Analysis of the Hatch Cover Maintenance System on the Mv. Ocean Perkasa to Support Smooth Loading and Unloading Processes

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Hatch covers are vital components on the bulk carrier MV. Ocean Perkasa, functioning to maintain weathertightness to protect dry bulk cargo from damage. This study aims to determine the hatch cover maintenance system procedures and analyze their influence on the efficiency and smoothness of loading and discharging activities in port. The research method used is descriptive qualitative, with data collection techniques including direct observation, in-depth interviews with the Chief Officer, and documentation studies. The results of the study indicate that although maintenance followed the Planned Maintenance System (PMS), significant operational obstacles were still encountered. An incident involving a burst hydraulic jack pipe occurred on December 20, 2024, which caused a loading/discharging delay of 4–5 hours due to a failure in the hatch opening system. The primary causes were corrosion on the hydraulic connection pipes and dirty oil filter conditions, which triggered extreme pressure. The use of an Ultrasonic Tightness Tester proved to be more effective and accurate in detecting leaks early without damaging the cargo compared to conventional methods. In conclusion, disciplined preventive maintenance on the hydraulic system and tightness components is crucial to prevent financial losses due to demurrage penalties and to ensure the smooth operation of the vessel.

Keywords: Hatch Cover, Maintenance, Hydraulic, Loading Discharging.

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1. Introduction

Technological advancements and the high demands of shipping operations require every merchant vessel to have a maintenance system capable of optimally maintaining equipment reliability, particularly the hatch cover, which protects cargo from seawater ingress during shipping. Poorly maintained hatch covers can lead to leaks, cargo damage, and even delays in loading and unloading at ports. Therefore, implementing an effective maintenance system is crucial for ensuring shipping safety, smooth logistics distribution, and maintaining the ship's seaworthiness.

MV. Ocean Perkasa has implemented various modern maintenance strategies to support the operational readiness of its hatch covers. One such technology is the use of an Ultrasonic Tightness Tester by the Chief Officer and crew to precisely detect small gaps in the rubber gasket before seawater leaks occur. Furthermore, LO Sample Analysis activities, recorded in the Planned Maintenance System (PMS), are conducted to monitor hydraulic oil quality, allowing early detection of contamination levels and preventing potential damage to the hydraulic pump before total system failure. The implementation of this technology demonstrates the preventive and predictive efforts in maintaining the reliability of the hatch cover system, ensuring optimal function during shipping and loading and unloading activities.

Based on observations and interviews, the maintenance strategies implemented on the MV Ocean Perkasa include preventive, corrective, and predictive maintenance. Preventive maintenance involves regular inspections of the hydraulic units, deck piping, cleats, and hatch tightness systems to prevent damage before operational disruptions occur. These activities include corrosion protection, leak checks, cleat compression adjustments of 2–3 mm, and hydraulic oil filter replacement to prevent system blockages. Corrective maintenance, on the other hand, is performed when damage occurs, such as in the case of a hydraulic pipe leak, which requires component removal and reinstallation after the repair process is complete. Predictive maintenance, on the other hand, utilizes an ultrasonic tester to detect gasket damage before a leak occurs, allowing for faster and more precise maintenance.

The study showed that preventive maintenance is the most frequently implemented strategy on the vessel. This is evident in the routine greasing and visual inspections recorded in the PMS every three months to ensure the smooth movement of mechanical components on the stowage rail. However, a combination of preventive and predictive maintenance is considered the most effective method implemented on the MV. Ocean Perkasa. Strengthening the predictive system allows the crew to obtain more accurate data on the condition of components most at risk of failure, thereby minimizing the potential for sudden disruptions requiring lengthy corrective maintenance. This strategy is increasingly important given the port's busy operational schedule, which often causes delays in some preventive maintenance activities. Based on the above background, the objective of this study is to analyze the hatch cover maintenance implementation system on board the MV Ocean Perkasa to support smooth loading and unloading activities.

2. Method

This study uses a qualitative descriptive approach to provide an in-depth description of phenomena related to hatch cover maintenance and inspection. Descriptive research aims to describe, explain, and analyze the condition of the research object at a specific time in order to generate general conclusions. The discussion presents the results of the study on hatch covers from both theoretical and practical perspectives. Sources of information were obtained from reference books, maritime literature, operational guidelines, and direct observations, which served as essential components of this research.

