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Analysis of Determining Criteria on Nautical Safety Tools to Maintain Marineable Ship Optimization in Pt Pelni Indonesia

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Abstract:- PT PELNI (Persero) is a ship transportation company that provides the best service for customers. The Focus Group Discussion (FGD) and Analytical Hierarchy Process (AHP) methodologies were used to identify the most important factor in the discrepancy in the quality of safety equipment on board PT PELNI (Persero) ships. In this study, four main criteria of non-conformance of nautical safety tools were identified. They are maintenance time, quality, cost, and technique. According to the findings of this study, the most prioritized criterion was the maintenance schedule. Using each criterion and its sub-criteria, the weight of each alternative is then calculated. The lifeboat with the highest value weight is the most important alternative.

Keyword:- *Nautical Safety Tools, Ship Optimization, Analytical Hierarchy Process (AHP).*

I. INTRODUCTION

Indonesia is the world's largest archipelagic country. Therefore, sea transportation is essential to the operations of some citizens and supports the tourism potential around the seas (Astri, 2020). On board the ship, crew members face many perils. Collisions, fires, leaks, drowning, and running aground are 80% human caused. Other hazards, such as storms and the sea's geography, are natural. SOLAS 'Amendment 2009 requires ships to carry safety equipment to avoid these threats. SOLAS 2009 Amendment Chapter 3 (Life-Saving Appliances and Arrangements) requires lifeboats, life rafts, lifebuoys, lifejackets, immersion suits, and other safety equipment on board (Rudiana & R.Safitri, 2020). PT PELNI (Persero) is an Indonesian state-owned maritime firm that provides passenger and inter-island transportation. The competitive service sector is growing. Transportation service providers must create market-capturing strategies (Megawati et al., 2021).

Society and businesses need affordable sea shipping. Shipping companies are adding ships to fulfill community needs. Unfortunately, some companies don't provide a board with safety equipment, thus endangering the crew (Cholil, 2016). The IMO and the ISM Code are two rules that guide shipping activities. IMO, a UN agency for the shipping sector, has compiled and established the ISM Code (International Safety Management Code). The ISM Code covers ship management, crew and passenger safety, and pollution avoidance. ISM Code Code 10 concerns ship and equipment maintenance.

Planning, maintenance, and good company-ship coordination help the ship operation run smoothly. Through planned maintenance, the main engine and auxiliary engines can be directly supervised. Docking and repair should be done regularly (Bangun & Hariyono, 2019). In reality, ship maintenance plans often don't happen due to a tight ship schedule, lack of office-ship communication, and difficulty procuring spare parts. Based on the description, it's required to examine ship maintenance performance to evaluate the effectiveness of ship maintenance and repair schedule. To provide an alternate approach for effective ship maintenance schedule to increase ship performance and maximize operational day (Bangun & Hariyono, 2019).

Previous studies analyzed ship SOLAS (Safety of Life at Sea) regulations. Safety equipment affects a company's production, thus it's important to optimize it on ships (Saputra, 2021). Based on the background, the problem is that there are still reports of non-compliance with nautical-safety-tools, thus it's required to analyze the selection of determining factors for nautical safety tools to maintain the optimization of seaworthy vessels at PT. PELNI (Persero).

II. LITERATURE REVIEW

A. Optimization

Optimization is the effective and efficient achievement of desired goals. Ship performance optimization leads to lower shipping costs (Pradana et al., 2020). The goal of optimization could be either maximization or minimization. Maximization is used when the objective of the optimization is profit, revenue, etc. While minimization is used for optimization purposes involving cost, time, distance, etc. Optimization is needed in various activities. Moreover, optimization is related to service to the community.

B. Seaworthiness

Worthiness of ship and shipping safety are supported by facilities and infrastructure. Safety issues overlooked increase ship accident risk. Seaworthiness and navigational regulations ensure water transportation safety and security. Certificates and ship's documents prove each ship's seaworthiness (Sitepu, 2017).

C. Nautical Safety Tools

Nautical is the study of sailing and driving ships. In addition to these regulations, the readiness of the ship's crew, equipment, and auxiliaries are key to a successful rescue at sea (Patayang & Lia, 2019). Regulation 4SOLAS '74 regulates the readiness of rescue equipment.

