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Article

Analysis of Lifeboat Maintenance to Support Crew Safety on Board MV. Aliyah Pratama: A Compliance Assessment Against Solas Chapter III

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ABSTRACT

Non-compliance in the execution of lifeboat maintenance procedures significantly heightens operational risks and impairs evacuation effectiveness during maritime emergencies. This study evaluates the conformity of lifeboat maintenance and operational readiness on board the bulk carrier MV. Aliyah Pratama against the specific requirements of the Safety of Life at Sea (SOLAS) Chapter III Regulation 20 and the Life-Saving Appliances (LSA) Code. Utilizing a qualitative descriptive case study approach, data were collected over a 12-month period at Cilegon Anchorage through direct field observations, structured interviews with three key deck officers, and systematic reviews of the ship's Planned Maintenance System (PMS) documentation. A compliance matrix was developed to benchmark observed mechanical and operational conditions against regulatory standards. The findings reveal critical discrepancies, including mechanical stiffness in the starboard gear brake, active corrosion on wire falls and winches, hardened watertight door seals, and expired emergency rations. Furthermore, abandon-ship drills demonstrated a lack of situational awareness and muster list comprehension among the crew. Root cause analysis, structured via the Ishikawa (Fishbone) framework, indicates that these non-conformities stem from superficial, visually limited inspections, high operational workloads, an aggressive saline environment, and shore-based procurement delays. The study concludes that the vessel's current maintenance execution functions primarily as an administrative formality rather than a rigorous functional safeguard. Corrective recommendations prioritize the implementation of deep-technical functional testing, expedited supply-chain logistics for safety equipment, and mandatory pre-drill tactical briefings to restore optimal evacuation.

1. Introduction

Sea transportation forms the backbone of global supply chains, necessitating that commercial vessels maintain highly integrated structural and navigational systems to ensure operational safety (Indarti et al., 2026). Maritime operations are inherently exposed to severe risks arising from extreme environmental conditions and technical mechanical failures (Hardiyono et al., 2026). Emergency scenarios at sea critically threaten human lives, vessel property, and the marine environment, requiring the execution of uncompromising safety management protocols and absolute crew readiness (Fahera et al., 2026).

To mitigate these maritime risks, adherence to international safety standards is paramount. The Safety of Life at Sea (SOLAS) 1974 convention, specifically Chapter III, comprehensively regulates life-saving appliances (LSA) and arrangements, mandating the strict provision, continuous maintenance, and functional readiness of all safety equipment (Mashartanto et al., 2023). Lifeboats serve as the ultimate primary survival craft, utilized for mass evacuation when a vessel is critically compromised and no longer habitable (Chairmanudin et al., 2025). According to the LSA Code established by the International Maritime Organization (IMO, 2017), every commercial vessel must be equipped with survival crafts that are maintained in a permanent state of operational readiness. Therefore, lifeboat maintenance must be executed rigorously to prevent mechanical failures during gravitational deployment (Rifaldh Hardhiyanto Syahputra, 2024).

Despite the existence of a robust international regulatory framework, empirical literature indicates that lifeboat maintenance implementation frequently fails to meet established statutory standards (Agung, 2023). Previous studies have documented that compliance failures are often driven by suboptimal implementations of the Planned Maintenance System (PMS), severe operational time constraints, and insufficient technical comprehension among crew members (Tambunan et al., 2023). These administrative and technical deficiencies degrade survival craft readiness, elevating evacuation risks during actual emergencies (Rachmi & Kendek, 2023). The critical necessity of lifeboat functionality was demonstrated by the

National Transportation Safety Committee (KNKT) investigation of the KM Mutiara Sentosa I fire in 2017, which verified that the physical condition and mechanical readiness of lifeboats are absolute determinants of successful mass rescue operations at sea.

While prior research has broadly identified human error and logistical delays as maintenance barriers, there remains a distinct scholarly gap regarding the systematic, criterion-by-criterion assessment of maintenance deficiencies against exact SOLAS and LSA Code provisions. Previous investigations have largely relied on narrative descriptions of maintenance failures without structurally mapping them to specific regulatory mandates or conducting structured root cause analyses. Consequently, this study makes a novel technical and managerial contribution by explicitly evaluating formal compliance through a structured matrix and employing a Root Cause Analysis (RCA) framework to dissect the operational constraints.

