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Article

Optimization of Deck Crane Maintenance to Facilitate the Loading and Unloading Process on MV. Tanto Keluarga

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A B S T R A C T

This research was conducted to analyze the implementation of deck crane maintenance, identify operational obstacles, and formulate optimization efforts to improve the cargo handling performance on MV Tanto Keluarga. The study utilized a qualitative descriptive approach supported by quantitative operational data, gathering evidence through 12 months of observation during sea practice, ship documentation analysis, and semi-structured interviews. The informants included the Chief Officer, Bosun, and an Able Seaman. The findings reveal that deck crane maintenance was significantly delayed due to the high pressure of the ship's port schedule, which disrupted the Planned Maintenance System (PMS). Consequently, the lack of timely lubrication led to critical wire rope wear and slewing gear corrosion. This chain of component degradation directly caused a heave-up system disruption, resulting in a documented 4-hour operational downtime during cargo discharging in Tobelo Port. Optimization interventions were systematically carried out through strict pre-operational visual inspections, massive re-lubrication, and schedule calibration between cargo operations and preventive maintenance. Following these interventions, subsequent loading and unloading operations recorded zero technical downtime, demonstrating a tangible improvement in equipment reliability and operational efficiency.

1. Introduction

The operational efficiency of commercial shipping relies heavily on the reliability of shipboard cargo-handling equipment. To prevent cargo-handling downtime and ensure operational safety, ship equipment must meet stringent seaworthiness conditions. This encompasses materials, construction, machinery systems, and lifting appliances, as mandated not only by the Government of the Republic of Indonesia (Regulation No. 51 of 2002) but also by international standards such as the International Safety Management (ISM) Code and manufacturer maintenance guidelines (Government of the Republic of Indonesia, 2002; International Maritime Organization, 2018).

One of the vital instruments for container vessels operating in secondary ports without adequate shore-side facilities is the deck crane (Robinson et al., 2020). Deck crane operations involve lifting heavy materials (hoisting), horizontal shifting (slewing), and precision load placement (Abdullah et al., 2023). Given the severe dynamic loads inherent in these operations, ILO Convention No. 152 requires all lifting appliances to be thoroughly inspected and certified safe before use (International Labour Organization, 1979). Negligence in complying with Planned Maintenance System (PMS) procedures often leads to catastrophic mechanical failures. For example, the MV LGH Prosper experienced a severe boom crane failure in 2022 due to a wire rope fracture, which occurred because the component had exceeded its manufacturer-recommended running hour threshold of 5,000 hours without adequate replacement (Abil Bachri A et al., 2024).

This study focuses on the MV Tanto Keluarga, a container ship operating on a highly congested domestic route (Surabaya-Makassar-Ternate-Tobelo-Weda). Preliminary observations indicated a severe inefficiency in cargo handling due to an unexpected deck crane downtime. This breakdown was triggered by wire rope wear and a lack of lubrication in the slewing gear. While previous studies have described maintenance issues in isolation, there remains a critical research gap in understanding how external operational pressures—such as tight port schedules—directly induce PMS compliance failures, component degradation, and subsequent operational downtime. Therefore, this study aims to analyze the implementation of deck crane maintenance, identify the specific operational constraints, and formulate evidence-based optimization actions to improve loading and unloading performance on the MV Tanto Keluarga.

2. Literature Review

2.1 Optimization and Maintenance Concept

In the context of maritime asset management, optimization refers to the strategic scheduling of maintenance, reliability improvement, downtime reduction, and spare-part readiness to ensure compliance with the Planned Maintenance System (Andari, 2017). Maintenance encompasses a series of planned activities—such as inspections, calibrations, and component replacements—designed to restore and maintain heavy equipment performance according to manufacturer standards (Danuasmoro, 2002). Ideal maintenance execution guarantees extended component life cycles, minimizes unnatural depreciation, and ensures full compliance with occupational safety regulations (Setiawan et al., 2026; Park & Lee, 2025).

2.2 Deck Crane Failure Modes and Cargo Handling

Based on Law Number 17 of 2008, loading and unloading are the central activities in transferring commodities between ship and shore (Republic of Indonesia, 2008; Triatmodjo, 2010). A hydraulic-electric deck crane converts 440 V electrical voltage into hydraulic fluid pressure to drive hoisting, slewing, and luffing motions (MacGregor Group, 2003). The reliability of these systems is frequently compromised by specific failure modes, including lubrication degradation, active corrosion, and dynamic load cycling. The wear rate of critical components, such as the wire rope and slewing gear, is directly affected by these mechanical stresses and strict wire rope inspection criteria must be adhered to in order to prevent sudden fractures (Abdullah et al., 2023; Robinson et al., 2020).

