significant contribution to the scientific literature and to have a positive impact on improving occupational safety in Indonesia's maritime sector. It may also serve as a basis for developing better safety policies in the maritime sector by introducing new technologies and more effective safety training for workers.

2. METHODS

2.1. Research Approach

This study applies a qualitative descriptive approach to analyze the factors causing occupational accidents during loading and unloading activities on board KMP Kalabia and to identify preventive measures that can be implemented to reduce such incidents. The qualitative descriptive approach was selected because it allows the researcher to explore field phenomena in depth and to understand the experiences and perceptions of ship workers regarding occupational safety during cargo operations.

2.2. Research Location and Subjects

This research was conducted on board KMP Kalabia, which operates on domestic port routes in Indonesia, particularly at ports frequently used for loading and unloading activities.

The study was carried out over a 12-month period, with observations and interviews conducted at various times during port operations. The research subjects consisted of personnel directly involved in loading and unloading operations, selected using purposive sampling based on the following criteria:

- a. KMP Kalabia crew members.** The study involved 22 crew members, including deck officers, supervisors, and other crew directly engaged in cargo handling operations, each with at least one year of experience in loading and unloading duties.
- b. Head of Occupational Safety.** The Head of Occupational Safety on board KMP Kalabia, who is responsible for implementing safety procedures and supervising the use of personal protective equipment (PPE) and compliance with standard operating procedures (SOPs), provided insight into safety policies and operational challenges.
- c. Port supervisors.** Port supervisors overseeing loading and unloading operations at ports where KMP Kalabia operates provided a broader perspective on the implementation of safety procedures during port activities.
- d. Port staff.** Port personnel involved in cargo operations, such as crane operators, forklift operators, and port security staff, provided insights into heavy equipment use and safety challenges during loading and unloading.

2.3. Data Collection Techniques

Data were collected using two primary methods:

- a. In-depth interviews.** Semi-structured interviews were conducted with 22 crew members, including officers and operational crew, directly involved in cargo handling operations. The interviews explored their experiences, perceptions, and knowledge regarding safety procedures, PPE usage, and factors affecting occupational safety during loading and unloading.
- b. Field observations.** The researcher conducted direct observations of loading and unloading activities at the port, documenting accidents or near-miss events and assessing the implementation of safety procedures, with a focus on PPE usage, compliance with SOPs, and environmental conditions such as weather, lighting, and heavy equipment operations.

2.4. Data Sources

Primary data were obtained from interviews with KMP Kalabia crew members and direct field observations. Secondary data included safety-related documents such as previous accident reports, the standard operating procedures implemented on KMP Kalabia, and national occupational accident statistics obtained from official sources such as BPJS Ketenagakerjaan.

2.5. Data Analysis Techniques

The collected data were analyzed using qualitative thematic analysis through the following steps:

- a. Interview transcription.** All interviews were transcribed to facilitate detailed analysis and ensure the accuracy and completeness of the recorded information.
- b. Coding and categorization.** Interview and observation data were coded and grouped into relevant themes such as PPE usage, cargo lashing procedures, crew supervision, and environmental safety factors.
- c. Interpretation and thematic analysis.** After categorization, an in-depth analysis was conducted to identify emerging patterns concerning the primary causes of accidents and practical prevention strategies.
- d. Data triangulation.** To enhance validity, interview results, field observations, and secondary data were compared to ensure the objectivity and reliability of the findings.

2.6. Research Variables

The study focuses on several variables considered influential in occupational safety during loading and unloading operations on board KMP Kalabia:

- a. Use of personal protective equipment (PPE):** crew compliance in using appropriate PPE during cargo operations, including helmets, safety shoes, and gloves.
- b. Crew understanding of cargo lashing procedures:** crew knowledge of proper cargo lashing techniques, including securing different types of cargo and vehicles.
- c. Supervision by watchkeeping crew:** the quality of supervision in monitoring loading and unloading activities and ensuring compliance with safety procedures.
- d. Occupational accident incidents:** accidents occurring during cargo operations, such as ramp door failures or vehicles falling into the sea, and their contributing factors.