The primary objectives of this study are twofold: (1) to evaluate the formal compliance of lifeboat maintenance and operational readiness on board the MV. Aliyah Pratama against the specific requirements of SOLAS Chapter III Regulation 20, and (2) to systematically identify the root causes of observed non-conformities using the Ishikawa (Fishbone) analytical framework.

2. Literature Review

2.1 Synthesis of Previous Studies

The academic exploration of maritime safety highlights recurring operational gaps in lifeboat maintenance across various commercial vessels. Research by Tambunan et al. (2023) on the MV. Maximus I concluded that the primary factors hindering optimal maintenance are the crew's lack of technical comprehension and chronic delays in the shore-based procurement of essential spare parts. Similarly, Rachmi and Kendek (2023) analyzed the KMP. Kirana II, revealing that survival craft maintenance is rarely performed periodically and is exacerbated by crew apathy during emergency drills.

The correlation between maintenance quality and survival rates was emphasized by Fuad Thantowie Nourrisman (2024), asserting that rigorous lifeboat maintenance transcends administrative obligations and represents a

concrete effort to protect human lives. Bahtianul (2020) identified that short-voyage operational schedules severely restrict the time available for deck officers to perform comprehensive maintenance, necessitating a more efficient distribution of tasks. Furthermore, Refaya et al. (2024) discovered severe mechanical hazards on the MT. Mitra Kemakmuran—specifically a nearly severed Fall Preventer Device (FPD) rope—underscoring the fatal risks of poor inspection discipline and the necessity of rigorous compliance monitoring. Synthesizing these studies reveals a consistent pattern: maintenance failures are rarely due to the absence of a PMS, but rather its superficial execution driven by high workloads and a lack of functional testing.

2.2 Concept of Marine Maintenance & Reliability

In industrial and maritime engineering contexts, maintenance extends beyond simple preservation; it encompasses scheduled, predictive, and corrective activities designed to ensure machinery functions reliably according to its original design parameters and statutory safety limits (Riswan, 2024). Effective maintenance requires comprehensive oversight to execute necessary repairs, adjustments, and component replacements to sustain planned operational states. Within the maritime sector, these principles are operationalized through the Planned Maintenance System (PMS), a mandatory safety management tool that dictates routine scheduling, inspection protocols, and the rigorous functional testing of life-saving machinery to prevent latent mechanical failures.

2.3 Regulatory Framework: SOLAS and the LSA Code

The Safety of Life at Sea (SOLAS) convention, formulated by the IMO, is the primary international instrument governing navigational safety. SOLAS Chapter III regulates Life-Saving Appliances and Arrangements. Specifically, Regulation 20 details the legal obligations for the "Operational Readiness, Maintenance, and Inspections" of survival crafts. Key provisions include Regulation 20.3 (maintenance ensuring continuous readiness), Regulation 20.6 (weekly and monthly visual and functional inspections), and Regulation 20.7 (routine maintenance of falls and release gear).

Furthermore, Regulation 19 mandates regular emergency training and abandon-ship drills to ensure crew competency.

The technical specifications of these appliances are dictated by the IMO's Life-Saving Appliances (LSA) Code. While the Code outlines general stability, buoyancy, and construction parameters, specific dimensions depend on the vessel's certification. For instance, the Totally Enclosed Lifeboats on the MV. Aliyah Pratama (measuring 6.5 meters) are certified to fulfill the specific capacity requirement of 25 persons while providing absolute watertight and weather protection as mandated by LSA Code Section 4.6 (IMO, 2017).

3. Research Methodology

3.1 Research Design and Setting

This study adopts a qualitative descriptive case study methodology, designed to provide an in-depth understanding of operational phenomena and compliance behaviors within a natural maritime context (Lim, 2025). The empirical investigation was conducted on board the bulk carrier MV. Aliyah Pratama, managed by PT. Transcoal Pacific, over a 12-month period from July 2024 to June 2025. Fieldwork was concentrated while the vessel was anchored at Cilegon Anchorage, allowing for comprehensive, uninterrupted evaluations of the ship's safety infrastructure and maintenance routines.

