Optimizing Lifeboat Maintenance to Ensure They Are Suitable for Use in The Event of an Accident

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Abstract

Maritime transport supports 80% of global trade, but inconsistent lifeboat maintenance threatens emergency safety, especially on Indonesian short voyage vessels such as the MV Tanto Bersinar. This study identifies factors inhibiting lifeboat maintenance optimization and proposes procedures in accordance with SOLAS. Using a qualitative descriptive method, purposive sampling targeted key crew (Third Officer, Third Engineer) for 12 months through interviews, observations, literature studies, and documentation. Data analysis followed reduction, presentation, and conclusion. The results found davit corrosion, wire rope friction, no engine test-run, incomplete PMS documentation, and limited short voyage time as gaps to SOLAS III/20 and MSC.402(96). Optimization requires scheduled operational tests, certified training, and spare parts stock. The conclusion recommends strengthening the PMS and authorized servicing for lifeboat readiness, minimizing evacuation risks.

Keywords: *Davit; Lifeboat; Maintenance Optimization; Lifeboat and SOLAS.*

I. INTRODUCTION

Maritime transportation continues to be the backbone of international trade and global economic development, as approximately 80% of world trade volume is transported by ship (BPS, 2024)(World Trade Organization, 2023). In the context of Indonesia as an archipelagic country, maritime transportation plays a crucial role in connecting domestic and international markets, supporting the national economy, and driving the industrialization process through an extensive shipping route network (BPS, 2024)(World Bank, 2022). However, on the other hand, high dependence on this mode also emphasizes the importance of shipping safety, especially through the readiness of safety equipment such as lifeboats, liferafts, lifebuoys, lifejackets, and immersion suits as regulated in SOLAS 1974 Amendment 2020, Chapter III (Lifesaving Appliances and Arrangements) (Islam, 2024)(Nursing et al., 2022).The main problem in shipping practices is the low consistency of lifeboat maintenance even though some shipping companies have increased their fleet and ship capacity (Fernando et al., 2022). Many companies only focus on capacity expansion without paying adequate attention to safety equipment maintenance, resulting in lifeboats that are not ready for use when an accident occurs (Reyhanandi & Sari, 2023).

Factors that are often cited as causing less than optimal maintenance include the lack of understanding and skills of ship crews in the use and maintenance of lifeboats, inconsistent maintenance programs, and limited spare parts and time constraints due to high sailing intensity (Pratama et al., 2022) (Sundame et al., 2022). In addition, several studies have shown that lifeboat failures do not only originate from technical factors, but also human factors, such as procedural errors during drills, lack of training, and a weak safety culture at the operational level (OCIMF, 2021).On the other hand, SOLAS 2020 and the ISM Code provide a clear regulatory framework regarding the maintenance of safety equipment, including the company's obligation to conduct periodic inspections, immediate repairs if damage is found, and routine training for ship crews (Nursyamsu et al., 2022) (OCIMF, 2021). However, implementation in the field is often not fully in sync with international standards, especially in lifeboat maintenance practices that include greasing davit components and lifeboat cables, periodic replacement of fall wires (every 5 years), inspection of the lifeboat's longitude and hull, and calibration of the release system and engine (Reyhanandi & Sari, 2023) (Sundame et al., 2022) (Sundame et al., 2022).

This mismatch between regulations and operational practices indicates a gap in knowledge and discipline, making lifeboats less suitable for use in emergencies requiring evacuation (Sundame et al., 2022) (Sundame et al., 2022). Based on these phenomena and problems, the purpose of this study is to identify factors that cause suboptimal lifeboat maintenance on board ships and explain lifeboat maintenance procedures in accordance with SOLAS standards and best practices in the international shipping industry (Fernando et al., 2022) (Sundame et al., 2022). This research has a high urgency because the safety of crew lives is highly dependent on the readiness and reliability of lifeboats as the main evacuation tool, especially in the context of Indonesia which has great potential in the maritime and shipping sector (World Bank, 2022) (BPS, 2024). The novelty of this study lies in its focus on optimizing lifeboat maintenance on Indonesian commercial vessels, by summarizing empirical evidence from several recent studies on lifeboat and life raft maintenance (Reyhanandi & Sari, 2023), while integrating the perspectives of SOLAS 2020 regulations, the ISM Code, and operational practices on Indonesian ships that still need to be strengthened (Nursyamsu et al., 2022).