1. General rules guiding arrangements on ships for lifeboats, life rafts, and floating equipment.
2. Lifeboats, life rafts, and other floating equipment must meet the following conditions to be considered ready:
   a. The current may be lowered into the sea swiftly and safely under adverse conditions and a slope of 1
   b. The boarding of lifeboats and life rafts must be smooth and organized.
   c. Lifeboats, life rafts, and other floating equipment must not impede operation.
3. Before leaving port and throughout the cruise, all auxiliary equipment must be in good condition and ready to use.

Ship accidents typically suggest noncompliance with international and national shipping conventions by domestic shipping corporations, particularly Law No. 17 of 2008 Regarding Shipping Safety and SOLAS.

D. Ship Maintenance

Ships are one of the most efficient means of transportation and are money-making machines for shipping companies or ship owners. To maintain good ship performance and to increase the economic value of the ship, it is necessary to maintain an efficient ship so that it does not have a significant effect on the operations of the ship itself. Compelling maintenance includes reducing the risk of failure to meet the productivity of the equipment, maintaining crew safety, and minimizing the risk of environmental pollution (Efendi, 2016).

Maintenance (maintenance) ensures that each physical asset continues to do what its users want; what users want depends on where and how the asset is used according to its operational context. There are two categories of ship maintenance: planned maintenance (preventive maintenance) and emergency maintenance. Planned maintenance is preventive maintenance, by preparing as early as possible through inspection, maintenance, and replacement of spare parts. While emergency maintenance is maintenance that is repairing after damage or non-compliance occurs (Gross, 2000).

E. Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process method is a research method carried out to obtain a priority scale through measurements starting from pairwise comparisons and assessing experts in the field studied (saaty, 2014). The primary function of the AHP method is to assist researchers in problem-solving and quantitative decision-making. AHP has three principles of analysis, the principle of hierarchy, the principle of setting priorities, and the principle of logical consistency. (Bahri & Soepangkat, 2015)

F. Planned Maintenance System (PMS)

Planned Maintenance (PMS) is a maintenance system carried out on machinery and other equipment on board in a planned and continuous manner, based on the instructions of the manufacturer of each tool to avoid breakdowns that can hinder the smooth operation of the ship. The ship enters the PMS data received into the ship's computer. Every time the ship carries out maintenance and repairs, it is recorded on the computer report. When an inspection is held, whether by an Internal audit/External audit officer, a Class Surveyor, an inspecting officer from Port State Control, or other authorized parties, it can be used as evidence when the ship docks at the port. The port state Control will also check the implementation of the PMS.

G. Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a maintenance activity that includes all company elements, aiming to create a critical mass in the industrial environment to achieve zero defects and zero accidents (Kurniawan, 2013). TPM aims to maximize the efficient use of the equipment and establish a preventive maintenance system designed for the entire equipment.

H. Non Conformity

The definition of a non-conformity according to ISO 9000:2000 is an inability to meet requirements. There are two types of discrepancies, namely minor and significant. A finding includes Minor non-conformities if they do not have a severe impact on the management system and are often caused by human error and are given a specific time limit to correct them. An audit finding is said to be in a Major category. If it is not following the requirements of the Management System, that should be implemented, and immediate corrective action must be taken.

III. METHODOLOGY

This research is mixed method research. Quantitative research methods are carried out using the Analytical Hierarchy Process (AHP) method to find the type of Nautical Safety Tools that is dominant as a non-conformity finding. At the same time, the descriptive qualitative method will use the Focus Group Discussion (FGD) method to determine what efforts will be taken from the several available options from the AHP method's

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results to suppress the findings of non-conformities in the Nautical Safety Tools.

IV. RESULTS

This study aimed to define the criteria for evaluating non-conformance in nautical-safety-tools on board, examine what efforts may be made to complete and minimize non-conformance of nautical-safety-tools, and provide recommendations for nautical-safety-tools based on company standardization. The author conducted a pre-survey in the data collection process by distributing questionnaire links to 30 respondents. As explained in the previous description, the data was obtained and processed further and held to obtain information related to criteria and alternatives that will be used and analyzed through AHP to decide which type of safety equipment will be prioritized. In this study, the author uses the Analytical Hierarchy Process (AHP) method to determine the results of the research and discussion. The basic principles of the Analytical Hierarchy Process (AHP) method are Decomposition, Comparative Judgment, Synthesis of Priority, and Consistency. For the first level, the criteria used in this study are Maintenance Schedule, Quality, Cost, and Technical. The second level is a sub-criteria of the first level. Meanwhile, the third level shows alternatives in the form of types of safety equipment. This study took six types of safety equipment: lifeboats, life jackets, lifebuoys, gas detectors, line throwing, and ILR (Inflatable Liferaft).