3.2 Data Collection and Triangulation

To establish high data validity and credibility, the study utilized a rigorous triangulation strategy, cross-verifying evidence across three primary sources:

1. **Field Observations:** Direct, participatory observations were conducted during scheduled monthly lifeboat inspections and abandon-ship launching drills. Key focal points included the physical condition of mechanical components (wire ropes, winches, davits, gear brakes, door seals) and crew coordination during emergency deployment.
2. **Semi-Structured Interviews:** In-depth interviews (lasting 30-45 minutes each) were conducted with $N=3$ key deck personnel directly responsible for safety management: The Chief Officer

(management oversight), the Third Officer (PMS execution), and the Boatswain (deck crew supervision). The interview protocol focused on operational constraints, PMS execution depth, and spare part procurement. Informed consent was obtained prior to all interviews.

3. Documentation Review: Official ship records were systematically reviewed, including the vessel's PMS checklists, Lifeboat Launching Standard Operating Procedures (SOP), Drill Reports, and LSA inventory logs.

3.3 Data Analysis Protocol

Data analysis followed the continuous interactive model (Miles, Huberman, & Saldana, 2014), encompassing Data Condensation (filtering raw transcripts to focus strictly on SOLAS compliance indicators), Data Display (structuring findings into a regulatory compliance matrix), and Conclusion Drawing/Verification.

To determine root causes, the Ishikawa (Fishbone) diagram was utilized. Addressing conceptual clarity, the analysis categorized sources of operational discrepancies into five coherent domains: *Man* (human competence), *Method* (procedures and inspections), *Material* (physical component degradation), *Environment* (marine conditions), and *Management* (organizational and logistical support).

4. Results and Discussion

4.1 Compliance Assessment Matrix

Observations of the MV. Aliyah Pratama's two Totally Enclosed Lifeboats (port and starboard) revealed a divergence between documented PMS completion and actual mechanical readiness. To systematically evaluate these findings, a compliance matrix (Table 1) was developed, benchmarking observed conditions against specific SOLAS and LSA Code requirements.

Table 1. Lifeboat Maintenance and Operational Readiness Compliance Matrix

Component / Activity	Regulatory Requirement (SOLAS / LSA Code)	Observed Discrepancy	Evidence Source	Operational Implication
Gear Brake Mechanism	SOLAS Ch III, Reg 20.6: Monthly inspections shall verify that survival crafts and launching appliances are in good order.	Starboard gear brake exhibited severe mechanical stiffness during the lowering test.	Field Observation (Lowering Test); Third Officer Interview.	Impairs controlled gravitational descent; risk of davit jamming during evacuation.
Wire Falls & Winches	SOLAS Ch III, Reg 20.4 & 20.7: Falls used in launching shall be inspected periodically with special regard for areas passing through sheaves.	Active corrosion documented on the port side boat winch and wire falls.	Field Observation; PMS Maintenance Log (Chipping/Greasing applied post-discovery).	Reduces structural integrity of load-bearing components; heightens risk of wire snapping.
Lifeboat Door Seals	LSA Code 4.6.2: Totally enclosed lifeboats shall be watertight when all	Rubber door seals on the port lifeboat were hardened and cracked due to	Field Observation; Inventory check.	Compromises the capsule's watertight integrity; risks water ingress

	entrances and openings are closed.	UV/weather exposure.		during heavy seas.
Emergency Rations	LSA Code 4.4.8: Lifeboat equipment shall include watertight receptacles containing food and water rations, strictly monitored for expiration.	Several emergency food and water rations were found to have passed their official expiration dates.	Documentation Review (Inventory Log); Field Observation.	Reduces life-sustaining capabilities for crew survival post-abandonment.
Abandon-Ship Drills	SOLAS Ch III, Reg 19.3.3: Drills shall ensure crew familiarity with duties, involving the preparation and simulated launch of lifeboats.	Sluggish coordination; specific deck personnel lacked muscle memory regarding muster list duties and release gear operation.	Field Observation (Monthly Drill); Chief Officer Interview.	Delays deployment time; heightens the risk of panic and uncoordinated evacuation under duress.

