Maritime Technology and Society
Vol. 5(1): 30-39, February 2026
https://doi.org/10.62012/mp.vi.47793

Regular Research Article

The Importance of Lifeboat Winch Maintenance for the Safety of Crew and Passengers on the KM Sultan Hasanuddin Training Ship

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Abstract: The primary objective of this study was to evaluate the effectiveness of the lifeboat winch maintenance program and identify influencing factors on the KM Sultan Hasanuddin using a qualitative descriptive approach supported by 4 direct observations, interviews with 8 key crew members, and a review of 18 monthly logbooks. The results of the study show that the lifeboat winch maintenance program on KM Sultan Hasanuddin is not yet effective. The condition of the equipment shows degradation, such as rust on the wire rope and blurred nameplates, while the Planned Maintenance System (PMS) documentation is not available. While safety drills occur (2 per quarter), low passenger participation (averaging 30%) compromises collective preparedness. Internal obstacles include limited crew competence (only 2/8 trained), shortage of 3 critical spare parts, and maintenance schedule deviations (up to 4 weeks), while external constraints involve the marine environment, ship operator policies, budget cuts (a reported 25% reduction), and weak external supervision. The results emphasize the need for implementing a documented PMS, ensuring consistent preventive maintenance, and conducting integrated drills to achieve 100% preparedness, offering a basis for maritime education to develop practical learning modules and mandating an immediate management intervention to allocate necessary budget, enforce compliance with international maintenance standards, and conduct targeted training for the engineering crew.

Keywords: Training Ship, Lifeboat winch, Preventive maintenance, Maritime safety, Planned Maintenance System.

1. Introduction

Maritime safety and security are key policies that must be prioritized in shipping to support the smooth running of maritime transportation in Indonesia as an archipelagic country. Indonesia has sovereignty over its entire maritime territory, so the sea plays a significant role both as a unifying force for the nation and territory of the Republic of Indonesia, and as a priceless national asset and the future of Indonesia [1]. In this context, safety equipment such as lifeboat winches or lifeboat launching machines play a vital role [2]. Lifeboat winches are designed to enable the quick and safe launch of lifeboats in emergency situations, thereby ensuring the safety of the crew and passengers [3]. The training ship KM Sultan Hasanuddin, as an educational facility for training professional sailors, has a major responsibility to ensure that all safety equipment, including the lifeboat winch, is

Received: 2025-10-15; Accepted: 2025-11-23

always in good working order. While a ship is sailing, there can be unexpected emergencies that put people's lives in danger. Because of this, each ship needs to have safety tools to protect everyone on board. One important tool is a lifeboat, which is used to get people off the ship if something goes wrong [4]. All lifeboats must be built properly and have the right shape and size so that they stay stable when they are fully loaded with the allowed number of people and their gear [5]. All lifeboats must also be able to stay stable in the sea when they are fully loaded with the allowed number of people and their gear [6].

Failure to lower lifeboats due to problems with lifeboat winches has become a serious concern in the shipping industry, given its impact on the safety of crew and passengers [7], [8]. The following are examples of cases that have occurred, both in Indonesia and around the world. In 2019, the MV Nur Allya ship had an accident in the waters of Halmahera. The National Transportation Safety Committee (KNKT) report indicated that one of the factors that influenced the evacuation process was the failure to lower the lifeboat. Although the specific details regarding the cause of the lifeboat winch failure were not described in detail in the report, this highlights the importance of routine maintenance and inspection of lifeboat lowering equipment [9]. In another ship accident, a jam occurred during an evacuation drill [10]. The exercise was conducted on December 20 in 2018, while the MV Kartini Baruna was anchored in Jepara. During the lowering and operation of the lifeboat, everything went smoothly. After the lifeboat was operated, the captain ordered the exercise to be completed and the lifeboat to be raised back onto the ship. During the process of raising the rescue boat, the winch motor malfunctioned and was unable to raise the rescue boat. The bosun repaired part of the winch motor, but it still did not work. Due to a lack of understanding of rescue boat maintenance, damage to the winch motor was unavoidable, causing the boat drill to not run smoothly and be stopped.

