Effectiveness of the Use of Occupational Safety Equipment on Commercial Vessels in Patrol Operations of the Bitung Class 2 Coast Guard Base

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ABSTRACT

This study aims to analyze the effectiveness of the use of occupational safety equipment on merchant ships in patrol operations carried out by the Bitung Class II Coast Guard Base (PPLP). This study uses a descriptive qualitative approach with data collection techniques in the form of in-depth interviews, direct observation, and documentation. The main focus of the study covers three aspects: planning, implementation, and supervision and evaluation of occupational safety equipment maintenance. The results of the study indicate that the maintenance planning system has not been documented in a standard and standard manner, only in the form of monthly reports that are prepared informally without a fixed schedule. The implementation of maintenance is generally preventive, but still depends on the initiative of ship officers and has not been integrated into the digital system. Meanwhile, supervision and evaluation are still internal, reactive, and have not produced comprehensive policy follow-ups. Five main determinant factors were found that influence the effectiveness of the maintenance system, namely completeness of documents, personnel capabilities, availability of spare parts, implementation of digital systems, and safety culture. This study recommends the implementation of a digital-based maintenance management system such as the Computerized Maintenance Management System (CMMS), preparation of standard maintenance documents, routine training for ship technicians, and strengthening of data-based supervision and evaluation systems as strategies to improve the reliability of occupational safety systems on merchant ships.

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INTRODUCTION

To find out, identify and analyze the occupational safety and health system on merchant ships of the Class 2 Bitung Coast and Sea Guard Base. To find out, identify and analyze the determinant factors in the maintenance system for merchant ship safety equipment at the Class 2 Bitung Coast and Sea Guard Base?

Adding scientific references in the field of public administration, especially related to the maintenance system of commercial ship safety equipment. As well as contributing to the development of organizational and management effectiveness theory in the maritime sector.

Practical aspects

Providing input for the Bitung Class II Coast Guard Base to overcome operational challenges and improve the effectiveness of the ship safety equipment maintenance and care system. As well as providing strategic recommendations for optimizing the use of technology and human resource management.

Etymologically, the word management comes from Old French ménagement, which means the art of carrying out and organizing. While in terminology, experts define management in various ways, including: Follet quoted by Wijayanti (2008: 1) defines management as the art of completing work through other people. According to Stoner quoted by Wijayanti (2008: 1) management is the process of planning, organizing, directing, and supervising the efforts of members of the organization and the use of other human resources in the organization in order to achieve the goals of the organization that have been set. Gulick in Wijayanti (2008: 1) defines management as a field of science that systematically seeks to understand why and how humans work together to achieve goals and make this system more useful for humanity.

Schein (2008: 2) defines management as a profession. According to him, management is a profession that is required to work professionally, its characteristics are that professionals make decisions based on general principles, professionals get their status because they achieve certain work performance standards, and professionals must be determined by a strong code of ethics. Terry (2005: 1) defines management as a process or framework, which involves guiding or directing a group of people towards organizational goals or real intentions. This includes knowing what to do, determining how to do it, understanding how they should do it and measuring the effectiveness of the efforts that have been made. From the several definitions mentioned above, it can be concluded that management is an effort carried out together to determine and achieve organizational goals by implementing the functions of planning, organizing, implementing (actuating), and supervising (controlling). Management is an activityn

The implementation is called management and the person who does it is called a manager. Managementnneeded at least to achieve goals, maintain balance between conflicting goals, and to achieve efficiency and effectiveness. Management consists of various elements, namely man, money, method, machine, market, material and information. 1) Man: Human resources; 2) Money: Money needed to achieve goals; 3) Method: Way or system to achieve goals; 4) Machine: Machine or tool for production; 5) Material: Materials needed in activities; 6) Market: Market or place to throw production results; 7) Information: Things that can help to achieve goals.

METHOD

This research method uses qualitative research. Qualitative research method is a research that intends to understand the phenomenon of what is experienced by the research subject, for example behavior, perception, motivation, action and others, holistically and by means of description in the form of words and language, in a specific natural context (Moleong, 2017: 6).

Strauss and Cobin (Tresiana, 2013:14) stated that qualitative research is research that produces findings that cannot be achieved using static procedures or by means of measurement. Bungin and Creswell (Tresiana, 2013:33) descriptive qualitative methods are the type of qualitative method that is most influenced by qualitative views. In writing research, researchers analyze the data and describe it as it is as original as possible. So that an explanation and description of the research topic can be obtained.