II. METHODS

This research is a qualitative descriptive study that aims to understand social phenomena in depth through individual experiences related to optimizing lifeboat maintenance in sea cadet practices at a shipping company. According to Sugiyono (2020), qualitative research is conducted intensively in the field with long-term participation of researchers, careful note-taking, and reflective data analysis to gain a holistic understanding. Ardiansyah et al. (2023) explain that qualitative research focuses on explaining natural phenomena through individual perspectives, while Creswell (2021) emphasizes an exploratory process to explore the meaning of specific groups. This paradigm aligns with the research objective of systematically examining information to gain new knowledge about lifeboat maintenance, as stated by Arib et al. (2024) and Waruwu (2023).The main instruments include interviews, observations, literature studies, and documentation as primary and secondary data sources. Interviews were conducted in person or virtually via Zoom, telephone, or WhatsApp to obtain respondents' views and experiences regarding lifeboat maintenance practices, as described by Ardiansyah et al. (2023) and Waruwu (2023). Observations relied on visual observation or cameras to record behavior and activities in the field in a structured or freehand manner, according to Ichsan & Ali (2020) and Fitriani (2022). Literature studies involved critical reviews of articles, journals, and documents for theoretical frameworks, according to Pusparani (2021) and Melinda & Zainil (2020), while documentation analyzed repeated written sources without modification, such as those from Rimelda Sibuea & Sukma (2021) and Shalsabila & Ningsih (2023). Sudaryono (2018) added that these instruments facilitated effective goal achievement.The study population included ship crews and cadets during a 12-month sea practice at selected shipping companies, with a purposive sample consisting of key informants such as lifeboat maintenance officers and field observers.

This sampling technique ensured an in-depth representation of natural phenomena in the field, in accordance with Emzir's (2012) qualitative principles that emphasize holistic data analysis from the subjects involved. The sample was drawn based on direct involvement with lifeboat maintenance, avoiding broad generalizations but focusing on specific cases, as recommended by Sugiyono (2020) for intensive research.Data analysis followed the reduction, presentation, and conclusion model with stages of transcribing oral data into text (Azizirrohman et al., 2020), familiarization to understand data characteristics (R. Fernando, 2023), organization for ease of access, and development for accuracy. The presentation used a flowchart for logical flow (Tuasamu et al., 2023), category design for grouping (Sulistyo & Oktavianto, 2020), and supporting images for illustration. Descriptive conclusions were made qualitatively based on the processed data, ensuring validity and anti-plagiarism, as per Emzir (2012) and Creswell (2021).The procedure begins with preparation at the sea practice site, followed by data collection through face-to-face/virtual interviews, direct observation, literature review, and documentation over a 12-month period. Data is iteratively reduced and analyzed in the field to produce cohesive conclusions regarding lifeboat maintenance optimization, with cross-validation of sources. This approach is systematic and accountable, as Sugiyono (2020), Sudaryono (2018), and Waruwu (2023) emphasize for qualitative field research.

III. RESULT AND DISCUSSION

Overview of Research Object

The research location was taken This research was conducted on the container ship MV. Tanto Bersinar, an Indonesian-flagged merchant ship with a GT of 13,235 and an overall length of 161.85 meters. This ship operates routinely on the domestic route Teluk Lamong–Belawan, with an average voyage duration of one week per trip, so it is categorized as a short voyage vessel. The ship is crewed by 22 people, with a division of safety duties where the Third Officer is responsible for the inspection, maintenance, and documentation of all LSA (Life Saving Appliances) equipment, while the Third Engineer plays a role in ensuring the readiness of the lifeboat engine, davit system, and launching mechanism.