3. RESULTS AND DISCUSSION

This research aims to analyze the factors contributing to work-related accidents during cargo handling on the KMP Kalabia ship and to propose prevention measures. The data were collected through interviews with the crew and port supervisors and through direct observations of cargo handling over a 12-month period. The following findings were identified.

3.1. Insufficient Use of Personal Protective Equipment (PPE)

One of the key findings is the low level of compliance among the KMP Kalabia crew in using personal protective equipment (PPE) during cargo handling activities. Interviews and observations revealed that consistent use of individual PPE items ranged from only 20% to 50%

of the crew (Table 1), despite the high-risk environment involved in cargo handling with heavy equipment. Most crew members wore PPE only when being inspected by supervisors or after a minor incident.

Table 1. PPE usage by KMP Kalabia crew

PPE type	Percentage of use	Notes
Helmet	50%	Worn mainly during inspections
Safety boots	40%	Not used consistently
Gloves	30%	Most crew do not use gloves
Eye protection	20%	Worn only during inspections

Table 1 illustrates that PPE usage is not consistently applied by the crew, with essential gear such as gloves and eye protection being used very infrequently. The findings suggest that PPE usage is reactive rather than preventive, being used only during safety checks or after incidents. This indicates a lack of ingrained safety culture, in which compliance is enforced only under supervision rather than being an ongoing personal responsibility.

The low compliance with PPE usage directly contributes to the high risk of injury in maritime cargo handling. This is consistent with the findings of Muhammad et al. (2025), who reported that weak compliance and supervision are leading factors in maritime transportation accidents. Increased adherence to PPE standards could significantly reduce injuries such as slips, falls, and exposure to hazardous materials (S. Wahyuni et al., 2025). Setyawan et al. (2025) highlight the importance of continuous education for workers to improve their safety awareness and PPE compliance.

Furthermore, Xi et al. (2025) emphasize that a safety culture on board ships leads to better safety behavior among officers. This culture can be fostered by ensuring that safety protocols, including the proper use of PPE, are strictly enforced and continuously practiced, as argued by Mba (2025). The introduction of more stringent monitoring and penalty systems for non-compliance may also play a crucial role in improving PPE usage rates. Therefore, a robust enforcement mechanism combined with ongoing education is crucial in ensuring the safety of workers on board KMP Kalabia.

3.2. Lack of Understanding of Proper Cargo Lashing

A significant finding was the limited understanding of correct cargo lashing procedures among the crew. Only 40% of the crew demonstrated sufficient knowledge of how to secure cargo properly, which led to incidents such as unstable loads, overturned vehicles, and damage

to heavy equipment. Many crew members did not fully understand the potential hazards associated with improperly lashed cargo.