In Comparative Judgment, each element of the criteria and alternatives is compared in pairs. The figures included in the pairwise comparison matrix were obtained from interview questionnaires conducted during the FGD using a sample of 10 respondents of stakeholders related to safety equipment on board. The criteria for using pairwise comparisons are based on a comparison scale of 1-9, according to Thomas L. Saaty's theory using expert choice 11 software (Nusraningrum et al., 2021).

The data from the calculation of pairwise comparisons between variables in determining the existence of discrepancies in ship safety equipment for level 1 criteria are as follows:

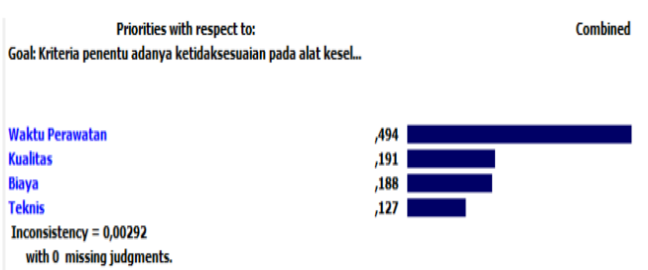

Fig 1 Criteria in Goal
Remark : Waktu Perawatan (Maintenance Schedule)
Kualitas (Quality)
Biaya (Cost)
Teknis (Technical)

The calculation results from pairwise comparisons between sub-criteria on the treatment time criteria, each weight is obtained as shown in the figure 2:

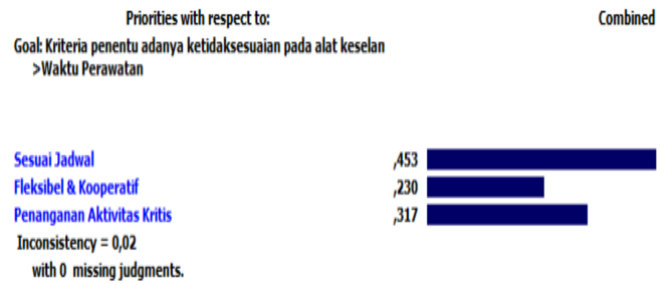

Fig 2 Sub-criteria Maintenance Schedule

Remark: Sesuai Jadwal (on-time schedule)
Fleksibel & Kooperatif (Flexible and cooperative)
Penanganan Aktivitas kritis (Critis activity)

The calculation results from pairwise comparisons between sub-criteria on quality criteria are shown in Figure 3.

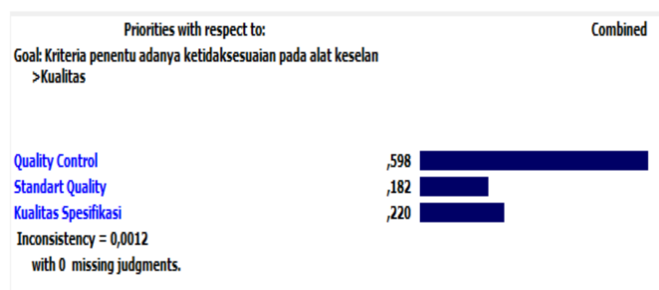

Fig 3 Sub-criteria Quality

Remark: Kualitas spesifikasi (Specification Quality)

The calculation results from pairwise comparisons between sub-criteria on the cost criteria are shown in Figure 4.

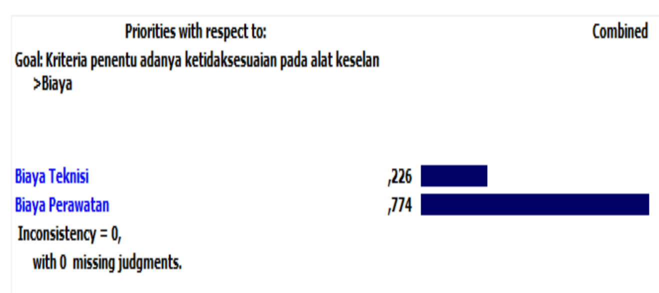

Fig 4 Sub-criteria Cost
Remark: Biaya teknisi (Technician Cost)
Biaya Perawan (Maintenance Cost)

The calculation results from pairwise comparisons between sub-criteria on technical criteria are shown in Figure 5.