Operational definitions of variables are used to explain the variables studied, both independent and dependent. Periodic inspections are conducted monthly or before the vessel departs. These inspections involve checking the hydraulic system, locking mechanisms, and gaskets, performing hatch cover opening and closing function tests, documenting inspection results and corrective actions, and replacing worn components according to manufacturer recommendations. Inspections during voyages refer to MSC.169(79), which requires external inspections of hatch covers, particularly after heavy weather conditions or at least once a week whenever possible. These inspections include identifying leaks in hatch cover joints, examining cleats and safety devices, and paying special attention to the forward 25% of the vessel, which is subjected to the greatest sea loads. Post-damage inspections include temporary repairs to maintain weathertight integrity, replacement of damaged components according to original specifications, retesting of cleat functions and pressure systems, and recording all maintenance activities in the maintenance record book.

Data collection techniques included observation, documentation, and interviews. Observation was conducted through direct observation of the research object to obtain accurate information through direct interaction with actual field conditions. This method also enabled the researcher to actively engage in the research process and gain a comprehensive understanding of hatch cover maintenance practices. The object of observation in this study was the maintenance and inspection process of hatch covers on board MV Ocean Perkasa.

Documentation studies were conducted to collect and record relevant evidence related to hatch cover maintenance activities. Documentation served as supporting evidence to strengthen the validity of the research findings and included maintenance records, inspection reports, photographs, operational documents, and other relevant materials related to hatch cover maintenance and inspection procedures.

Interviews were conducted through face-to-face verbal communication between the researcher and respondents to obtain detailed information regarding hatch cover maintenance practices in supporting loading and unloading operations. The informants involved in this study consisted of the Master, Chief Officer, Bosun, and Able Seamen (AB) who were directly involved in maintenance and supervisory activities. The interview data were transcribed and subsequently analyzed using NVivo 12 qualitative data analysis software. NVivo 12 facilitated the organization, coding, classification, and interpretation of qualitative data obtained from the interviews. Through this software, interview transcripts were systematically processed to identify recurring patterns, significant themes, and relationships among findings relevant to the research objectives.

The data analysis technique in this study utilized qualitative data in the form of words, sentences, and descriptive information obtained from observations, interviews, documentation, and supporting literature. The collected data were analyzed systematically through several stages, including data organization, data reduction, coding, categorization, and theme development. Interview transcripts and supporting qualitative data were imported into NVivo 12 to facilitate the coding process and thematic analysis. The software assisted in identifying key concepts, grouping similar responses, and generating thematic relationships from the collected data.

The resulting themes and findings were then compared with actual implementation in the field to evaluate the conformity of hatch cover maintenance practices with applicable theories, regulations, and operational standards. Finally, the analyzed data were presented systematically in the form of descriptive narratives supported by tables, interview excerpts, and photographic documentation. This presentation provided a comprehensive basis for drawing conclusions and formulating recommendations regarding hatch cover maintenance in accordance with applicable maritime standards and regulations.

3. Results And Discussion

Research Results

Periodic Maintenance Implementation (Schedule Inspection)

Periodic maintenance on the MV Ocean Perkasa is carried out based on the Planned Maintenance System (PMS) guidelines integrated with the head office. This can be seen in the appendix.

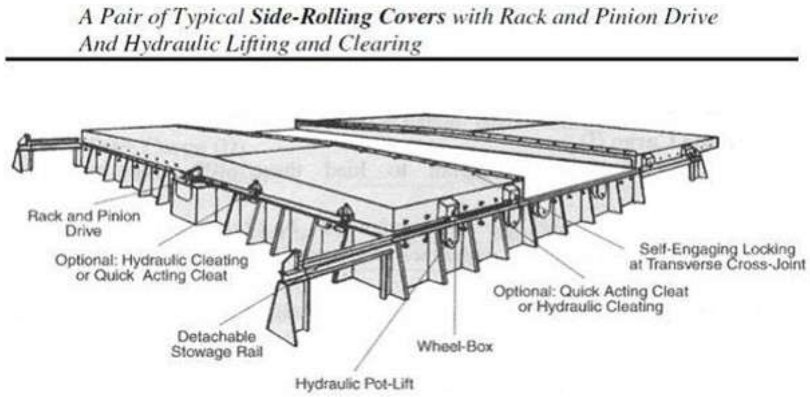

Figure 1. Hatch Cover Characteristics on the MV. Ocean Perkasa
Source: MV. Ocean Perkasa