In February 2013, the Thomson Majesty cruise ship suffered a fatal accident while conducting a lifeboat drill in the port of Santa Cruz de La Palma, Spain [11]. Five crew members were killed when a lifeboat fell from a height of about 20 meters into the sea. An investigation revealed that a mechanical failure in the winch system caused the lifeboat's support rope to break, resulting in the lifeboat's fall. This incident highlights the importance of regular inspection and maintenance of winch systems and other lifeboat lowering equipment. In April 2016, the cargo ship Glovis Maple experienced an incident in the waters of Taboneo, Indonesia. While the lifeboat was being raised back to its original position after a drill, the support rope (fall wire) suddenly broke, causing the lifeboat to fall from a height of approximately 13.5 meters into the water. Four crew members who were in the lifeboat suffered serious injuries. An investigation by the National Transportation Safety Committee (KNKT) found that the support cable had suffered significant damage due to a lack of lubrication and adequate maintenance. In addition, standard operating procedures were not followed correctly, and training for the crew was deemed inadequate. This case highlights the importance of routine maintenance and proper training in the operation of lifeboat lowering equipment. From the examples above, it is clear that failure to lower lifeboats is often caused by a lack of maintenance and routine inspection of the winch system and related components. In addition, the lack of training and understanding of the crew regarding the correct operating procedures also contributed to the incident. Therefore, it is very important for ship operators to ensure that all safety equipment, including the lifeboat winch, receives adequate maintenance and that the crew is given appropriate training to operate it. This study was conducted to highlight the importance of lifeboat winch maintenance on KM. Sultan Hasanuddin as a training ship that plays a strategic role in producing professional sailors. By focusing on effective maintenance, it is hoped that the safety of the crew and passengers can be guaranteed.

Lifeboat winch maintenance is a critical safety requirement strictly governed by international regulations, primarily SOLAS

Chapter III, Regulation 20, which mandates that all life-saving appliances be in working order and ready for immediate use [12]. The regulatory framework, further detailed in IMO resolutions like MSC.402(96), sets out detailed requirements for the thorough examination, operational testing, and repair of lifeboats and their launching appliances (winches and davits). Weekly and monthly inspections, along with annual dynamic testing of the winch brake and five-yearly overhauls, are core mandates. Recent studies, such as one published in 2025 on lifeboat maintenance issues, highlight those deviations from Standard Operating Procedures (SOPs), low crew comprehension, and limited maintenance time due to vessel schedules significantly impair operational readiness, leading to non-conformities and equipment damage[13]. Maintaining the winch involves meticulous attention to the brake mechanism, remote control systems, power supply, and hoist wire condition especially at the sheaves with falls to be renewed at least every five years [14].

Effective lifeboat winch maintenance must integrate a proactive risk management approach, consistent with principles found in ISO 31000 (Risk Management – Guidelines). While ISO 31000 is a general risk framework, its adoption in the maritime sector is crucial for enhancing safety management systems, as highlighted in current industry training and guides [15]. The ISO 31000 methodology encourages organizations to systematically identify, analyze, evaluate, and treat risks related to winch failure, moving beyond mere compliance. For instance, a 2023 journal article analyzing lifeboat accident data found that improper re-setting of the brake mechanism after testing was a key contributing factor in winch failure incidents. Applying the ISO 31000 framework, alongside strict adherence to SOLAS requirements and manufacturer instructions, ensures a holistic strategy that minimizes the likelihood and consequence of a winch failure, ultimately supporting the reliable deployment of lifeboats in an emergency.

2. Methods

This study uses a qualitative descriptive approach. This approach aims to understand phenomena in depth through observation, interviews, and analysis of data relevant to the maintenance of lifeboat winches or lifeboat launching machines on the KM Sultan Hasanuddin training ship. With this approach, the study focuses on the processes, meanings, and interactions that occur in the field without manipulating the existing variables. The qualitative descriptive approach was chosen because it is suitable for describing the reality and dynamics that occur in relation to lifeboat winch maintenance and its impact on the safety of the ship's crew and passengers. This study also emphasizes the interpretation of data collected from primary and secondary sources, thereby providing a comprehensive overview of the importance of maintaining safety equipment. With this approach, researchers can identify key issues, contributing factors, and relevant solutions for improving safety on board ships. This study is based on maritime safety management theory that integrates the maintenance of safety equipment as part of the ship safety management system (Safety Management System/SMS). In addition, predictive maintenance theory forms the basis for analyzing effective approaches to lifeboat winch maintenance. Practice-based learning theory is also relevant to this study, given that KM. Sultan Hasanuddin serves as a training ship that provides students or cadets with direct experience in understanding the importance of safety equipment maintenance.