2.3 Characteristics of Loading and Unloading Equipment (Deck Crane)

Based on Law Number 17 of 2008, loading/unloading activities are the central activity in moving commodities from ships to land or vice versa (Republic of Indonesia, 2008; Triatmodjo, 2010). Deck cranes play a major role in this cycle, especially for ships that dock at secondary ports without container crane facilities. The hydraulic-electric type crane unit operates through synchronous motor power that converts the electrical voltage (440 V) into hydraulic fluid pressure to drive the hoisting (up-and-down load), slewing (360-degree rotation), and luffing (boom arm up-and-down motion) (MacGregor Group, 2003). The wear rate of crane components, such as wire rope, sheave block, and slewing gear, is directly affected by static and dynamic workloads during the load lifting process (Abdullah et al., 2023; Robinson et al., 2020).

2.4 Synthesis of Past Literature

Previous scholars have extensively explored the maintenance of cargo-handling equipment. Studies by Suratni Ginting (2021) and Fahlevi Al Bahari et al. (2025) identified crew unfamiliarity and indiscipline as the primary causes of lashing equipment failures and compromised cargo safety. Similarly, Fany Amin Nur Rofiq et al. (2025) and Teguh Prasetyo et al. (2023) highlighted that indiscipline regarding PMS execution and failed visual inspections routinely result in hydraulic valve damage and cargo claims. Furthermore, Abil Bachri A et al. (2024) proved that neglecting running-hour thresholds directly causes wire crane failures. While these studies collectively position PMS discipline and visual inspection as determinants of equipment reliability, they largely treat human error as an isolated variable. This paper synthesizes these findings to address a distinct gap: exploring how systemic operational pressures (e.g., tight port schedules) force crew members to delay PMS routines, thereby accelerating physical wear and causing measurable downtime.

3. Research Methodology

This research employs a qualitative descriptive approach, which is deemed highly suitable as the qualitative inquiry is reinforced by quantitative operational evidence (such as exact downtime durations and PMS delay records) extracted from the ship's logs. The investigation was conducted during the researcher's 12-month sea practice aboard the MV Tanto Keluarga.

Data was gathered from three key informants directly responsible for crane operations: the Chief Officer (managing deck operations, >10 years of experience), the Bosun (technical execution, 8 years of experience), and an Able Seaman (field implementation, 5 years of experience). These participants were purposively selected for their technical authority and daily interaction with the equipment. Primary data was collected through participatory observation and semi-structured interviews (Purhantara, 2010; Romdona et al., 2025). Secondary data was extracted from the Deck Cargo Crane Logbook, PMS matrix, and Main Port Schedule (Rahmawati et al., 2025).

The data analysis followed an interactive process adapted from Miles, Huberman, and Saldana (2014). This included data condensation (coding interview transcripts into themes such as "schedule pressure" and "maintenance delays"), data presentation through operational tables, and conclusion drawing. The interview evidence was continuously triangulated against the PMS matrix and logbook entries to establish credibility and dependability (Saldana, 2014; Dahri et al., 2022).

4. Results and Discussion

4.1 Operational Conditions and Obstacles of Deck Crane

MV Tanto Familia, a 6812 GT cargo ship made by Ningbo Boda Shipyard (2019), relies on a pair of MacGregor GL4028-2 Electro-Hydraulic deck cranes to support logistics activities in the eastern region of Indonesia. Based on a review of the Deck Cargo Crane Logbook on November 28, 2024 at Tobelo Port, the ship experienced a delay (downtime) in discharging activities that lasted for 4 effective hours, from 09:12 to 13:12 local time. The mechanical damage caused the paralysis of crane number 1 and forced activities to continue in a marathon manner until the operational work deadline ran out at 17:00.

Visual inspections documented a reduction in the wire rope diameter and significant frictional wear. Furthermore, the slewing gear exhibited active corrosion and degraded grease, inferred directly from the presence of heavy rust deposits and a reported increase in the motor's operational temperature. This condition caused the motor to fail in executing rotary movements without excess friction, triggering the heave-up system to stall.

The results of the post-damage field inspection found structural anomalies in the main components. First, hoisting wire rope is indicated to experience frictional wear and diameter shrinkage due to failure to provide protective lubricant in a timely manner. Secondly, the slewing gear bearings show symptoms of excess moisture accompanied by active corrosion due to the thinning of the grease layer between the gears. This condition causes the motor to fail to execute the rotary movement without friction, thereby increasing engine heat and triggering a stall of the heave up system.

4.2 Analysis of PMS Implementation Delays

Cross-tracing of the Planned Maintenance System (PMS) matrix and the Main Port Schedule confirmed that the damage to the deck crane was not caused by technical negligence alone, but rather the fruit of commercial operational pressure. In October and November 2024, ships are scheduled to return to back-to-back cycles of zero downtime charter cruises. In short, the port stay ratio (an average docking time of 1-2 days per visit) takes up all the man-hours of the deck crew to supervise the loading and unloading of cargo. As a result, quarterly preventive work such as periodic lubrication, dead-eye thimble inspections, and wire tension calibration that would ideally be recorded in the Deck Cargo Crane Maintenance Checklist is severely delayed.