Figure 1 shows a visual diagram of the Side-Rolling Covers hatch cover system, used to illustrate the main components requiring routine maintenance on the MV. Ocean Perkasa. The diagram shows that the system's drive mechanism uses a rack and pinion drive, which works in conjunction with a hydraulic system to lift and slide the hatch panel horizontally. This system is a critical component in loading and unloading operations and therefore requires regular monitoring and maintenance to maintain optimal function.

The diagram also shows the cleating system, consisting of quick-acting cleats or hydraulic cleats, installed along the sides of the hatch. This component maintains weathertightness while the vessel is sailing, so the locks must always be in good working condition to prevent leaks that could damage the cargo. Furthermore, the diagram identifies the wheel box and stowage rail as supporting components that must be free from corrosion to ensure the hatch wheels can move smoothly without placing excessive stress on the hydraulic motor. Hatch cover maintenance is carried out routinely through several key maintenance actions. One of these is greasing all hinge points, road wheels, and cleats. Based on observations, the greasing process is carried out every time the ship leaves the loading port to ensure all mechanical components can move smoothly during the voyage. In addition, the rubber packing is inspected to ensure that no part of the packing has come loose from its path or experienced permanent deformation that could reduce the hatch's tightness. The hydraulic system is also the focus of inspections by checking for leaks in the hydraulic pipes and cleaning the piston rod of cargo dust that could potentially damage the seals in the hydraulic system.

If damage is discovered while the hold is loaded, emergency repairs are immediately coordinated to maintain weathertightness. The AB's role is crucial in this stage, including tightening cleats or temporary repairs to rubber gaskets using hand tools. After permanent repairs are made, the system is not immediately considered normal. A thorough inspection is conducted, including a test run of the hatch opening and closing operation by the Bosun to ensure mechanical synchronization, a hydraulic system pressure check by the Chief Officer, and a detailed inspection of each bolt and pipe connection by the AB to ensure there are no secondary leaks. Sections that have experienced serious damage, such as the hydraulic system in hold number 2, are placed on an intensive monitoring list for more frequent rust removal and protective paint application than other area

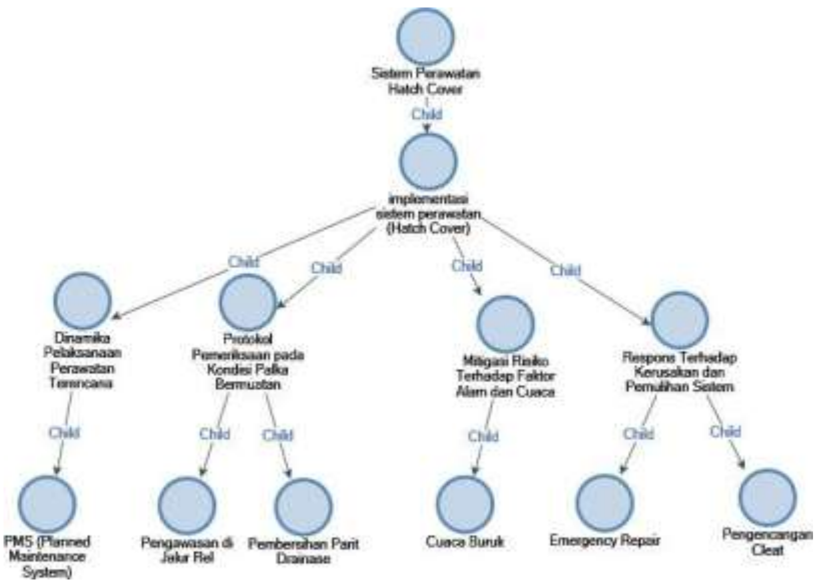

Figure 2. Project Map Resulting from Interview Data
Source: NVivo 12 Application (2026)

Based on the coding process of interview data using NVivo 12 software, several main categories and subcategories were obtained that illustrate the focus of the research problems.

