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Article

Optimizing The Use Of Safety Equipment to Prevent Workplace Accidents at KM. Kelud

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ABSTRACT

Operational activities on board a ship constitute a work environment with a high risk of workplace accidents. One of the challenges that is still frequently encountered relates to the crew's suboptimal compliance with safety procedures and the use of personal protective equipment (PPE), resulting in a significant potential for accidents. This study focuses on evaluating the implementation of workplace safety equipment on ships as well as examining crew behavior in support of workplace accident prevention efforts. A qualitative approach was applied in this research, utilizing observation, interviews, and documentation as data collection methods during a 12-month period of sea training aboard the KM. Kelud. Research findings indicate that the occupational safety system has been supported by the availability of safety equipment, standard operating procedures, and the regular conduct of safety meetings. However, its implementation in the field has not been consistent, as it remains influenced by individual awareness levels, established work habits, factors related to workplace comfort, and supervision that has not yet been optimized. Consequently, the use of workplace safety equipment has not been fully effective in reducing workplace accident rates, where human factors remain the most dominant cause. This situation highlights the need to strengthen safety culture through continuous training, improve the effectiveness of supervision, and enforce strict penalties to foster discipline among the ship's crew.

1. Introduction

Sea transportation functions as a fundamental component of global and domestic logistics, requiring vessels to maintain rigorous safety and navigational standards to ensure the continuous distribution of goods and passenger mobility (Indarti et al., 2026; Susanti, 2022). The maritime operational environment is inherently hazardous, demanding absolute readiness from the crew and the strict implementation of occupational health and safety protocols (Akbar, 2022; Rikardo & Saleh, 2023). To systematically mitigate these occupational risks, the utilization of Personal Protective Equipment (PPE) is strictly mandated by international conventions to protect seafarers from physical, chemical, and mechanical dangers (Hardiyono et al., 2026; Fahera et al., 2026). Despite the existence of comprehensive regulatory frameworks, practical adherence to these safety protocols frequently remains inconsistent during daily shipboard operations, leading to preventable incidents (Mashartanto et al., 2023; Chairmanudin et al., 2025; Tambunan et al., 2023). The Maritime Labour Convention (MLC) 2006 establishes comprehensive minimum standards designed to ensure safe, secure, and decent working environments for seafarers globally, explicitly categorizing occupational safety as a fundamental right (ILO, 2006; Lillie, 2008). Proper PPE utilization forms a critical pillar of this convention. However, human factors—including complacency, established unsafe work habits, and inadequate direct supervision—often compromise these safety measures (Rachmi & Kendek, 2023; Baihaqi et al., 2024). The fatal workplace accident that occurred aboard the MV. LUMOSO Hawari on April 12, 2024, serves as a stark illustration of these risks; during a routine deck cleaning operation, a crew member suffered a fatal fall after slipping on a pipe while their safety helmet was detached, underscoring the severe consequences of momentary safety lapses (Wahyurizaldi, 2024; Sais, 2023). KM. Kelud is a major passenger vessel operated by PT Pelayaran Nasional Indonesia (PELNI), serving high-mobility routes such as Tanjung Priok – Batam – Tanjung Balai Karimun – Belawan. With a gross tonnage of 14,665 GT, a length of 146.5 meters, and a massive carrying capacity of up to 2,607 passengers, the vessel requires its crew of approximately 150 personnel to perform highly demanding and continuous

maintenance tasks (Yutimura & Haris, 2023; Samuel, 2024). Ensuring absolute compliance with PPE protocols is crucial for maintaining operational integrity and preventing occupational accidents on such a large-scale vessel. Therefore, this study systematically evaluates the implementation of PPE on KM. Kelud, assessing its procedural compliance with MLC 2006 standards and its overall effectiveness in preventing workplace accidents among the deck crew.