Thus, it is hoped that this qualitative approach will produce data systematically, factually and accurately so that we can dig deeper into the facts. Effectiveness of the Use of Occupational Safety Equipment on Commercial Vessels in Patrol Operations of the Bitung Class 2 Coast Guard Base.

Because the researcher explains in detail the situation and conditions at the research location and analyzes and interprets the existing data, both interview results and documents.

RESULT AND DISCUSSION

Determinant factors in the safety equipment maintenance system for Bitung Class 2 Sea and Coast Guard Base commercial vessels

The findings of the research interviews conducted at the Bitung Class II Coast Guard Base (PPLP) indicate that the maintenance system for commercial ship safety equipment at this location is influenced by several interrelated main determinant factors. The maintenance system for safety equipment on commercial ships, as an integral part of occupational safety and health (K3) management, should ideally be supported by careful planning, consistent implementation, and systematic and documented supervision and evaluation. However, the reality in the field shows that the success of this system does not only depend on regulations and standard procedures, but is also determined by internal and external factors that influence its effectiveness. Based on field data collected through interviews with technical personnel and supervisors at the Bitung Class II PPLP, five main determinant factors were identified that influenced the safety equipment maintenance system, namely completeness of documents, personnel capabilities, availability of spare parts, implementation of integrated digital-based systems, and safety culture. These five factors interact with each other and form a maintenance system that is not only oriented towards administrative compliance, but also prioritizes the sustainability and reliability of safety equipment to support safe and effective patrol operations.

1. Completeness of Documents

Completeness of documentation is a key pillar in an effective maintenance system, as it serves as a work guideline and valid proof of implementation. According to ISO 45001:2018, complete documentation includes written procedures, inspection records, evaluation results, and follow-up improvements that must be systematically arranged and documented. SOLAS 1974 also requires accurate safety equipment inspection and maintenance records to ensure compliance with international safety standards. Good documentation not only serves as a control tool, but also as a basis for data-based decision making.

The findings at PPLP Class II Bitung show that maintenance documentation is still manual, informal, and does not have a standard format. Planning documents are only in the form of monthly reports prepared by operational staff or captains, without regular updates. This causes information gaps, coordination difficulties, and low data validity during audits or inspections. In fact, complete documents should contain detailed schedules, tool lists, inspection records, and identification of responsible personnel.

Research by Sitepu (2017) and Muliadi et al. (2020) reinforces this finding, where the lack of maintenance documentation causes decreased safety equipment readiness and increases the risk of equipment failure in an emergency. Incomplete documents make it difficult to evaluate the effectiveness of the system and hinder continuous improvement. Similar conditions also occur in other shipping industries, as shown by Sitorus & Sihombing (2021) who highlight weak documentation as the main cause of irregular maintenance.

In-depth analysis shows that without complete documents, the maintenance system becomes vulnerable to non-conformities and deviations from procedures. This not only impacts operational effectiveness, but also the safety of the ship's crew and the sustainability of the voyage. Therefore, the preparation of complete, standard, and documented maintenance documents, supported by a digital system to facilitate data access and tracking, is a strategic step in strengthening the safety equipment maintenance system.

2. Personnel Capabilities

Personnel capabilities in the maintenance system include technical knowledge, practical skills, and understanding of regulations and work procedures. According to Robbins & Coulter (2018), personnel competency development is a vital element in organizations that want to achieve optimal performance. ISO 45001:2018 emphasizes that personnel involved in K3 must have adequate training, relevant certification, and a deep understanding of their responsibilities. In the maritime context, personnel who manage safety equipment are required to have certifications such as BST, AFF, and MEFA.

In PPLP Class II Bitung, findings show that personnel involvement is still limited, with most technicians not receiving routine training related to safety equipment maintenance. Maintenance tasks are mostly handed over to ship officers (3rd mate) who have basic certificates, without adequate technical supervision. This causes maintenance implementation to be inconsistent between ships and prone to technical errors, especially when facing sudden damage.

Wulandari et al.'s (2022) and Rachman & Santoso's (2020) research supports these findings, by emphasizing that low technician competency increases the risk of accidents and worsens maintenance effectiveness. In a study of the shipping industry, Alsyouf & Al-Ali (2021) also emphasized the importance of continuous training and technical expertise development as a foundation for building a sustainable safety culture.

Analysis shows that improving personnel capabilities requires not only technical training, but also a continuous mentoring and coaching system. Regulation-based training and best practices must be part of the work culture, so that personnel can implement maintenance effectively, adaptively, and support the sustainability of the ship's safety system.