The coding results for the first node identified several sub-nodes of concern, including: implementation of the hatch cover maintenance system, PMS (Planned Maintenance System), on-track supervision, cleaning of drainage ditches, and tightening of cleats. The second node, severe weather, encompasses emergency repairs, and a node for mitigating risks from natural and weather factors, which describes anticipatory measures for environmental conditions. The node, Response to Damage and System Recovery, demonstrates how relevant parties handle operational disruptions and restore the hatch cover maintenance system.

Overall, the NVivo coding results indicate that hatch cover maintenance faces two main challenges: weaknesses in the routine maintenance system (including PMS implementation, supervision, and the physical condition of the rail track and cleats), and external factors such as severe weather, which require mitigation strategies and a rapid response to damage.

Figure 3. Hydraulic Hatch Cover
Source: MV. Ocean Perkasa

Figure 3 shows the hydraulic drive unit, the main component of the Side-Rolling Hatch Cover system on the MV. Ocean Perkasa. Based on field observations, this system consists of several integrated components to support optimal hatch opening and closing. One of the main components is the Hydraulic Jack or Hydraulic Cylinder, which functions to lift the hatch panel before moving it horizontally using a rack and pinion drive system. This component plays a crucial role in ensuring stable and safe hatch movement.

Furthermore, there are Hydraulic Piping and Hoses, which serve as high-pressure fluid distribution lines from the main pump to each hydraulic cylinder on the ship's deck. This piping system serves as the primary connection in the distribution of hydraulic power, so it must always be ensured that the pipes are free from leaks and damage to ensure stable system pressure during operation. This system also utilizes Flexible Hoses, flexible rubber hose connections that allow for dynamic movement when the hatch panel is opened or closed. The presence of this flexible hose helps maintain the smooth operation of the hydraulic system while reducing the risk of damage due to continuous mechanical movements during ship loading and unloading activities.

Figure 4. MV closed hatch cover. Mighty Ocean
Source: MV. Ocean Perkasa

Figure 5. Removal of Hydraulic Connection Pipe
Sumber : MV. Ocean Perkasa

During the operation of the hatch closing system on the MV Ocean Perkasa, one of the corrective maintenance actions carried out was the removal and replacement of the hydraulic connection pipe due to damage to the number 2 hatch drive system. The documentation in Figure 3 shows the hydraulic connection pipe removed from the hydraulic jack and placed on the ship's deck. Visual inspection revealed the pipe to be quite long, as it serves to reach a pressure point in the hydraulic pot-lift system. The pipe was removed after indications of a leak and a drastic drop in hydraulic pressure were detected, disrupting the hatch opening and closing process and hampering loading and unloading activities.

Referring to the technical diagram in Figure 3, the removed pipe is a critical part of the hydraulic fluid distribution line that powers the Hydraulic Pot-Lift component. This component transmits pressure from the pump to the hydraulic cylinder to lift the hatch panel before it is moved horizontally via the rack and pinion drive system. Damage to the connection pipe, such as a leak or rupture, directly impacts the operational failure of the entire hatch system, as hydraulic pressure cannot be optimally distributed.

Based on an interview with the Chief Officer, the pipe removal was part of the inspection procedure following the damage. The initial step involved isolating the system by shutting off the hydraulic pump pressure to prevent an oil spray when the pipe was removed. The crew then dismantled the pipe connections at key points on the ship's deck in accordance with established technical procedures. After the removal and repairs were completed, the ship underwent a thorough inspection of the hold system to ensure there were no further impacts or other damage resulting from the hydraulic system disruption.

Figure 6. Inspection using an Ultrasonic Tightness Tester
Source: MV. Ocean Perkasa

Pressure and leak testing of the hatch cover system on the MV. Ocean Perkasa is carried out through a hydraulic system inspection and hatch tightness testing. Hydraulic pressure checks are performed through a hydraulic control unit that monitors the working pressure in the Hydraulic Pot-Lift components and hydraulic cylinders. This system allows the ship's crew to directly monitor the operating pressure. A drastic drop in pressure indicates a leak or damage to the hydraulic connection pipes, requiring further inspection of the fluid distribution system.

In addition to the hydraulic pressure check, a watertightness test (leak test) is also performed to ensure there are no gaps or leaks in the hatch seals. This test uses an Ultrasonic Tightness Tester, which works by detecting ultrasonic signals passing through gaps in the rubber gasket. This tool allows for more precise hatch tightness measurements, allowing for early detection of potential leaks before they cause damage to the cargo or disrupt ship operations.