2. Literature Review

2.1 Review of Previous Studies

The academic exploration of maritime safety highlights significant operational gaps in safety compliance across various commercial vessels. Baihaqi et al. (2024) demonstrated that despite the physical availability of PPE on the MV. Ibrahim Zahier, crew compliance remains critically low during daily operations due to poor safety awareness and insufficient disciplinary oversight. Similarly, Wahyurizaldi (2024) observed that engine room personnel on the SPOB ARS 09 frequently neglect protective gear, prioritizing task speed over personal safety. Sais (2023) and Samuel (2024) further indicate that seafarers frequently discard safety gear during routine maintenance tasks, misjudging the associated risk levels because they perceive the tasks as standard or low-risk. Furthermore, Yutimura and Haris (2023) established a direct correlation between a seafarer's positive perception of occupational health programs and their practical adherence to safety regulations, emphasizing the need for continuous education.

2.2 Concepts of Optimization and Safety Equipment

Optimization is defined as the systematic process of achieving the most effective outcome by utilizing available resources efficiently to meet specific operational goals (Siringoringo, 2005). Within maritime safety, this translates to maximizing the protective capabilities of available safety equipment. According to the Indonesian Dictionary (KBBI), safety equipment refers to devices designed to protect individuals from injury hazards. Personal Protective Equipment (PPE) comprises specific essential gear engineered to shield workers from exposure to workplace hazards (Tarwaka, 2014). Based on International Maritime Organization (IMO) standards, shipboard PPE includes safety

helmets (to prevent head impacts), safety shoes (for foot protection against heavy objects and slip hazards), protective gloves, safety goggles, ear protection (ear plugs and ear muffs for high-decibel engine environments), respiratory protection (masks for dust and chemical vapors), and safety harnesses for elevated work (IMO, 2018).

2.3 Workplace Accidents and the Maritime Labour Convention (MLC) 2006

Workplace accidents are defined as unexpected and unintended occurrences resulting from operational activities that cause physical injury, occupational illness, or material loss (Ervianto, 2005; Pratiwi, 2012). Safety at work requires a conscious effort to eliminate these hazards through strict operational procedures (Rachmatiah, 2012; Danuasgoro, 2019). The MLC 2006 framework explicitly demands that shipowners provide functional protective equipment and foster an environment that actively prevents occupational diseases and injuries (Exarchopoulos et al., 2018; Lohinov et al., 2024). Under Regulation 4.3 concerning health and safety protection, the convention integrates labor rights with maritime safety protocols to guarantee decent working conditions, emphasizing the flag state's absolute responsibility in enforcing non-discriminatory safety standards (Christodoulou-Varotsi, 2012; Carey, 2017; Yilmaz, 2025; Piñeiro, 2015).

3. Research Methodology

This research employs a qualitative descriptive methodology to systematically investigate social and operational phenomena within their natural environment, providing a deep understanding of crew behavior without relying on numerical data manipulation (Creswell, 2013; Merriam, 2009; Lim, 2025; Sugiyono, 2019). The empirical investigation was conducted aboard KM. Kelud during a 12-month sea project (praktik laut), allowing for continuous, direct observation of shipboard maintenance operations in various locations, including the Bintang 99 Batam Port and Tanjung Priok docking areas.

Data collection utilized a triangulated approach comprising participatory observation, structured interviews, and documentation (Umar, 2013; Fuad & Sapto, 2013; Saroso, 2017). Observational data focused on crew behavior during daily maintenance tasks (such as

chipping, painting, and mooring) and toolbox meetings, specifically monitoring the deployment and condition of PPE. Structured interviews were conducted with key operational personnel responsible for deck safety, including the Chief Officer (Mualim II Senior), Boatswain (Bosun), and Deck Storekeeper (Kasap Deck), to evaluate the availability of equipment, regulatory enforcement, and human constraints. Secondary data were gathered through a comprehensive literature review of official ship records, academic journals, and regulatory frameworks (Snyder, 2024; Klarin, 2024).

Data analysis was performed using the interactive model proposed by Miles, Huberman, and Saldana (2014), which involves three concurrent phases: data condensation (filtering raw observation and interview transcripts to focus strictly on safety compliance), data display (structuring the curated data into narrative descriptions for clear comprehension), and conclusion drawing/verification (verifying empirical findings against MLC 2006 literature.).).