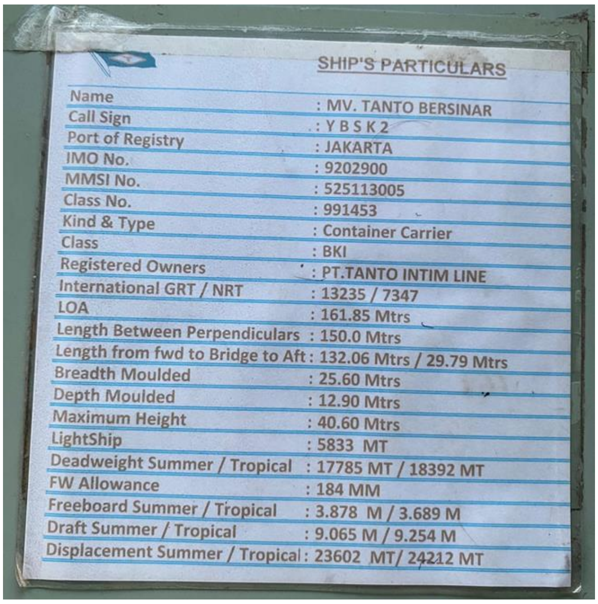

Fig 1. Ship Particular

Data Presentation

Table 1. Observation Results of Lifeboat Components

No	Observation Aspect	Frequency of Findings	Information
1	Davit corrosion	3 of 6 inspections	*Hook plate*& drum shows early rust/erosion
2	Wire rope drags / makes a "creaking" sound	2 lowering exercises	Indication of insufficient lubrication or poor wire winding
3	Lifeboat engine test run	0 times in 6 weeks	Hampered by short voyage schedule
4	Full gear release test	0 times in the period	Just a basic visual & functional check
5	Maintenance documentation	There are some but some are incomplete	*Log*partially empty machine, minimal photos
6	Availability of spare parts	*Requisition*1 incident	Limited stock of hook pin/gear

Table 2. Standard operating procedure (SOP) for lifeboat component maintenance

Frequency	Maintenance Activities	Person responsible
Weekly	Visual inspection of lifeboat, wire rope, hull	Third Officer & Bosun
Monthly	Inspection of release gear without load, check of survival equipment	Third Officer
Monthly	*Test run*lifeboat engine (ideal)	Engineer III
3 months	Corrosion cleaning, complete lubrication, davit system verification	Third Officer & Third Engineer
6 months	Davit & winch structure inspection	Chief Officer & Third Officer
Annual	Thorough inspection as per*plan maintenance system* (PMS)	All related departments
5 years	*Overhaul release gear*& load test	Official Service Provider

Table 3. Results of Interviews withThird Officer(Third Lieutenant)

No	Interview Questions	Third Officer's Answer
1	What is the general condition of the lifeboat based on your routine checks?	In general the lifeboat is in good condition, but some parts such as the davit and hook-plate are starting to show light to moderate corrosion.
2	How often do you perform physical checks on lifeboats?	Visual checks are carried out weekly as per*plan maintenance system* (STDs), but in-depth examinations are usually only performed every 3 months.
3	Is lowering of lifeboats done routinely?	Not always. Drilling is usually done, but full lowering is sometimes not done due to time constraints.
4	What are the most common obstacles you encounter during lifeboat drills?	*Wire rope*It often feels tight and sometimes makes a "creaking" sound. This interferes with the lowering process.
5	What is the condition of the survival equipment in the lifeboat?	Complete and up to standard, but still needs to check the expiration date of drinking equipment, rations, and signals.
6	What is documentation*maintenance plan*system (PMS) for lifeboats is complete?	Not yet. Some sections, such as inspection photos and test-run records, are often blank or lack detailed documentation.
7	Whether*standard operating procedure*(SOP) and lifeboat maintenance checklist are running according to standards?	Already available*standard operating procedure*(SOP), but its implementation does not always match the implementation time due to busy ship operations.
8	Have you ever done a load test on the release gear?	No, because load tests can only be performed by authorized service providers.
9	How do you coordinate with the Engineer III in maintaining the lifeboats?	Pretty good. I checked the safety equipment, while the Third Engineer focused on the engine and davit system.
10	In your opinion, what needs to be optimized most in lifeboat maintenance?	More consistent drill execution, scheduled machine test-runs, and improved documentation quality*maintenance plan*system (PMS).