Before After

Figure 7. Hydraulic Oil Filter
Source: MV. Ocean Perkasa

Hydraulic Oil Filter Maintenance Figure 5 shows the condition of the Hydraulic Oil Filter, removed for inspection and eventual replacement. This filter functions to filter contaminants and microparticles from the hydraulic oil that drives the Hydraulic Pot-Lift. A clean hydraulic system ensures smooth movement of the hatch panel on the rails. A clogged filter can overload the pump, potentially causing extreme pressure in the connecting pipes. Therefore, regular filter replacement is part of preventative maintenance to prevent sudden hydraulic system failure..

Figure 8. Reinstallation of Hydraulic Pipes
Source: MV. Ocean Perkasa

After removing and repairing the hydraulic system, the next crucial step was reinstalling the hydraulic piping components to restore the hatch cover's operational function. The repaired hydraulic piping was reinstalled on the ship's deck. This process involved reconnecting the steel piping connecting the pump unit to the Hydraulic Pot-Lift component. The crew ensured that each fitting was securely locked to prevent recurrence of fluid pressure leaks that could disable the hatch mechanism. Along with the piping installation, a new or cleaned Hydraulic Oil Filter was also installed. This ensured that the hydraulic fluid circulation remained clean from contaminating particles that could damage the pipe walls or clog the side-rolling cover control valves. Once all piping was reconnected, the system was reactivated to perform a hatch opening and closing function test. Based on interviews, a thorough inspection of each related system was conducted post-repair to ensure there were no cascading effects from previous damage. As a final step to validate the success of the repair, the crew used an Ultrasonic Tightness Tester. This inspection ensures that the hatch is not only mechanically movable but has also achieved optimal weathertightness, indicated by a zero or safe indication on the device's digital display.

MV Ocean Perkasa Hatch Cover Maintenance

Preventive maintenance on the MV Ocean Perkasa is a form of compliance with the International Convention for the Safety of Life at Sea (SOLAS) 1974 Chapter II-1, which requires ships to maintain the structural integrity and watertightness of hatches to ensure crew safety and ship stability during voyages. In the context of maritime law, hatch system failure can seriously impact a ship's seaworthiness and potentially revoke its certificate. Therefore, preventive measures are consistently implemented, one of which is material protection using Denso tape on hydraulic pipe connections to prevent intergranular corrosion due to high seawater salinity.

In operational practice on the ship's deck, the crew faces the challenge of highly aggressive corrosion on the mechanical components of the hatch cover system. Based on field experience, delayed lubrication of stowage rails and wheels can cause metal friction, which increases the torque load on hydraulic motors. Therefore, data in the Planned Maintenance System (PMS) stipulates the use of EP-2 lithium grease as a mandatory standard to ensure that hatch panels weighing tens of tons can continue to move smoothly without mechanical obstruction..

From a financial and technical risk management perspective, preventive maintenance of hydraulic oil filters plays a crucial role in preventing chain failures in hydraulic systems. Clogged filters can cause cavitation in hydraulic pumps, triggering oil temperature increases and overpressure. On the MV Ocean Perkasa, the crew's discipline in regularly changing filters is considered to reduce the risk of major damage, which can incur repair costs of thousands of dollars if the hydraulic circuit becomes heavily contaminated. This prevention is also crucial for maintaining dry cargo holds, as stipulated in the Charter Party, which requires the vessel to provide suitable cargo holds.

Optimizing mechanical components is also a crucial part of preventive maintenance. Components such as cleats, bearing pads, and locating devices are visually inspected daily to ensure there are no problems with the hatch cover system. Field experience shows that dust from coal or iron ore cargo often gets into small gaps and hardens, hindering the movement of hatch panels. Therefore, AB routinely performs manual cleaning using compressed air or direct brushing to keep components clean and maintain the optimal life cycle of the hatch cover system.

a. Corrective Maintenance

Corrective maintenance on the MV Ocean Perkasa is an emergency response to technical failures that suddenly arise during the ship's operations. Although reactive, this strategy is a last resort to maintain smooth ship operations, especially amidst busy port activities and high time pressure. Corrective maintenance also tests the professionalism and resilience of the deck crew in handling technical problems quickly and accurately.