4. Results and Discussion

4.1 Research Results

4.1 Research Results

The empirical data for this qualitative case study was collected through continuous participatory observation, structured interviews, and rigorous documentation over a 12-month sea project aboard KM. Kelud. As a primary passenger vessel operated by PT Pelayaran Nasional Indonesia (PELNI) with a gross tonnage of 14,665 GT and a capacity for 2,607 passengers, the operational demands on the vessel's crew are continuous and highly intensive. To ensure analytical transparency, the findings are systematically separated into direct field observations, equipment condition assessments, and interview-based explanations.

4.1.1 Administrative Safety Infrastructure and Preparations

During the observation period, crew behavior was systematically monitored across various deck operations. Observations revealed a sharp dichotomy in compliance depending on the crew's task perception and the presence of direct supervision. During high-risk maritime operations, such as mooring and heavy maintenance, compliance with Personal Protective Equipment (PPE) protocols was

notably high. Conversely, critical behavioral lapses were documented during routine tasks perceived as low-risk.

4.1.2 Systematic Assessment of Degraded PPE

A physical inspection of the active PPE inventory exposed specific logistical and material vulnerabilities. While the total volume of equipment met fundamental regulatory requirements, the qualitative condition of the gear in circulation was compromised. Unserviceable items were frequently stored alongside functional equipment without proper segregation. The condition of the degraded PPE, assessed against standard visual inspection criteria and company maintenance guidelines.

4.1.3 Interview-Based Explanations from the Command Structure

Structured interviews provided necessary operational context to the observational anomalies.

- a. **The Mualim II Senior (Chief Officer)** confirmed that while the vessel adheres to procedural safety standards, practical execution is frequently undermined by the crew's operational complacency. He noted that toolbox meetings are conducted daily, but crew members often treat them as administrative formalities rather than critical safety briefings.
- b. **The Bosun** explicitly identified physical ergonomics as the primary barrier to compliance. He explained that the

extreme heat, high humidity, and restricted mobility associated with heavy PPE incentivize crew members to remove the gear to maintain physical comfort and avoid fatigue during long shifts.

- c. **The Kasap Deck (Deck Storekeeper)** highlighted an administrative disconnect: crew members routinely check out equipment from the centralized store to satisfy formal logging requirements, but frequently fail to wear the items continuously on the deck. Furthermore, the Kasap Deck reported that the deck department has recorded zero major occupational accidents over the preceding three years.

4.2 Discussion

4.2.1 Regulatory Compliance Analysis (MLC 2006)

The procedural safety framework currently instituted aboard KM. Kelud aligns fundamentally with the theoretical mandates of the Maritime Labour Convention (MLC) 2006, specifically Regulation 4.3, which dictates occupational safety and health protections. The vessel successfully fulfills the primary regulatory obligation by providing necessary protective gear without financial burden to the seafarers. However, to distinguish between nominal compliance and actual operational effectiveness, a structured compliance assessment is detailed in Table 1.

Table 1. MLC 2006 Regulation 4.3 Compliance Assessment					
Regulatory Requirement (MLC 2006 Reg 4.3)	Actual Shipboard Condition	Evidence Source	Compliance Status	Risk Implication	Corrective Action Required
Provision of appropriate PPE	Equipment is physically provided and stored centrally.	Direct observation; Kasap Deck interview.	Compliant (Administrative)	None directly, provided gear is utilized.	Continue adequate provisioning and inventory logging.
Ongoing maintenance and inspection of PPE	Degraded and unserviceable PPE remains in active circulation without segregation.	Direct observation; PPE Condition Assessment.	Partially Compliant	Increases risk of injury due to equipment failure during a hazard event.	Implement strict, routine safety audits to confiscate and replace degraded gear.

Ensuring crew compliance with safety policies	Compliance is highly inconsistent; strongly dependent on direct officer supervision.	Direct observation; Chief Officer interview.	Non-Compliant (Operational)	Elevates occupational risk during unmonitored routine tasks.	Shift from supervised obligation to a continuous safety culture; enhance peer accountability.
Ergonomic and health considerations	Standard PPE causes severe thermal discomfort and fatigue in tropical climates.	Bosun interview; Direct observation.	Partially Compliant	Encourages unsafe behavioral workarounds (removing gear).	Source climate-appropriate, breathable PPE; optimize work-rest schedules.