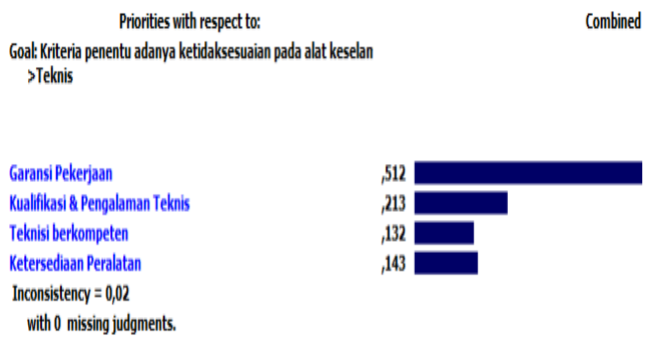

Fig 5 Sub-criteria Technical
Remark: Garansi pekerjaan (Work Guarantee)
Kualifikasi & Pengalaman teknis (Qualification & Experience)
Teknisi berkompeten (Competent technician)
Ketersediaan peralatan (Equipment availability)

The data from the calculation of pairwise comparisons between alternatives in the sub-criteria (W1) according to the maintenance schedule the following results

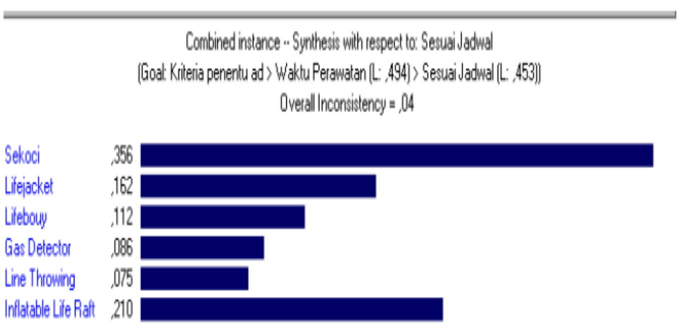

Fig 6 Sub-criteria Alternatives Maintenance Schedule

Furthermore, the calculation of pairwise comparisons between alternatives in the sub-criteria (W2) is flexible & cooperative.

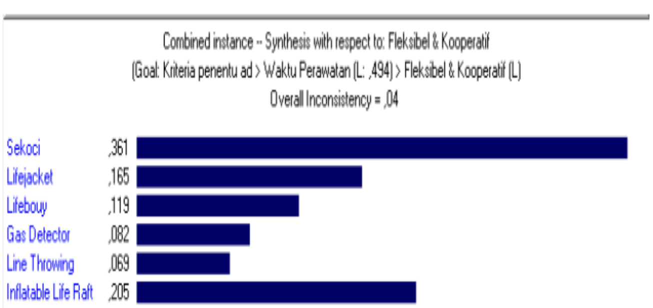

Fig 7 Sub-criteria Alternatives Flexible and cooperative

Pairwise comparisons between alternatives in the sub-criteria (W3) for handling critical activities.

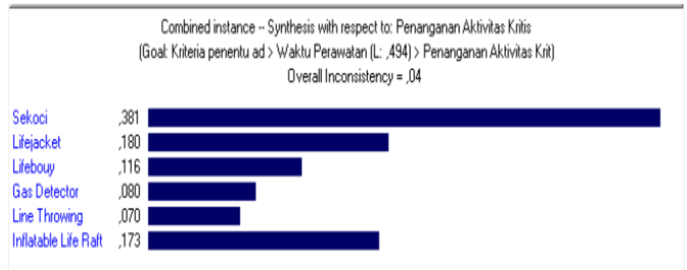

Fig 8 Sub-criteria Alternatives Critical Activities

After the pairwise comparison matrix is found, the next step is to find the eigenvector or average value (local priority).