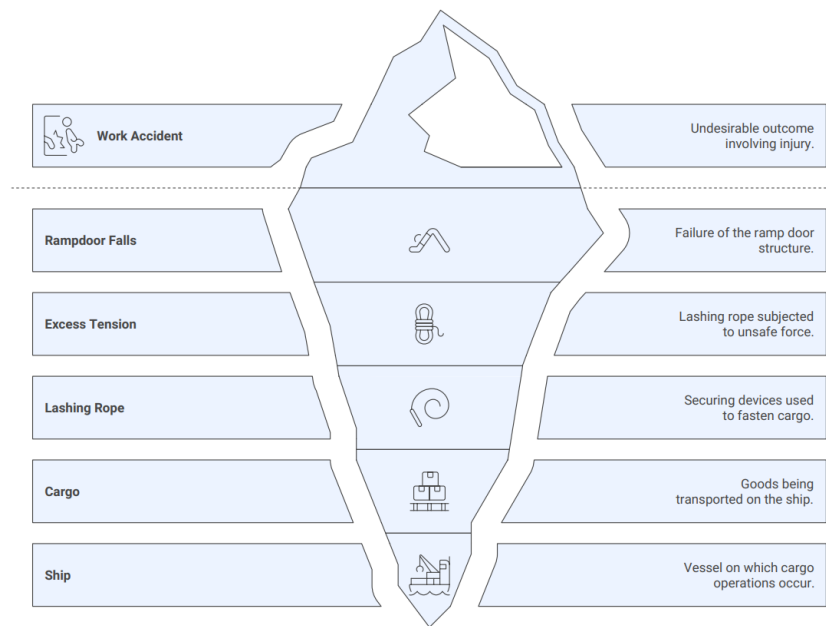


Figure 1. Improper cargo lashing (example case)

Figure 1 illustrates how improper cargo lashing can lead to an accident. Excess tension in the lashing rope can cause the ramp door to fall, leading to a work accident. The figure demonstrates the critical role of proper cargo securing, showing how small errors can escalate into significant incidents.

The lack of understanding of cargo lashing procedures is therefore a critical factor to address in preventing accidents. This finding is consistent with Dare and Ibietela (2025), who emphasize that appropriate lashing methods are essential for securing cargo on board. Proper training on how to handle and secure different types of cargo is essential to ensure the safety of both workers and the equipment used. Pambayun et al. (2024) likewise emphasize that risk mitigation measures, including training and adherence to procedures, are needed to reduce work accidents during ship operations in port.

Data-driven analyses of maritime occupational accidents also identify insufficient training and unsafe practices among the main contributing factors (Yu et al., 2025). To reduce this risk, specialized maritime education and training programs that focus on different types of cargo and their specific handling and securing techniques are needed (Yercan & Bolat, 2025). Therefore, a comprehensive training program on cargo securing is essential for improving safety standards.

3.3. Inadequate Supervision During Cargo Handling

It was found that supervision during cargo handling was inadequate. In several instances, supervision of equipment and cargo conditions was not carried out consistently. For example, ramp doors were not thoroughly inspected before use, increasing the risk of accidents such as ramp doors falling or vehicles falling into the sea.

Table 2. Supervision during cargo handling

Supervision Aspect	Percentage of Proper Supervision	Notes
Ramp door inspection	55%	Supervision is only conducted occasionally
Inspection of other equipment	50%	Much heavy equipment is not inspected
Monitoring of PPE usage	40%	Insufficient monitoring of PPE compliance
Monitoring of work environment	30%	Weather and port conditions are often neglected

Table 2 shows that supervision is inadequate, especially for the inspection of ramp doors and other heavy equipment. The lowest percentages of supervision were found in the monitoring of PPE usage and the work environment, indicating systemic gaps in ensuring safety during cargo handling.

The lack of consistent supervision is a key contributor to accidents during cargo handling (Mišković et al., 2022). This finding supports the need for stronger monitoring systems to ensure that safety procedures are followed at all times. The absence of regular checks on equipment such as ramp doors increases the chances of mechanical failures (Bye et al., 2021). Bose et al. (2025) also pointed out that communication technologies enabling real-time monitoring can enhance supervision effectiveness, particularly when human oversight is insufficient. Improving supervision, especially through the integration of technology, would reduce the risk of accidents and ensure compliance with safety protocols.

3.4. Ramp Door Falling into the Sea Due to Overloading

Ramp doors falling into the sea due to vehicle overloading was a common incident observed. Observations showed that the ramp door was often unable to support the weight of overloaded vehicles, leading to system damage and the ramp falling into the water. This typically occurred because routine checks on the ramp door system were not conducted and load capacity was not regularly assessed.