4.2.2 Efficacy of PPE and Occupational Risk Implications

The interview data reported an absence of major workplace accidents involving the deck crew over a three-year period. While this serves as positive operational evidence, it cannot be interpreted as definitive proof of continuous PPE effectiveness, particularly given the observational data showing frequent non-compliance. Rather than concluding that the safety system is flawlessly effective, the evidence suggests that the strict enforcement of PPE during high-risk operations (e.g., mooring) successfully mitigates acute hazards. However, the sporadic compliance observed during routine tasks fundamentally reduces the crew's protective margin and increases occupational risk. The continued circulation of physically degraded equipment further diminishes actual protection, creating a latent vulnerability where the equipment may fail when exposed to mechanical or chemical stress.

4.2.3 Engagement with Prior Empirical Research

The findings from KM. Kelud corroborate and extend prior empirical research in maritime occupational safety. The observed dependency on direct supervision for PPE compliance confirms the findings of Baihaqi et al. (2024) and Yutimura & Haris (2023), who identified that human factors and authoritative oversight heavily dictate safety behavior at sea. Furthermore, this study extends the conclusions drawn by Sais (2023) and Wahyurizaldi (2024)—who noted that seafarers discard gear during routine tasks—by providing a specific ergonomic explanation:

thermal discomfort and fatigue in tropical maritime environments serve as primary catalysts for non-compliance. Unlike studies that frame non-compliance purely as a disciplinary failure, the KM. Kelud case highlights the critical intersection between equipment ergonomics, environmental stress, and safety culture.

5. Conclusion

A comprehensive analysis of the empirical data gathered aboard KM. Kelud yields several key conclusions regarding maritime occupational safety. First, the implementation of Personal Protective Equipment (PPE) is procedurally aligned with the global standards established by the Maritime Labour Convention (MLC) 2006. The vessel's management successfully executes the administrative prerequisites of occupational safety through the adequate provision of safety gear and the execution of daily safety briefings.

Second, despite administrative compliance, practical adherence to safety protocols remains inconsistent at the operational level. Crew compliance is heavily influenced by subjective risk perception and the presence of direct supervision, leading to the frequent circumvention of safety protocols during routine tasks. Furthermore, the continued circulation of physically degraded equipment undermines the overall protective capacity of the vessel's safety system.

Third, while the reported absence of major accidents provides operational evidence that PPE successfully mitigates hazards during high-risk activities, inconsistent compliance fundamentally increases long-term occupational

risk. The barriers to optimal safety are multifaceted, stemming not only from a lack of individual awareness but also from significant ergonomic challenges, such as thermal discomfort and fatigue, which disincentivize the continuous use of protective gear.

To bridge the gap between regulatory compliance and actual shipboard safety, interventions should move beyond purely punitive disciplinary measures and adopt a preventive, "just-culture" approach to safety management. The following recommendations are proposed:

Systematic Equipment Auditing and Procurement: Vessel management must overhaul equipment inspection protocols. Routine, rigorously documented safety audits should be implemented specifically to identify, confiscate, and immediately replace degraded protective equipment. Furthermore, procurement strategies should prioritize ergonomic, climate-appropriate PPE (e.g., breathable fabrics, proper sizing) to alleviate thermal discomfort and physical fatigue, thereby removing the primary physiological barrier to compliance.

Enhancing Organizational Safety Climate: Safety compliance should be reframed from a supervised obligation to an intrinsic organizational value. Daily toolbox meetings should be optimized to facilitate two-way safety communication rather than a one-way administrative briefing. Encouraging an open reporting culture for near-misses and equipment discomfort without fear of retribution will foster stronger peer-to-peer accountability.

Fatigue and Work-Schedule Management: Acknowledging that fatigue contributes to unsafe behaviors, management should evaluate work-rest schedules in conjunction with the physical demands of wearing heavy PPE in tropical environments. Implementing strategic rest breaks during strenuous deck operations can significantly improve both crew well-being and continuous safety compliance.

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