Based on a case study of a ruptured hydraulic connection pipe in hold number 2, the repair process was carried out under high time pressure because the damage immediately hampered loading and unloading processes. The ship's crew had to work in a coordinated manner under extreme weather conditions on deck to quickly replace the damaged pipe so the system could resume normal operation. The main technical challenge in the repair process was ensuring the precision installation of the steel pipe fittings. A small error, such as a tilted connection, could cause hydraulic fluid pressures reaching hundreds of bars, damaging the seal and triggering a re-leak. This situation demonstrates that the success of corrective actions is highly dependent on the hands-on technical skills of the crew, as well as the technical supervision and coordination of the Bosun.

Damage requiring corrective maintenance also directly impacts the economic aspects of ship operations. A 4–5-hour delay due to hydraulic pipe repairs is not only a technical issue but also has the potential to cause financial losses for the ship. Delays in loading and unloading processes can trigger demurrage claims or late fees from the charterer. With the high value of daily charter hire, every minute of delay due to inoperable holds means economic loss for the shipping company. Therefore, emergency repair procedures are aimed at minimizing the Mean Time to Repair (MTTR) without compromising safety procedures.

After corrective actions are completed, the Chief Officer is required to conduct a Root Cause Analysis to determine the root cause of the damage. In the case of the hydraulic pipe rupture, the investigation revealed that the damage was not only caused by the age of the pipe but also by a surge in back pressure that could not be properly filtered due to a dirty filter. The results of this analysis will serve as evaluation material for ship management to tighten the implementation of preventive maintenance on the hydraulic system so that similar incidents do not recur in the future.

b. Predictive Maintenance

The predictive maintenance strategy implemented on the MV Ocean Perkasa demonstrates that the ship's maintenance system has moved toward modern operational standards that prioritize the use of scientific data over mere guesswork or intuition. This strategy enables the ship's crew to detect potential damage early, allowing for more planned, efficient, and targeted maintenance.

One key application of this predictive strategy is the use of an Ultrasonic Tightness Tester as a tool to mitigate the risk of cargo damage. The use of this technology represents a significant advancement in hatch cover maintenance management, as it complies with IMO Circular MSC/Circ.1061, which recognizes ultrasonic testing as a valid method for verifying weathertightness. In practice, the use of this tool eliminates the need for hose tests, which require large amounts of water and risk wetting drainage ditches when the hold is loaded. Using this tool, the Chief Officer can more accurately predict the wear level of the rubber gasket based on the detected decibel value. If the indicator shows a high value, the crew can immediately plan gasket replacement before seawater leakage occurs and damages moisture-sensitive cargo.

Predictive strategies are also implemented through LO (Lubricant Oil) Sample Analysis activities, which are recorded in the Planned Maintenance System (PMS). Laboratory analysis of hydraulic oil samples is used to determine the metal particle content, water content, and viscosity level of the oil, providing an "internal diagnosis" of the hydraulic system. The presence of micro metal particles is an early indication of wear on gears or hydraulic pumps, while high water content indicates potential condensation in the tank. With this data, companies can predict component life and prepare spare parts in advance. Furthermore, repair schedules can be planned while the vessel is dry docked, thus avoiding the risk of sudden breakdowns at sea.

The implementation of condition-based maintenance also positively impacts vessel operational efficiency. Through data obtained from ultrasonic equipment and oil analysis, crews avoid having to replace serviceable components simply because they have passed the maintenance schedule. This system makes maintenance more effective because it is based on the actual condition of components in the field. In addition to reducing operational costs, this approach also helps reduce the workload of deck crews, who often face busy port schedules. Thus, a predictive maintenance strategy not only improves maintenance efficiency but also supports shipping safety and ensures the overall smoothness of the ship's loading and unloading process.

Based on data collected through in-depth interviews with four key members of the deck crew on the MV Ocean Perkasa: the Master, Chief Officer, Bosun, and Crew Member, a comprehensive overview of the implementation of the hatch cover maintenance system to support smooth ship operations was obtained. Routine maintenance is heavily influenced by port operational schedules, particularly when vessels encounter loading and unloading activities with short turnaround times. Although all maintenance activities are scheduled in the Planned Maintenance System (PMS), delays of 1–3 days often occur due to the busy operational activities. Under these circumstances, the Bosun implements a policy of conducting inspections in stages, prioritizing lubrication of moving parts to prevent mechanical jams. Crew members also continue to clean the deck area immediately after operational activities to ensure safe working conditions and optimal hatch system function.