Table 4. Results of Interview with Third Engineer (Machinist III)

No	Interview Questions	Answer*Third Engineer*
1	What is the condition of the lifeboat engine based on your routine inspection?	The engine is in good condition, but since it has never been fully test-run, its actual performance cannot be confirmed.
2	Are lifeboat engine test runs conducted periodically?	Visual inspections were performed, but full test-runs were not routinely conducted due to the vessel's operating time constraints.
3	What mechanical parts do you find most often problematic?	*Wire rope*It often runs dry and sometimes jams. Additionally, some davit lubrication points require extra attention.
4	Has the davit system ever experienced any problems during the drill?	There was a loud rubbing noise on the wire drum, but after cleaning and re-lubricating the problem subsided.
5	How do you handle wire rope when it makes a “cracking” sound when lowering?	I stopped the lowering process, checked the condition of the drum and wire, then re-lubricated it before continuing drilling.
6	Are there any critical spare parts that are often in short supply?	Yes. Spare wire rope, davit grease, and hook pins are not always available on board.
7	Have you ever carried out a thorough inspection of the lifeboat davits and engines?	Routine basic inspections are performed, but thorough inspections such as load tests should only be performed by certified technicians.
8	What is the lubrication condition of the davit and winch system?	Tends to dry out quickly, especially when operating in humid and salty areas. Requires more frequent maintenance.
9	How effective is your coordination with the Third Officer?	It's quite effective. We complement each other's inspection results to ensure the lifeboats are ready for use.
10	In your opinion, what are the main priorities in optimizing lifeboat maintenance?	*Test run*Machines must be routinely serviced, wire ropes must be kept in optimal condition, and in-depth inspections need to be carried out more frequently.

*Third Officer*The Third Officer (Third Officer) stated that although administrative maintenance of the Plan Maintenance System (PMS) was in place, operational tests (engine test runs and lifeboat lowering) were often not carried out on time due to ship operational factors. The Third Engineer (Third Engineer) confirmed that basic engine inspections had taken place but that a full operational test had never been conducted. Both parties agreed that critical spare parts and limited port time were the main obstacles to optimizing lifeboat maintenance.

Table 5. Comparison of Ship Standard Operating Procedures (SOP) with IMO/SOLAS Regulations

Aspect	MV Tanto Bersinar Practice	IMO / SOLAS Regulations	Main Gap
*Test run*lifeboat engine	No full test has been performed within 6 weeks of observation	SOLAS Reg. III/20 & MSC.402(96) require routine operational testing. (IMO)	Test-run implementation is not consistent
Davit & release gear corrosion	Corrosion found; release gear only tested for basic function	MSC.402(96) requires an annual, 5-year inspection; section 6.2/6.3. (IMO)	*Maintenance*structural not yet in full interval
Maintenance documentation	*Checklist*routine is there, but test/test-load logs and photos are minimal	SOLAS Reg. III/36: on-board maintenance manual, complete records. (dma.dk)	Documentation is less detailed
Availability of spare parts	*Spare parts*critical sometimes not available quickly	MSC.402(96) demands availability of spares and service providers. (irclass.org)	Spare part inventory needs to be increased
Personnel competency	The Third Officer & Third Engineer are responsible, there is no evidence of specific certification yet	MSC.402(96) requires certified personnel to be authorized service providers. (irclass.org)	Verification of personnel certification needs to be strengthened

Observation data shows that although the ship operates a planned maintenance system (PMS), the operational and structural implementation of lifeboat maintenance does not fully meet requirements. Interviews confirmed that the main obstacles are ship operational time and spare parts availability. Comparison with international regulations revealed priority gaps that must be addressed, particularly in lifeboat engine test runs, release gear overhauls, documentation, and personnel competency.