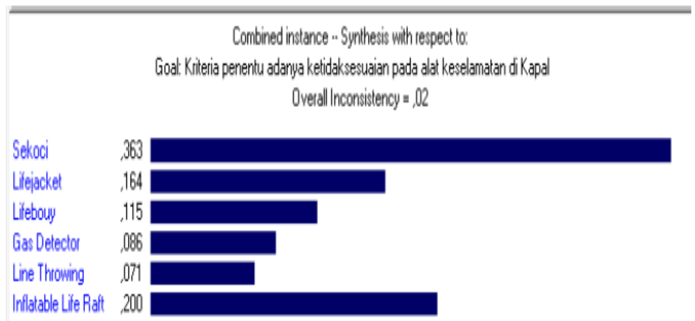

Fig 9 The biggest determining criteria for non-compliance with safety equipment on Ship

This consistency stage aims to determine the correctness of the eigenvector values obtained from the previous synthesis of the priority process. Criteria that can be said to be consistent are those whose CR value is <0.1 or less than 10%. In this study, the Consistency Ratio (CR) value was obtained at 0.0217 or (CR)) < 0.1, which means that the pairwise comparison matrix values for the seven criteria were declared consistent and acceptable.

Overall the most critical determining criteria discrepancy in the safety equipment on board the ship is the lifeboat as the priority with a weight value of 36.3%. The second priority is the Inflatable Life Raft (ILR), with a weight value of 20%. The third priority is Lifejacket, with a weight value of 16.4%. The fourth priority is Lifebuoy, with a weight value of 11.5%. The fifth priority is the Gas Detector with a weight value of 8.6%, while the last priority is Linethrowing with a weight value of 7.1%.

V. DISCUSSIONS

Based on the research results discussed in the sub-chapter above, it can be seen that the criteria that are the company's priority in determining the findings of non-conformance in safety equipment at PT PELNI are the criteria for maintenance time, quality, cost, and technical. These criteria are taken from recommendations from management as the decision maker in monitoring and maintaining safety equipment on board and the questionnaire results.

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The results that have been processed show that of the four criteria used to select the first determining factor for the incompatibility of the condition of the safety equipment is the maintenance time factor with a weight value of 49.4%. This result strengthens the previous research conducted by Simion et al., 2020 which said that where the ship and its equipment must be maintained and scheduled maintenance is carried out and strived always to be good and functioning. The importance and role of the maintenance process are based on how to maintain scheduled maintenance equipment and systems.

Moreover, the second biggest determining factor is that which is caused by the quality of the safety equipment itself, with a weight value of 19.1%. This result reinforces previous research (Patayang & Lia, 2019), which said that in most of the safety facilities listed above, the brand/quality of the ship must be considered to function more optimally.

Then the third determining factor is caused by the cost of the marine safety equipment on board the ship, with a weight value of 18.8%. These results reinforce previous research conducted by Resobowo (2016), and Tac et al. (2020) in their research that a tool must be able to function correctly and be ready (availability) is also a determining factor in the management of safety equipment maintenance on ships. Moreover, the last determining factor is technically caused by the value of the weight of 12.7%, which also strengthens the previous research conducted by El-khalek et al. (2019).

VI. CONCLUSSIONS

The results of this study reveal that while attempting to gather information connected to the criteria for safety equipment that often arises, there is still a finding of non-compliance with the conditions of the nautical safety tools on board. To determine nautical safety tool nonconformance, time maintenance, quality, cost, and condition are used. PT PELNI (Persero) hasn't optimized ship safety equipment maintenance. Lack of a proper maintenance system could render the ship unseaworthy. As in the previous explanation, 49.4% is affected by not implementing maintenance time according to standards for safety equipment on board. This means that there are several factors, such as schedule (45.3%), flexible and cooperative (23%), and handling critical activities (31.7%).

Based on the findings of this study, researchers recommend that scheduled maintenance be documented and monitored in the Plan Maintenance System (PMS) Application Implementation, which is consistent with previous research (Rudiana, R.Safitri, 2020) and (Simion et al., 2020). Furthermore, the corporation should also apply individual key performance (KPI) to each marine and land employee equally to maintain strong performance, have quality control (QC), and receive equal pay for their work. PT PELNI (Persero) needs to make suitable standardization of scheduled maintenance based on field conditions. Cooperate with the ship operations division regarding the personnel so that there is enough time within 1 week for the crew to do periodic maintenance. This study's findings are consistent with earlier research (Resobowo, 2016).

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