4.2 Root Cause Analysis (Fishbone Framework)

To move beyond descriptive findings, the Ishikawa framework was applied to identify the systemic causes of the non-conformities outlined in the compliance matrix.

1. Man (Human Factors): Interviews with the Chief Officer confirmed that a segment of the junior crew lacks ingrained familiarity with emergency protocols. This translates into hesitation during drills, where crew members do not automatically execute muster list roles without repetitive verbal commands.
2. Method (Procedural Factors): While the PMS exists, the Third Officer noted that routine inspections are predominantly visual. The deep, functional testing required to assess complex internal mechanisms (e.g., the stiff gear brake) is frequently bypassed to expedite checklist completion.
3. Material (Component Factors): The physical degradation of components, specifically the hardening of rubber seals and the oxidation of wire ropes, directly degrades deployment capabilities.
4. Environment (Marine Conditions): The aggressive saline environment, characterized by high humidity and continuous saltwater exposure at anchorages, exponentially accelerates the corrosion rates of metallic launch systems and UV degradation of polymers.

5. Management (Organizational & Logistical Support): The Boatswain highlighted severe operational time constraints driven by high cargo-handling workloads, leaving minimal dedicated time for meticulous safety maintenance. Furthermore, the shore-based management exhibits bureaucratic delays in procuring requested spare parts (e.g., replacement door seals and rations), paralyzing the vessel's ability to restore equipment promptly.

4.3 Discussion

The empirical evidence indicates a distinct fracture between the theoretical mandates of SOLAS Chapter III Regulation 20 and the operational reality aboard the MV. Aliyah Pratama. The presence of active corrosion on critical load-bearing launch systems and stiff mechanical brakes explicitly compromises the reliable deployment of the lifeboats.

Consistent with the findings of Refaya et al. (2024) regarding mechanical hazards on commercial vessels, the implementation of the PMS on this vessel currently functions more as an administrative shield than an operational safeguard. The tendency to execute superficial visual inspections fails to identify latent mechanical failures until functional testing (such as a lowering drill) forces the issue. This procedural weakness is compounded by crew fatigue and the prioritization of commercial

cargo duties, aligning with Bahtianul's (2020) observations on short-voyage constraints.

Furthermore, the sluggish coordination during abandon-ship drills demonstrates that the mere existence of life-saving hardware is insufficient. If the human operators lack the ingrained reflex and technical competency to prepare the davits and release gears efficiently, the evacuation process is severely jeopardized. While the observed defects do not definitively prove that the lifeboat would catastrophically fail in an emergency, they undisputedly elevate the operational risk and erode the safety margins mandated by international maritime law.

5. Conclusion

The execution of Operational Readiness, Maintenance, and Inspections for the lifeboats on board the MV. Aliyah Pratama is formally documented through the Planned Maintenance System (PMS) and routine drills. However, a criterion-by-criterion assessment against SOLAS Chapter III Regulation 20 and the LSA Code reveals that the system has not achieved an optimal state of readiness. Documented physical discrepancies include mechanical stiffness in the starboard gear brake, active corrosion on wire ropes and winches, deteriorated watertight door seals, and expired emergency rations. Furthermore, crew coordination during launching drills remains inadequate due to a lack of muster list familiarity. Root cause analysis confirms that these deficiencies are driven by superficial, visually limited technical inspections, excessive deck workloads, an aggressive marine environment, and logistical delays in shore-based spare parts procurement.

To restore and maintain the safety margins mandated by SOLAS, the following prioritized corrective actions are recommended:

1. Methodological Shift in PMS Execution (Immediate): The Chief Officer must enforce a transition from superficial visual checks to comprehensive functional testing during monthly inspections, specifically ensuring the smooth mechanical operation of gear brakes and release mechanisms.
2. Crew Competency and Drill Optimization (Short-term): To eliminate hesitation and improve deployment speed, all future abandon-ship drills must be preceded by mandatory tactical briefings outlining

specific muster list duties, followed by a strict post-drill evaluation to build crew muscle memory.

3. Logistical Supply Chain Improvement (Long-term): Shore-based company management must streamline procurement logistics to ensure the rapid, unhindered delivery of critical LSA spare parts (e.g., rubber seals, pyrotechnics, and rations), preventing administrative delays from compromising shipboard safety.

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