Data analysis

Table 6. Analysis of Observation Findings on Regulations

Observation Findings	International Regulations	Summary Analysis
Corrosion on the davit	MSC.402(96) Section 6.2	Needs more in-depth inspection and recoating.
*Wire rope*drag	SOLAS III/20	Indication of insufficient lubrication and risk of lowering failure.
Machine not test-run	SOLAS III/20.7	Operational test obligations have not been fulfilled.
*Release gear*only visually checked	MSC.402(96)	Does not meet functional & load test standards.
Incomplete documentation	SOLAS III/36	Notes*plan maintenance system*(PMS) needs to be corrected for treatment validity.

Data analysis was conducted by combining the results of observations, interviews, the ship's Standard Operating Procedure (SOP), and international regulations to identify factors causing suboptimal lifeboat maintenance on the MV. Tanto Bersinar. Observations revealed several technical issues, namely corrosion on the davit, wire rope drag during lowering, and the absence of a test run of the lifeboat engine during the observation period. These issues indicate that mechanical maintenance has not fully met the comprehensive inspection standards as required by MSC.402(96) (International Maritime Organization, 2016). In addition, the release gear was only inspected visually without a load test, even though regulations stipulate that functional testing and load tests are the main requirements to ensure reliability in an emergency.

Table 7. Analysis of Interview Results

Theme	Interview Results	Analysis
Operational hours	The docking time is too short	Becoming a major obstacle to test-run & drill.
lifeboat engine	Visual check only	The risk of engine failure during an emergency increases.
Wire rope	Needs re-lubrication	Less than optimal mechanical maintenance.
Documentation	Incomplete	Indicates gaps in PMS management.

Interviews with the third officer and third engineer revealed that the biggest obstacle stemmed from time constraints due to the short-voyage operating pattern, often delaying engine test runs and lifeboat lowering drills. This aligns with previous research findings that suggest time constraints and operational pressures are common causes of suboptimal safety equipment operational testing on merchant vessels.(Care & Power, 2025). In addition, the plan maintenance system (PMS) documentation was found to be inconsistent, which has the potential to cause inaccurate evaluation of equipment condition, even though documentation is a mandatory part of SOLAS Regulation III/36 (International Maritime Organization, 2014). Through an analysis of the ship's Standard Operating Procedure (SOP), it was apparent that the maintenance procedures were essentially in accordance with the company's planned maintenance system (PMS), but their implementation was not fully aligned with international regulations. The main gaps included: (1) inconsistent engine test-run implementation, (2) incomplete release gear inspections, (3) davit structural inspections not meeting thorough examination standards, and (4) the absence of authorized service providers for the five-yearly inspection. These conditions could have a direct impact on the lifeboat's readiness in an emergency, as reflected in several mechanical findings in the field.

Table 8. Recommendations for Optimizing Maintenance

Parameter	Detailed Recommendations	Reference Standard	Eligibility Target
David& lifeboat structure	In-depth corrosion inspection, thickness measurement, recoating, replacement of worn components	MSC.402(96) 6.1–6.3	Corrosion-free and fully operational structure
Steel wire rope	Manufacturer's standard lubrication, wear check, replacement if drag or diameter reduced	SOLAS III/20 & LSA Code	*Wire*moves smoothly without abnormal sound
lifeboat engine	*Test run*full minimum 1x/month, check oil, filter, starter, cooling system	SOLAS III/20.7	Engine starts <10 seconds, stable idle
Release mechanism (Release gear)	Functional testing + periodic load test, reset test, hook pin check	MSC.402(96)	The open/close mechanism works without fail.
PMS (plan maintenance system) documentation	Complete checklist, photo documentation, time recording and test results	SOLAS III/36	All maintenance activities are documented
Drill & operational test	Controlled lifeboat lowering, evacuation simulation at least 1x/month	SOLAS III/19	Crew is competent and familiar with procedures
Authorized Service Provider	Involvement of certified technicians for 5-yearly inspections	MSC.402(96) Res.1	Inspection meets global standards
Crew training	LSA & davit maintenance certification, internal refreshment training	IMO Model Course	*Crew*have adequate technical competence