The results of the interview with the Chief Officer and Bosun affirmed that the crew only acted curatively (checking after the system refused to respond to its hydraulic function).

Table 1. Summary of Interview Results

	General Information	Remarks
	Respondent Name	Ilham Jaya
	Departments	*Chief officer*
	Interview Date	December 12, 2024
	Location	Coral Jamuang, Madura
Yes	**Interview Questions**	Answer
1.	How is the implementation of *deck crane* maintenance, is it in accordance with the ideal maintenance time in the field?	The implementation of *deck crane* maintenance has basically followed the *Planned Maintenance System* (PMS) schedule which is carried out every three months. However, in practice, the implementation has not always run according to schedule because it is influenced by the congestion of loading and unloading activities, and the limited operational time of the ship.
2.	How does the heavy loading and unloading activity affect the *crane deck maintenance schedule*?	Heavy loading and unloading activities cause *crews* to focus more on cargo operations than *maintenance*. As a result, some maintenance work that should have been carried out according to the PMS schedule was delayed.
3.	What factors cause a disturbance in the *heave up deck crane system*?	The disturbance is influenced by the high intensity of crane use , the implementation of maintenance that has not run optimally, and the condition of several components that have experienced wear.
4.	What actions are taken after a disturbance is found on the *deck crane*?	*The crew* inspected the parts of *the crane* that experienced disturbances, carried out lubrication, and submitted repair requests and spare parts needs to the company, as well as evaluation of the *main port* to be more optimal.
5.	After maintenance, does the *deck crane*'s performance improve when loading and unloading?	Yes, after maintenance, *the crane* is more normal when used and the loading and unloading time barrier is reduced

General Information	Remarks
Respondent Name	Ilham Jaya
Departments	*Chief officer*
Interview Date	December 12, 2024
Location	Coral Jamuang, Madura
6. What evaluations and recommendations need to be made so that the implementation of *deck crane* maintenance can run more optimally in the future?	The implementation of maintenance needs to be carried out more disciplined according to the PMS schedule. In addition, good coordination between *crews* is needed, regular supervision of the *crane's condition*, and the availability of adequate spare parts so that damage can be handled immediately and does not interfere with ship loading and unloading activities.

4.3 Maintenance Optimization Interventions

To prevent recurrent failures, the ship's Master convened an integrated Toolbox Meeting on December 20, 2024, attended by the Chief Officer, Bosun, and deck crew. The meeting assigned specific responsibilities and implemented the following optimization actions:

1. **Massive Re-Greasing:** The deck crew was assigned to immediately execute deep re-lubrication on the wire ropes and sheave blocks, and manually remove rust deposits from the slewing gear.
2. **Pre-Operational Layered Inspections:** The Chief Officer mandated a strict visual inspection checklist. The Able Seamen must verify sling cable integrity, hydraulic pump temperatures, and operator cabin cleanliness before the crane is energized.
3. **Schedule Harmonization:** Management submitted a formal request to the Marine Superintendent onshore to secure a "buffer time" in future port schedules, allowing dedicated operational breaks for PMS execution.

Before-and-After Evidence: The impact of these interventions was immediately evident in the subsequent voyage. During operations on January 2, 2025, the cargo discharging process (Bay 01-03 to Bay 05-07) was completed with zero hours of technical downtime. This verifies that synchronizing PMS discipline with adequate port-stay time successfully restores deck crane reliability and cargo-handling efficiency.

Figure. 1. Re-greasing the deck crane wire rope. This preventive maintenance activity restores necessary lubrication, mitigating frictional wear and preventing the severe downtime experienced in previous operations.

Figure 1. Re-greasing Wire rope Deck crane

5. Conclusion

The implementation of deck crane maintenance on MV Tanto Keluarga relies on a structured Planned Maintenance System (PMS). However, the data reveals that strict port schedules and zero-downtime commercial pressures forced severe delays in executing these maintenance routines. This schedule deviation led directly to progressive wear on the wire rope and the formation of active corrosion in the slewing gear due to a lack of lubrication, culminating in a 4-hour hydraulic heave-up failure and significant cargo-handling downtime.

The operational crisis was mitigated through evidence-based optimization actions, including a dedicated toolbox meeting, the enforcement of strict pre-operational visual inspections, and a calibration between commercial docking schedules and preventive maintenance windows. Following these interventions, subsequent cargo operations recorded zero technical downtime. To ensure long-term reliability, it is highly recommended that onshore shipping management integrates adequate "buffer time" into future sailing schedules, allowing the crew sufficient operational breaks to execute mandatory PMS routines before components exceed their material fatigue limits.

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