The collected data were analyzed using qualitative analysis methods with the following steps: 1) Data Collection, collecting data from various sources, both primary and secondary, through interviews, observations, and documentation; 2) Data Reduction, the data obtained were then selected, chosen, and simplified to focus on information relevant to the research objectives; 3) Data Presentation: The reduced data is presented in the form of descriptive narratives, tables, or diagrams to facilitate understanding; 4) Drawing Conclusions: From the analyzed data, researchers draw conclusions about the importance of boat winch maintenance for the safety of the crew and passengers.

The provided methodology, which uses a qualitative descriptive approach combining interviews, observations, and documentation (data collection step), inherently relies on triangulation to ensure the reliability and trustworthiness of its findings, even though the term isn't explicitly used. Triangulation is the act of using multiple, independent sources of data to confirm a single finding, thereby mitigating the bias or limitations of any one source. For this study on the KM Sultan Hasanuddin, findings derived from crew interviews (subjective perception) must be cross-checked against the physical evidence from site observations (actual practice) and the records in the maintenance logs or Safety Management System (SMS) documents (official standards). If all three data sources converge on the same conclusion, for instance, regarding the frequency of winch brake checks the finding is considered robust and reliable. Beyond triangulation, the steps of Data Reduction and Data Presentation function as internal validation checks. Data Reduction ensures that the final analysis focuses only on information strictly relevant to the research objective (lifeboat winch maintenance and safety), filtering out noise and simplifying the interpretation process, which increases the focus and clarity of the results. Subsequently, Data Presentation in descriptive narratives and tables creates a transparent audit trail; readers and researchers can clearly see how the raw data led to the conclusions. This transparency improves the confirmability and coherence of the study, guaranteeing that the final conclusions about the importance of winch maintenance logically follow from the evidence collected and analyzed, making the research trustworthy for improving safety on board the training ship.

3. Results

Data analysis began with a general overview of the results of observations and interviews on the KM Sultan Hasanuddin training ship. This study focused on the condition of the lifeboat winch as one of the main safety devices. Based on direct observation, the physical condition of this equipment shows several important findings that need to be considered. Corrosion and dirt were found to be attached, as shown in Figure 1. This corrosion is clearly caused by exposure to a highly corrosive marine environment due to high salt content and humidity around the deck. Rusty wire ropes have the potential to experience a reduction in tensile strength so that they are no longer able to withstand loads according to specifications. If this condition is left unaddressed without regular lubrication and replacement, the possibility of the rope breaking during operation will increase. In terms of safety, this is very dangerous because wire rope failure can cause the lifeboat to fall suddenly or be unable to be lowered at all in an emergency.

Figure 1. Condition of the wire rope on the lifeboat wire drum

Figure 1 displays a wire rope wound around a lifeboat wire drum, showing noticeable signs of deterioration and corrosion. The rope's surface appears heavily covered in a brownish, rusty residue and dirt, suggesting a lack of sufficient lubrication and exposure to harsh marine or outdoor elements. This poor condition is a significant concern for operational safety, as corrosion severely weakens the rope's tensile strength and structural integrity, increasing the risk of failure during an emergency deployment of the lifeboat. Furthermore, the rusty deposit indicates a compromised protective layer and potential wear on the individual wires, underscoring the immediate need for a thorough inspection, maintenance, and likely replacement of the wire rope to ensure the lifeboat system remains reliable and compliant with safety regulations. In addition to the condition of the wire rope, the nameplate on the winch, as shown in Figure 2, which should contain technical specifications such as Safe Working Load (SWL), capacity, type, and other important data, appears blurred and rusty. This condition makes the technical information difficult to read. In fact, this information is the main guideline for operators to avoid operating the winch beyond its capacity limits. If the capacity limit is unknown or ignored, the risk of overloading increases. Other components such as bolts, nuts, and pulleys also show signs of wear and rust. Although the ship's deck appears clean and well-maintained visually, the condition of the main components of the lifeboat winch does not receive the same attention. This indicates that the focus of maintenance is more on environmental cleanliness rather than on the technical maintenance of safety equipment.

From interviews conducted by the research team, as shown in Figure 3, it was found that lifeboat winch maintenance on ships involves eight engine crew members, including the Chief Engineer, Engineers I–III, the Foreman, and three oilers.

Figure 2. Lifeboat winch nameplate

Meanwhile, operations during drills involve 8 deck crew members, namely the Captain, First Mate, Second Mate, Third Mate, Bosun, and three helmsmen (AB). In addition, there are 10 additional respondents consisting of passengers and instructors. Interestingly, most of them stated that they had never witnessed a lifeboat drill while on board the ship.