When the hold is loaded, inspections focus on external parts that are still accessible without compromising cargo security. The Chief Officer emphasized that cargo safety is a top priority during both the voyage and the loading and unloading process. Technical supervision is carried out by the Bosun, ensuring that the trackway is free of foreign objects that could impede the movement of the hold panels. Meanwhile, the AB is responsible for carrying out detailed cleaning of the drainage ditch to ensure there is no remaining cargo or corrosion clogging the drainage channel. This action is important to prevent waterlogging that can accelerate rust growth on the gasket and reduce weathertightness.

Heavy weather is a major obstacle to inspections and maintenance during a ship's voyage. All informants stated that crew safety is the highest priority, so all external inspections are suspended when large waves reach the ship's deck. Slippery deck conditions and unstable ship motion make physical inspections of the holds a high-risk activity. In such situations, maintenance focus is shifted to components in safer and more protected areas to maintain work productivity without compromising crew safety.

If damage is discovered while the hold is still loaded, emergency repairs are immediately undertaken to maintain its watertightness. The crew member plays a crucial role in the initial repair phase, such as tightening cleats or temporarily repairing rubber gaskets using hand tools. Once permanent repairs are completed, the system is not immediately declared normal but undergoes a series of thorough inspections. The Bosun conducts operational tests of the hatch opening and closing to ensure proper mechanical synchronization, the Chief Officer checks the hydraulic system pressure, and the crew member inspects the details of bolts and pipe connections to ensure there are no secondary leaks. Parts that have experienced serious damage, such as the hydraulic system in hold number 2, are subjected to intensive monitoring, requiring rust removal and protective painting more regularly than other parts.

Interviews also revealed that the smooth loading and unloading process on the MV Ocean Perkasa relies heavily on the collaboration between the ship's management, managerial supervisors, and technical personnel. The crew's discipline in maintaining the cleanliness of the filters and drainage ditches, technical coordination by the ship's boss, oversight by the chief officer, and the captain's strategic decisions form an operational system that supports the ship's readiness to face adverse weather conditions and high port activity. The captain emphasized that compliance with the Safety Management System (SMS) and the ship's seaworthiness are top priorities that cannot be neglected. The chief officer ensures that periodic inspections are carried out according to the PMS schedule, while the bosun maintains the mechanical readiness of the hold system so that it can be operated at any time. The crew is considered crucial because they are able to detect early damage such as minor leaks in hydraulic pipes and blockages in drainage channels.

In practice, inspections are sometimes delayed when the ship is in port with a very busy loading and unloading schedule. However, the captain allows for tolerance as long as these conditions do not violate ship class and certification regulations. When the hold is loaded, inspections focus solely on accessible external components, such as the hydraulic system, cleats, and drainage channels, to maintain weathertightness and avoid cargo claims due to cargo damage. Bad weather is also a major hindering factor in conducting routine inspections at sea. For crew safety, external inspections are halted if large waves reach the ship's deck, and maintenance activities are diverted to safer areas.

Based on observations and interviews, the hatch cover maintenance system on the MV Ocean Perkasa is implemented through three main approaches: preventive maintenance, corrective maintenance, and predictive maintenance. Preventive maintenance is implemented through periodic inspections such as gasket checks, hydraulic oil changes, visual inspections of panels, bearing pads, hydraulic system leaks, and friction point lubrication to maintain system operational readiness. Corrective maintenance is performed when damage or malfunctions occur, such as a ruptured hydraulic pipe, which requires the crew to perform a rapid diagnosis, component replacement, leak testing, and record repair results in a maintenance logbook to minimize Mean Time to Repair (MTTR). Meanwhile, predictive maintenance is implemented through system condition monitoring using an Ultrasonic Tightness Tester, which helps crews detect potential damage to the hatch tightness system without requiring excessive physical dismantling. Test data is used to determine the most appropriate maintenance time before damage occurs, thus reducing the risk of sudden downtime and maintaining the ship's operational efficiency.