Table 3. Ramp door incidents

Type of incident	Number of cases	Percentage of incidents	Notes
Ramp door falling into the sea	7	50.0%	Caused by overloaded vehicles
Ramp door system damage	5	35.7%	Not routinely inspected
Lost cargo	2	14.3%	Cargo not properly secured
Total	14	100.0%	

Table 3 reveals that overloading is the primary cause of ramp door incidents, accounting for 50% of the cases. The lack of routine inspection and the failure to assess load capacity contribute significantly to these incidents. Regular inspection could help detect issues before they result in accidents.

Overloading and inadequate inspection are significant factors in causing ramp door incidents. E. Wahyuni et al. (2024) emphasized the importance of regular maintenance and ship safety practices. Bye et al. (2021) further stressed that failing to inspect critical systems increases the risk of equipment failure, and Karatuğ et al. (2023) noted that planned maintenance schedules are essential for preventing equipment failures. Adhering to load limits for all equipment, including ramp doors, is vital for safe cargo handling, and implementing a regular inspection schedule can help identify potential issues before they lead to accidents (Malindo et al., 2025).

3.5. Vehicles Falling into the Sea

Another frequent incident involved vehicles falling into the sea, caused primarily by a lack of adherence to safety procedures during cargo handling. Insufficient supervision during vehicle movements in and out of the ship was the primary cause of these accidents. Of the 10 recorded incidents, 7 were caused by inadequate monitoring during the cargo handling process.

Table 4. Vehicles falling into the sea

Type of incident	Number of cases	Primary cause
Vehicle falling into the sea	7	Inadequate supervision during handling
Vehicle damage	3	Incorrect vehicle securing procedures
Total	10	

Table 4 indicates that the primary cause of vehicles falling into the sea is inadequate supervision. Most incidents (70%) were caused by poor monitoring during cargo handling, which shows the need for better oversight and adherence to vehicle securing procedures.

The frequent occurrence of vehicles falling into the sea indicates a significant failure in enforcing cargo handling safety procedures. Poor supervision and non-compliance with safety standards are primary contributors to such accidents (Mišković et al., 2022; Yen et al., 2022). Strengthening supervision and ensuring proper vehicle securing techniques are essential for preventing these incidents. Real-time monitoring and tracking systems could help reduce these types of accidents and improve safety during cargo handling operations (Bose et al., 2025; Spadon et al., 2024).

4. CONCLUSION

This study aimed to analyze the factors causing work-related accidents during cargo handling on the KMP Kalabia ship and to identify prevention measures that can be implemented. The main findings include low compliance with the use of personal protective equipment (PPE), the crew's lack of understanding of proper cargo lashing procedures, inadequate supervision, and accidents related to ramp door overloading and vehicles falling into the sea. These work accidents are caused by non-compliance with safety procedures, insufficient training, and weak supervision during cargo handling operations. Therefore, to reduce accident risks, continuous safety training, strict enforcement of PPE usage, and the implementation of real-time monitoring technologies are required to strengthen supervision. In addition, routine inspections of heavy equipment such as ramp doors and tighter supervision at each stage of cargo handling should be conducted to prevent similar incidents in the future.

5. DECLARATIONS

Author contributions: M.K.: Conceptualization, Investigation, Writing – original draft; C.Y.A.N.: Methodology, Formal analysis; F.M.: Investigation, Data curation; O.C.K.: Validation, Writing – review & editing; A.M.: Supervision, Project administration, Writing – review & editing. Each author reviewed the manuscript and approved its submission.

Conflict of interest: The authors state that they have no conflict of interest to report.

AI usage statement: All parts of this manuscript, including the analysis and interpretation of the interview and observation data, were completed by the authors without the assistance of generative AI.

Ethical approval: The crew members, the Head of Occupational Safety, port supervisors, and port staff were informed about the purpose of the study before the interviews and took part voluntarily. Names of individuals are not reported, and accident records are presented only in aggregate form.

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Data availability: Interview transcripts, observation notes, and the summarized accident records are held by the authors and may be shared by the corresponding author upon reasonable request, subject to permission from the ship operator.

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