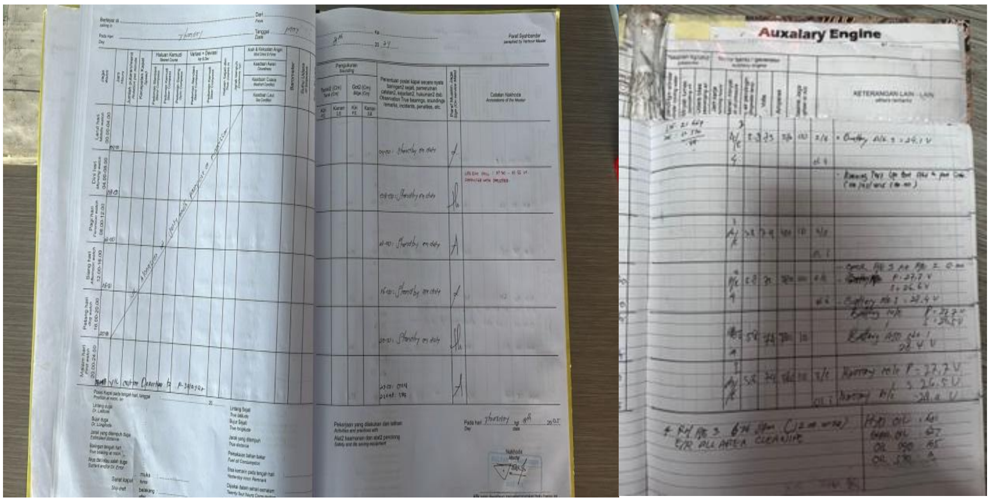

Figure 4. Deck (a) and Engine (b) Logbook Entries

Figure 4 shows the ship's deck and engine logbook, which indicates that drills were indeed conducted on May 8, 2024, and March 29, 2025. However, these activities were not followed or witnessed by passengers. This shows that the drills were carried out more to fulfill administrative obligations than to build collective preparedness on board. In general, the data shows that there is a gap between international safety standards (SOLAS, ISM Code, IMO Guidelines) and the actual conditions in the field. The physical condition of the lifeboat winch, which has deteriorated, the absence of Planned Maintenance System (PMS) documentation, and the limited involvement of passengers in drills indicate that the maintenance system has not been implemented optimally.

Table 1. Summarizing internal and external factors influencing maintenance effectiveness

Factor	Specific Factor	Influence on Maintenance Effectiveness
Internal Factors	Crew Competency & Training	Directly impacts the quality of routine checks, troubleshooting, and repairs.
	Planned Maintenance System (PMS)	Determines the scheduling, scope, and documentation of all maintenance tasks.
	Budgetary Allocation & Spares	Affects the ability to procure genuine spare parts and specialized tools promptly.
	Safety Culture & Leadership	Determines the priority given to safety equipment readiness over operational demands.
External Factors	Regulatory Compliance (SOLAS/IMO)	Mandates the frequency, standards, and methods of maintenance, setting the legal baseline.
	Manufacturer's Guidelines & Support	Provides the definitive technical specifications, tolerances, and procedures for the specific equipment.
	Port State Control (PSC) Inspections	Acts as an enforcement mechanism, using the threat of detention to drive compliance and maintenance diligence.
	Environmental Factors	The operating environment (e.g., corrosion from salt spray, extreme temperatures) accelerates degradation.

The effectiveness of lifeboat winch maintenance is determined by the interplay between critical internal and external factors. Internally, crew competency and a robust Planned Maintenance System (PMS) are paramount, as the quality of daily checks and procedural adherence directly impact operational readiness. However, these internal efforts are constantly checked against powerful external influences. Regulatory Compliance, particularly mandated by SOLAS Chapter III and enforced by Port State Control (PSC), sets the non-negotiable standards for maintenance frequency and scope. Furthermore, Manufacturer's Guidelines provide the essential technical blueprint for specific winches, while harsh Environmental Factors (like corrosion) act as a continuous challenge, often necessitating adjustments to the PMS to ensure that safety-critical components remain reliable despite operational conditions.