3. Availability of Spare Parts

The availability of spare parts is a crucial technical factor in maintaining the continuity of maintenance and readiness of safety equipment. According to Kumar et al. (2022), effective spare parts management must include a planned procurement system, inventory monitoring, and good logistics coordination. In the context of PPLP Class II Bitung, the spare parts procurement system does not fully support operational needs, so there are often delays in component replacement and urgent repairs.

Interview results showed that spare parts were often not available on time, especially for specific safety equipment components. Reliance on manual procurement and the lack of a dedicated logistics system added complexity. This led to delays in repairs, decreased implementation effectiveness, and potential equipment failure in emergencies.

This finding is in line with research by Gopalakrishnan et al. (2020) which highlights the importance of a digital-based spare parts management system to support maintenance effectiveness. A study by Sitorus & Sihombing (2021) also shows that procurement delays increase the risk of system failure, especially in the maritime sector which requires a rapid response to technical problems.

In-depth analysis confirms that strengthening technology-based logistics and procurement systems, including the use of CMMS for stock monitoring and procurement reminders, is a strategic solution. In addition, strengthening cooperation with spare parts providers and developing buffer stocks in operational units will support equipment readiness and the sustainability of ship operations.

4. Integrated Digital Based System

The use of a digital system based on a Computerized Maintenance Management System (CMMS) has been proven to increase the effectiveness and efficiency of maintenance. According to Zhang & Xie (2021), CMMS facilitates asset management, maintenance scheduling, automatic reporting, and historical data integration that supports decision making. In the maritime sector, the implementation of CMMS helps ensure compliance with SOLAS standards and national regulations with complete and accurate documentation.

Findings at PPLP Class II Bitung show that digital systems have not been implemented in maintenance management. The planning, implementation, and monitoring processes are still carried out manually, with records that are prone to being lost or unverified. The absence of CMMS results in weak documentation control, maintenance history tracking, and limited data analysis needed for continuous improvement.

Computerized Maintenance Management System (CMMS) is a software-based system designed to manage and facilitate all maintenance activities, from planning, implementation, monitoring, to evaluation, with complete and integrated documentation. CMMS functions as a bridge between daily operational activities and strategic maintenance management by providing a comprehensive database of equipment inventory, maintenance schedules, maintenance history, spare parts, and performance reports (Mobley, 2019). The implementation of CMMS supports the creation of a safe and productive work environment, because this system is able to increase data transparency, facilitate evidence-based decision making, and minimize the potential for equipment failure that can endanger safety.

In the context of ship safety equipment maintenance, CMMS is a very relevant solution because it is able to overcome various obstacles that often occur in the field, such as minimal manual documentation, irregular maintenance schedules, and lack of maintenance history tracking. According to Gopalakrishnan et al. (2020), CMMS is able to optimize safety equipment management by providing a system that facilitates routine inspection scheduling, maintenance reminders, and spare part management, so that preventive maintenance can be carried out systematically and consistently. This system also supports the creation of complete and accurate reports, which can be used as evidence of compliance with regulations such as SOLAS 1974 and Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 7 of 2024 which requires complete documentation and reporting of safety equipment maintenance.

Technically, CMMS works by automating the maintenance workflow. Initial data regarding assets and equipment is entered into the system, including technical specifications, location, and status. The system will then generate a maintenance schedule based on time intervals or condition indicators, complete with notifications and reminders for technicians. Maintenance history will be recorded automatically, making it easier to track equipment conditions over time. According to Zhang and Xie (2021), CMMS can also be integrated with Internet of Things (IoT)-based sensors to support condition-based maintenance, further improving the accuracy and effectiveness of maintenance.

The implementation of CMMS in the management of ship safety equipment not only reduces the risk of human error due to manual recording, but also supports increased productivity and cost efficiency. This system allows management to prioritize maintenance based on real-time data, shorten response time to damage, and ensure operational readiness of safety equipment in emergency conditions.

Research by Alsyouf & Al-Ali (2021) and Kumar et al. (2022) supports the importance of implementing CMMS as a solution to improve maintenance performance, reduce downtime, and increase system reliability. Sitorus & Sihombing (2021) also noted that digital systems help build a data-driven safety culture and increase process transparency.

In-depth analysis shows that the implementation of CMMS in PPLP Class II Bitung will strengthen the documentation system, facilitate monitoring of tool performance, and support accurate data-based reporting. This implementation requires management commitment, technical training, and adequate digital infrastructure.

5. Safety Culture

Safety culture is the foundation that supports the success of the maintenance system. According to Reason (2016), a strong safety culture is characterized by the involvement of all levels of the organization, commitment to procedural compliance, and continuous learning. ISO 45001:2018 underlines the importance of a safety culture based on participation, effective communication, and stakeholder involvement.