Discussion

On the MV. Ocean Perkasa, the hatch cover maintenance system encompasses preventive, corrective, and predictive maintenance. Preventive maintenance is implemented through a routine schedule within the Planned Maintenance System (PMS), corrective maintenance is implemented when sudden technical problems occur, and predictive maintenance is performed to ensure optimal hatch tightness. Of these three strategies, a combination of preventive and predictive maintenance is considered the most effective method implemented on board. This is because the implementation of full preventive maintenance is often hampered by tight docking and loading/unloading schedules at ports. By integrating predictive approaches such as the use of Ultrasonic Tightness Testers, the ship's crew can predict potential damage without the need for routine component disassembly. This strategy reduces unnecessary interventions and minimizes the risk of sudden damage requiring lengthy corrective maintenance, thus ensuring smooth loading and unloading.

The implementation of preventive maintenance is the primary foundation for maintaining the reliability of the hatch cover system on the MV. Ocean Perkasa. Observations of the hydraulic system revealed that the above-deck pipe connections (unions) were maintained through protection against seawater corrosion and routine leak checks in accordance with the PMS. Furthermore, the tightly closed hatch cover indicated that the Quick Acting Cleat function was functioning properly. This demonstrated that regular adjustment of the rubber gasket compression by 2–3 mm successfully maintained weathertightness throughout the voyage. Quarterly greasing and visual inspections also ensured the smooth movement of mechanical components on the stowage rail, allowing uninterrupted loading and unloading operations.

Furthermore, corrective maintenance was performed in response to damage that disrupted ship operations. This was evident in the rupture of a hydraulic pipe in hatch number 2, which required the crew to isolate the system and urgently replace components. Researchers' analysis revealed that the damage was caused by a clogged hydraulic oil filter, which caused overpressure in the system. After removing and reinstalling the damaged pipe, the hatch function was successfully restored. However, the repair process, which takes approximately 4–5 hours, indicates that delays in preventive action on the oil filter can impact the ship's berthing time efficiency and smooth loading and unloading.

The implementation of predictive maintenance on the MV Ocean Perkasa demonstrates the use of modern technology in the hatch cover maintenance system. The use of an Ultrasonic Tightness Tester by the Chief Officer and crew allows early detection of small cracks in the rubber gasket before seawater leaks occur. Furthermore, LO Sample Analysis activities, recorded in the PMS, are conducted to monitor hydraulic oil quality, allowing for early detection of contamination levels and preventing hydraulic pump damage before total system failure. The synchronization of visual data and maintenance strategies demonstrates that each vessel component is handled according to its condition and function. Hydraulic units and deck piping are maintained through preventive maintenance, while pipe repairs following leaks are considered corrective maintenance. Meanwhile, the use of an Ultrasonic Tester is part of predictive maintenance because it provides accurate data on gasket condition and potential damage.

Based on observations and interviews, the most frequently implemented strategy on ships is preventive maintenance, but a combination of predictive maintenance and monitoring is the most ideal approach. Strengthening predictive systems allows crews to identify the most critical components that require immediate attention, allowing for faster and more targeted maintenance. This minimizes the risk of sudden breakdowns requiring lengthy corrective maintenance, particularly when busy port schedules potentially delay some preventive maintenance activities.

4. Conclusion

This study concludes that the implementation of the Side-Rolling hatch cover system maintenance strategy on the MV Ocean Perkasa has been carried out in an integrated manner through a strategic combination of Preventive, Corrective, and Predictive Maintenance. Preventive maintenance acts as the frontline in maintaining the ship's seaworthiness through adherence to the Planned Maintenance System (PMS) schedule, while corrective maintenance is a crucial step in restoring operations after damage, despite the risk of downtime that can trigger demurrage fines. Meanwhile, predictive maintenance through the use of

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ultrasonic technology and oil sample analysis has proven to be the most efficient method in mitigating the risk of cargo damage, as it can precisely detect system anomalies before fatal failures occur. The success of this maintenance system depends not solely on technological sophistication, but rather on solid operational synergy between the Captain, officers, and deck crew. By consistently integrating these three strategies, the MV Ocean Perkasa has achieved optimal loading and unloading efficiency, ensuring greater cargo security, while simultaneously extending the lifespan of the ship's components sustainably.

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