Maritime education institutions can effectively integrate lifeboat winch maintenance modules into cadet training curricula by adopting a competency-based and blended learning approach. This involves moving beyond theoretical SOLAS and LSA Code requirements to focus on hands-on, practical skills and risk management, mirroring the approach suggested by the IMO's revised STCW Convention. Modules should combine classroom instruction on regulatory frameworks (e.g., SOLAS Chapter III), failure analysis (using principles from ISO 31000), and manufacturer instructions, with mandatory simulator-based training for troubleshooting electrical and mechanical faults. Crucially, institutions must utilize the ship or training equipment like KM Sultan Hasanuddin for practical demonstration and performance assessment of critical tasks, such as brake mechanism inspection, lubrication, wire-fall renewal, and post-drill re-setting procedures, ensuring cadets achieve proficiency in both corrective and predictive maintenance techniques before graduating.

3.1. Analysis of the Effectiveness of Care Programs

The effectiveness of the lifeboat winch maintenance program is measured through three main indicators, namely the physical condition of the equipment, the documentation system, and the implementation of drills.

a. Physical Condition of Equipment

Observations show that the condition of the wire rope, nameplate, and other winch components are not well maintained. The presence of corrosion and rust indicates that preventive maintenance is not being carried out consistently [16]. Ideally, wire ropes should be lubricated regularly to prevent corrosion, while nameplates should always be legible so that operators are aware of the safe capacity. With these findings, it can be stated that maintenance is more corrective (performed after a problem occurs) than preventive (to prevent damage).

b. Documentation System

The effectiveness of the maintenance program can also be seen from the availability of Planned Maintenance System (PMS) documents [17]. Based on interviews, the crew claimed to perform routine maintenance, but could not produce official PMS documents. PMS should contain maintenance schedules, inspection records, and inspection reports. Without these documents, there is no written evidence that can be verified in audits or safety inspections. This clearly weakens the effectiveness of the maintenance program because there is no system that can be evaluated objectively.

c. Drill Implementation

According to the Deck and Engine Logbook, lifeboat drills were indeed conducted twice during the research period. However, the drills did not involve passengers. In fact, SOLAS Chapter III requires everyone on board to participate in evacuation drills [18]. Drills that only involve the crew are not effective enough to build comprehensive preparedness. Thus, even though drills are recorded, their effectiveness is still low because they do not meet standards. Based on these three indicators, the lifeboat winch maintenance program on KM Sultan Hasanuddin is considered ineffective. The equipment shows physical degradation, PMS documentation is unavailable, and drills are not conducted in accordance with international standards. This increases the risk of equipment failure during emergencies.

3.2. Internal and External Factors Affecting Care

From the results of observations and interviews, a few internal and external factors can be identified. Internal factors include crew competence in understanding the functions of the equipment but lack training in documentation, limitations in original spare parts so that some components are not replaced on time, inconsistent maintenance schedules, and a safety culture that has not been fully internalized. External factors include corrosive marine environmental conditions in the area of operation, ship operator policies that must balance educational and commercial functions, limited maintenance budgets, international regulations that have not been fully implemented, and weak external supervision that focuses only on administrative compliance during audits.

4. Discussion

Findings on KM Sultan Hasanuddin show that lifeboat winch maintenance still has a number of fundamental weaknesses. Rusted wire ropes, illegible nameplates, and the absence of Planned Maintenance System (PMS) documentation indicate that maintenance has not been carried out in accordance with international standards. These results are in line with previous studies [19], which confirms that wire rope is a critical component in lifeboat launching systems. Damage caused by corrosion can significantly reduce safety factors, especially in emergency operations. These findings are reinforced by previous research [20], which states that ships with scheduled preventive maintenance have lower accident rates than ships that only perform corrective maintenance.

The absence of PMS on KM Sultan Hasanuddin is also consistent with findings regarding the importance of documentation of maintenance on training ships [21]. Without documentation, maintenance activities are difficult to evaluate and audit, resulting in a decline in quality. This condition becomes even more critical because training ships should set an example of best practices in safety equipment maintenance. In general, the literature emphasizes that the reliability of lifeboat winches is determined by three main factors, namely: 1) Scheduled preventive maintenance; 2) Official documentation through PMS; 3) Involvement of all parties in safety drills. These three aspects were found to be weak on KM Sultan Hasanuddin. Therefore, the results of this study show consistency between the conditions in the field and previous theories and studies on the causes of safety equipment failure on ships.