In PPLP Class II Bitung, safety culture has not been fully developed, as seen from weak documentation, low personnel involvement in training, and reactive supervision. Lack of communication between units and minimal emphasis on data-based evaluation hamper the development of an adaptive and risk-responsive system.

Wulandari et al.'s (2022) and Rachman & Santoso's (2020) research emphasizes that a system-based and data-based safety culture increases maintenance effectiveness and reduces the potential for incidents. Alsyouf & Al-Ali (2021) also noted that a work culture that supports technological innovation and open reporting contributes to improved maintenance performance.

The analysis shows that building a safety culture requires management commitment, continuous training, effective communication, and the application of digital technology. This culture must be supported by clear procedures, a transparent monitoring system, and the active participation of all crew members to create a reliable and sustainable maintenance system.

CONCLUSION

The occupational safety and health system on merchant ships at PPLP Bitung is still not optimal, especially in the planning, implementation and supervision of safety equipment maintenance 1) In planning, the absence of complete, standard, and systematically documented planning documents causes data inconsistency and weak coordination between units. The preparation of plans is only based on monthly reports that are not updated regularly and are prepared informally, thus reducing the readiness of equipment in emergency conditions; 2) In the implementation, limited technical skills of personnel, minimal routine training, and inadequate availability of spare parts are the main obstacles. The maintenance reporting system is still manual, without the use of digital technology such as CMMS, slowing down the repair process and making accurate documentation difficult. As a result, maintenance implementation tends to be inconsistent between units and is prone to delays in equipment repair; 3) Meanwhile, in the aspect of supervision, the implementation of inspection and evaluation is still reactive and not well documented. Supervision is only carried out if there is a report of a major problem, without clear performance indicators and a data-based evaluation system. The lack of documentation and communication between units causes supervision to lose its function as a tool for early detection and control of maintenance quality; 4) There are determinant factors that influence the maintenance of safety equipment for Bitung Class 2 Sea and Coastal Guard Base commercial vessels a) The completeness of document: Lack of documented maintenance planning and scheduling impacts the sustainability of the maintenance system. b) Personnel capabilities: Lack of technical training and awareness of the importance of safety equipment maintenance reduces the effectiveness of the system; c) Availability of spare parts: Limited availability of spare parts has an impact on slow repair and replacement of equipment; d) Integrated digital based system: Digital-based management systems such as CMMS have not been fully integrated, thus hampering maintenance recording and monitoring. Safety culture: Low implementation of work safety culture causes negligence in equipment maintenance, which ultimately increases the risk of accidents

REFERENCES

Agbola, T. (2012). The impact of occupational safety and health management on work productivity in manufacturing firms. Journal of Safety Research, 43(3), 153-162.

Ansori, & Mustajib. (2013). Production Facility Maintenance Management. Jakarta: University of Indonesia Publisher.

Dye, T. R. (2013). Understanding Public Policy (14th ed.). Boston: Pearson.

Fajar, & Heru. (2010). Occupational Safety and Health (K3) in the Maritime Industry. Jakarta: Erlangga.

Follet, M. P. (2008). The Essential Mary Parker Follett: Ideas We Need Today. Cambridge: Harvard Business Press.

Gulick, L. (2008). Papers on the Science of Administration. New York: Columbia University Press.

Hadiningrum, S. (2003). Occupational Safety Supervision and Accident Prevention. Yogyakarta: Pustaka Pelajar.

Heinrich, H. W. (1931). Industrial Accident Prevention: A Scientific Approach. New York: McGraw-Hill.

Hidayat, Y. (2011). Public Asset Management. Alfabeta.

International Maritime Organization. (1974).International Convention for the Safety of Life at Sea (SOLAS). London: IMO.

International Organization for Standardization (ISO). (2018). ISO 45001:2018 Occupational Health and Safety Management Systems - Requirements with Guidance for Use. Geneva: ISO.

Kavanagh, P., Guinn, N., & Williams, H. (2019). *Risk-Based Inspection and Maintenance Strategies for Effective Safety Management*. Journal of Safety Research, 70(3), 125–135.

Ministry of Transportation of the Republic of Indonesia. (2021). Regulation of the Minister of Transportation Number PM 57 of 2021 concerning Procedures for Inspection, Testing, and Certification of Ship Safety. Jakarta: Ministry of Transportation of the Republic of Indonesia.

Ministry of Transportation of the Republic of Indonesia. (2024)**.**Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 7 of 2024 concerning Procedures for Inspection and Testing of Ship Safety Equipment. Jakarta: Ministry of Transportation.