To achieve optimization in accordance with mechanism and regulatory standards, lifeboat maintenance must be directed towards priority actions, namely increasing the depth of technical inspections, consistency of operational testing, and ensuring competence and documentation. This can be achieved through rescheduling critical maintenance, improving the integrity of plan maintenance system (PMS) documentation, and additional training for responsible personnel. This optimization aligns with safety recommendations from research.(Kirana et al., 2023)which emphasizes the importance of regular operational tests and in-depth inspections to maintain the readiness of lifeboats on merchant ships.

Discussion

What factors cause suboptimal maintenance of lifeboats on ships?- The main factor causing suboptimal lifeboat maintenance on the MV. Tanto Bersinar is the limited operational time due to the short voyage pattern. The short berthing time means that operational testing processes, including engine test-runs, full lifeboat lowering, and release gear inspections, are often not carried out according to standards. In addition, several technical findings such as corrosion on the davits and dragging wire ropes indicate that routine inspections are more visual in nature and do not follow the thorough inspection as mandated by MSC.402(96). This condition is exacerbated by incomplete plan maintenance system (PMS) documentation, so that maintenance cannot be evaluated accurately.Other factors stem from the competence and availability of certified maintenance services. While ship officers may have operational experience, thorough inspections and load tests should involve authorized service providers in accordance with International Maritime Organization (IMO) regulations. Limited critical spare parts and a lack of advanced technical training for Life Saving Appliances (LSA) are also additional factors that reduce the effectiveness of lifeboat maintenance. All of these factors indicate a gap between the ship's Standard Operating Procedure (SOP) and international standards, necessitating ongoing optimization efforts.

What are the procedures for maintaining lifeboats on a ship?- The lifeboat maintenance procedures on the MV. Tanto Bersinar generally refer to the Planned Maintenance System (PMS) program. Inspections are carried out in stages, starting from weekly, monthly, quarterly, and annual inspections. The Third Officer is responsible for checking the physical condition of the lifeboat, wire rope, survival equipment, and release gear, while the Third Engineer handles the lifeboat engine and davit system. Ideally, this procedure includes lubrication of moving parts, structural inspection, verification of locking mechanisms, and engine test-runs. However, in practice, some operational procedures such as lowering lifeboats and full engine testing are not always carried out due to time constraints and the ship's operational conditions.Based on SOLAS III/20 and MSC.402(96) regulations, maintenance procedures should include thorough examination, operational testing, and periodic load tests. However, implementation on board indicates that release gear load testing, in-depth component inspections, and engine performance verification have not been fully implemented in accordance with international standards. This results in lifeboat maintenance being carried out administratively but not yet achieving the level of mechanical reliability required for emergencies. Thus, existing procedures need to be improved, especially in the aspects of operational testing and technical documentation.

IV. CONCLUSION

This study found that the lifeboat maintenance on the MV. Tanto Bersinar was suboptimal due to limited operational time during short voyages, which prevented engine test-runs, full lowering, and in-depth inspections of the release gear, as well as technical findings such as davit corrosion and wire rope drag, as compared to SOLAS III/20 and MSC.402(96) standards. Interviews with the Third Officer and Third Engineer confirmed gaps in incomplete PMS documentation and the need for critical spare parts, which reduced emergency evacuation readiness despite the existence of basic SOPs. Optimization is recommended through rescheduling routine maintenance, training certified crew, and involving authorized service providers for five-yearly load tests, to align with IMO regulations. However, the limitations of this study are its qualitative descriptive nature, focused on a single vessel, making the results difficult to generalize. It relies on a 12-month observation period without quantitative statistical data. Suggestions for further research include multi-vessel comparative studies or a mixed-methods approach with LSA failure metrics for stronger empirical validation. Practically, the research's implications encourage Indonesian shipping companies to strengthen their PMS, monthly drills, and safety culture to minimize the risk of maritime accidents.

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