The conditions on the KM Sultan Hasanuddin are also relevant to a number of major accidents in the shipping world caused by lifeboat winch failure. The 2013 Thomson Majesty case in Spain is one of the most fatal examples. Five crew members died when a lifeboat fell from a height of 20 meters. The investigation revealed that the mechanical failure of the winch was due to inadequate maintenance and inspection. This condition is similar to the wire rope on KM Sultan Hasanuddin, which showed signs of corrosion, a clear indication of weak preventive maintenance. The 2016 Glovis Maple case in Taboneo, Indonesia, is also relevant. The National Transportation Safety Committee (KNKT) found that the lifeboat support rope broke due to heavy wear that went undetected due to minimal lubrication and inspection. Four crew members suffered serious injuries. These findings show a similar pattern to the condition of the wire rope on KM Sultan Hasanuddin. The incident on MV Kartini Baruna in 2018 further emphasizes the importance of crew understanding of maintenance. During the exercise, the winch engine jammed when the lifeboat was being raised back onto the ship. The root cause was the crew's lack of understanding of maintenance procedures. Interviews on the KM Sultan Hasanuddin revealed similar conditions: the crew knew how to operate the winch, but did not have the official PMS documentation to guide them. All three cases showed a recurring pattern: lack of preventive maintenance, weak documentation, and limited understanding among the crew. This confirms that the conditions on the KM Sultan Hasanuddin are not unique, but part of a global problem in the shipping industry.

The results of the investigation also revealed a gap between international regulations and their implementation in the field. According to SOLAS Chapter III, every ship must ensure that its lifeboat system is always ready for use through routine inspections and periodic drills. Drills must involve everyone on board, including passengers. However, on the KM Sultan Hasanuddin, drills only involved the crew and were not witnessed by passengers. This condition shows that regulations are only fulfilled as a formality. The ISM Code also requires PMS documentation as proof that maintenance is carried out systematically. The absence of PMS on this ship shows non-compliance with international standards. This weakens the safety culture on the ship because there is no system to ensure consistency in maintenance. In the context of audits and inspections, this weakness also has serious implications. The ship may be declared non-compliant with safety standards if the maritime authorities conduct a thorough inspection. This not only affects the reputation of the ship, but also the maritime educational institution that oversees it.

5. Conclusions

Based on the results of a study on the importance of lifeboat winch maintenance on KM Sultan Hasanuddin, as well as data analysis and discussions that have been carried out, it can be concluded that the lifeboat winch maintenance program on KM Sultan Hasanuddin has not been effective. This is evident from the physical condition of the equipment, which has deteriorated (corrosion on the wire rope, blurred nameplates, rusty bolts and nuts), the absence of Planned Maintenance System (PMS) documentation, and the implementation of drills that do not involve passengers. Maintenance tends to be corrective rather than preventive, so it does not fully comply with SOLAS and ISM Code standards. The implementation of lifeboat winch maintenance is influenced by a number of internal factors, such as the competence of the ship's crew, which emphasizes technical aspects without supporting documentation, limited availability of original spare parts, inconsistent maintenance schedules, and a weak safety culture. External factors include a corrosive marine environment, ship operator policies that focus more on commercial functions than education, budget constraints, and weak external supervision and oversight. These conclusions indicate that to ensure the safety of crew, passengers, and cadets, fundamental improvements are needed in both technical maintenance and managerial aspects through the implementation of PMS, strengthening of safety culture, and the involvement of all parties in safety drills.

Based on the research results and conclusions above, several recommendations are proposed, namely for the Ship and Crew to carry out preventive maintenance of lifeboat winches in accordance with IMO and SOLAS guidelines, including routine lubrication of wire ropes and replacement of worn components. Implement a documented Planned Maintenance System (PMS) to ensure that every maintenance activity can be evaluated and audited. Furthermore, safety drills should be conducted with the involvement of all ship crew, passengers, and cadets to ensure more comprehensive preparedness.

A key policy implication is the urgent need to mandate and standardize advanced, practical competency-based training (CBT) for all seafarers involved in life-saving appliance (LSA) maintenance, beyond the current STCW basic requirements. This policy must require maritime education and training (MET) institutions and shipping companies to integrate specialized, winch-specific modules focusing on failure analysis, complex troubleshooting, and the rigorous documentation of tasks, with a particular emphasis on the critical procedures for brake adjustment and dynamic testing. This shift ensures that seafarers are not just aware of the regulations but are verifiably proficient in executing manufacturer-specific maintenance protocols, thereby directly mitigating human error the single greatest risk factor identified in recent maritime safety analyses and strengthening the vessel's overall Safety Management System (SMS).

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