Kurniawan, R. (2013). Preventive Maintenance Strategy in Industry. Bandung: ITB Press.

Mintzberg, H. (2017). Managing the Myths of Health Care: Bridging the Separations between Care, Cure, Control, and Community. California: Berrett-Koehler Publishers.

Mangkunegara, AP (2005). Corporate Human Resource Management. Jakarta: PT. Remaja Rosdakarya.

Mobley, R. K. (2019). An Introduction to Predictive Maintenance (2nd ed.). Butterworth-Heinemann.

Modjo, M. (2007). Implementation of Occupational Safety and Health Programs in Increasing Productivity. Jakarta: Salemba Empat Publisher.

Moleong, LJ (2017). Qualitative Research Methodology (Revised Edition). Bandung: PT Remaja Rosdakarya.

Mustofa, S. (1997). Machine and Production Equipment Maintenance Management. Yogyakarta: Andi Offset.

Osborne, D., & Gaebler, T. (1992). Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector. Reading, MA: Addison-Wesley.

Panggabean, M. (2004). Human Resource Management. Jakarta: Ghalia Indonesia.

Schein, E. H. (2008). Organizational Culture and Leadership (4th ed.). San Francisco: Jossey-Bass.

Stoner, JAF, Freeman, RE, & Gilbert, DR (2008). Management (6th ed.). New Jersey: Prentice Hall.

Sugiyono. (2014). Quantitative, Qualitative and R&D Research Methods. Bandung: Alfabeta.

Supandi, R. (1990). Maintenance and Care Management of Production Machines. Jakarta: Rineka Cipta.

Terry, G.R. (2010). Principles of Management (11th ed.). Illinois: Richard D. Irwin.

Thomas, R.D. (2013). Policy Analysis and Governance. New York: Routledge.

Terry, G.R., & Rue, L.W. (2010). Fundamentals of Management. New York: McGraw-Hill.

Wijayanti, R. (2008). Basics of Management and Leadership. Jakarta: PT Gramedia Pustaka Utama.

Wati, S. (2009). Maintenance and Care Management of Production Machines. Bandung: ITB Press.

Williams, P. (1965). Principles of Management. New York: McGraw-Hill.

Scientific Journal

Ardila, Febrina Eka. (2020). Analysis of the Implementation of Patrol Boat Operation Plan Activities at the Class II Tanjung Perak Surabaya Sea and Coast Guard Base (PPLP). Repository. PIP. Semarang.

Indriyani, EAS, Rayendra, A., & Hartanto, DR (2023). Maintenance of Liferaft Ship Safety Equipment and Light Fire Extinguisher Equipment of TB. Rizaluta Patra 3202 Ship by PT. Spectra Tirtasegara Line. Saintara: Scientific Journal of Maritime Sciences, 5(2), 121-130.

Muliadi, Bustamin, & Fauziah, GN (2020). Optimization of Safety Equipment Maintenance on the MT. Jayne-1 Ship. Journal of Scientific Works of Taruna Andromeda, 8(1), 45-56.

Nasution, M., & Sari, N. (2021). Evaluation of the Effectiveness of Safety Equipment Maintenance on Merchant Ships. Indonesian Maritime and Logistics Journal, 6(2), 121–134.

Rachman, A., & Santoso, H. (2020). *Implementation of Digital-Based Maintenance System in Increasing Ship Efficiency and Safety*. Journal of Maritime Engineering, 9(1), 15–25.

Robson, L.S., Clarke, J.A., Cullen, K., & Bielecky, A. (2021). *The Effectiveness of Occupational Health and Safety Management System Interventions: A Systematic Review*. Safety Science, 143, 105–113.

Sitepu, F. (2017). Optimization of Safety Equipment Maintenance as a Support for Crew Safety at KN. Bima Sakti. Marine Dynamics, 6(3), 210-220.

Sitorus, H., & Sihombing, M. (2021). Evaluation of CMMS Implementation in the Shipping Industry. Journal of Maintenance Systems, 12(1), 1–10.

Wulandari, L., Putri, S., & Ramadhan, A. (2022). *Analysis of the Effectiveness of Safety Equipment Maintenance Systems on Passenger Ships*. Journal of Maritime Transportation, 4(1), 89–102.

Zhang, Y., & Xie, M. (2021). *Integrating IoT and CMMS for Smart Maintenance Management*. Computers in Industry, 129, 103448.

Director General of Transportation (2025).https://hubla.dephub.go.id/home/post/read/9202/pangkalan-plp-kelas-ii-tanjung-perak-komit-jagakeselamatan-dan-keamanan-pelayaran-di-perairan-indonesia