DETERMINATION OF DEPOT LEVEL MAINTENANCE AT WARSHIP USING ANALYTICAL HIERARCHY PROCESS (AHP) AND TOPSIS METHOD

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KRI maintenance is carried out at three separate levels based on the resources and capabilities required to carry out maintenance: Organizational, Intermediate, and Depot Levels. Therefore, a solution strategy and maintenance mechanism is needed to deal with these obstacles. This study aims to provide an analysis of determining the depot level maintenance in order to support the readiness of the Marine Operations Command I.

This research uses the Analytical Hierarchy Process (AHP) and TOPSIS method approaches. Based on the results of the study, the Criteria for selecting the Security Level showed that these criteria had the highest weight of 0.181 with a consistency ratio (CR) of 0.093. Then the Criteria for the Use of Technology has a weight of 0.158 as the second criteria. Criteria Cost as the third criteria with a weight of 0.131. While the Operational Time Criteria has a weight of 0.061 as the criteria with the lowest weight.

Based on the results of research using the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method, it can be concluded that the first rank comes from TUX with a weight of 0.772. IBX as the second alternative with a weight of 0.633. KRI SRE as the third alternative with a weight of 0.600. PTX as the fourth alternative with a weight of 0.587. While SSX with a weight of 0.274 as the last alternative because currently (2021) is carrying out maintenance at the depot level.

Key Words: *Depot Level Maintenance, Indonesia Warship (KRI), Analytical Hierarchy Process (AHP), TOPSIS (Technique For Others Reference by Similarity to Ideal Solution).*

1. INTRODUCTION

The availability of budget for the maintenance and repair of the *KRI* is one of the obstacles that is quite difficult for the Navy in carrying out the scheduled and planned maintenance of the defense equipment (Sarjito, 2020). This is because the PMS (Plan Maintenance System) requires relatively large costs and a long time to support its programs. So that in its implementation the predetermined PMS (Plan Maintenance System) schedule is often missed and what happens next is as long as a system / spare part has not been damaged, the component will continue to operate (Ardhi, et al., 2018).

The life cycle of the *KRI* (Indonesian Warship) is determined by the implementation of maintenance and repairs carried out. Thus, operational demands and expectations change both strategically and tactically over its lifetime. *KRI* maintenance is carried out at three separate levels based on the resources and capabilities required to carry out maintenance: Organizational, Intermediate, and Depot Levels. Therefore, a solution strategy and maintenance mechanism is needed to deal with these obstacles.

This study aims to provide an analysis of determining the depot level maintenance in order to support the readiness of the Marine Operations Command I. This research uses the Analytical Hierarchy Process (AHP) and TOPSIS method approaches. The AHP method is used to determine the selected criteria in the implementation of depot level maintenance. The TOPSIS method is used to analyze the priority of the KRI Parchim class in determining the depot level maintenance.

Previous studies related to AHP and TOPSIS are Implementing Fuzzy TOPSIS on Project Risk Variable Ranking (Husin, et al., 2019), Risk Management and Control of Dams Based on Integrating TOPSIS and RAM-D Techniques (Case Study: Paveh Rood Dam, Iran) (Sadeh & Rezaian, 2017), Risk Assessment Using Fuzzy TOPSIS and PRAT for Sustainable Engineering Projects (Koulinas, et al., 2019), Urban Network Risk Assessment Based on Data Fusion Concept using Fuzzy-AHP, TOPSIS and VIKOR in GIS Environment (Rokhsari & Sadeghi-Niaraki, 2015), Project Risk Assessment in Enterprises with the Use of TOPSIS Method in the 2014–2020 Perspective (Walaszczyk, 2016), Using Fuzzy AHP And Fuzzy TOPSIS Approaches For Assessing Safety Conditions At Worksites In Construction Industry (Basahel & Taylan, 2016), Risk Management In Urban Tunnels Using Methods Of

Game Theory And Multi-Criteria Decision-Making (Nikkhah, et al., 2019), A Hybrid Fuzzy TOPSIS – Best Worst Method for Risk Prioritization in Megaprojects (Norouzi & Namin, 2019), Group Decision-Making Using Improved Multi-Criteria Decision Making Methods for Credit Risk Analysis (Wua, et al., 2016), A fuzzy AHP-TOPSIS Framework for The Risk Assessment of Green Supply Chain Implementation in the Textile Industry (Nazam, et al., 2015), Implementation of AHP and TOPSIS Method to Determine the Priority of Improving the Management of Government's Assets (Febriansyah, et al., 2017), Improved AHP–TOPSIS Model for The Comprehensive Risk Evaluation of Oil And Gas Pipelines (Wang & Duan, 2019) and Risk Level Evaluation on Construction Project Lifecycle Using Fuzzy Comprehensive Evaluation and TOPSIS (Gebrehiwet & Luo, 2019).

This research is expected to develop knowledge in the scope of the planned maintenance system to support the readiness of the KRI. Furthermore, this research is expected to provide input for the Indonesian Navy in determining the maintenance of the depot level in the implementation of KRI maintenance. In this study, there are several limitations of the problem, among others, this research is limited to the work area of the Fleet Command I on the KRI Parchim class. Second, this research was carried out at the depot level maintenance system.

This research consists of several sections. Section 2 explains the theory of maintenance, categories of maintenance, Repair and maintenance in KRI. Section 3 describes the research method consisting of the Analytical Hierarchy Process (AHP) method, the TOPSIS method, research sources, data collection, processing, and data analysis. Section 4 and 5 describes the results of the research analysis and discussion. Section 6 describes the conclusions of the study.

2. LITERATURE REVIEW

2.1. Theory of Maintenance

Maintenance is most commonly defined as all activities aimed at maintaining a system or restoring it to a condition deemed necessary for it to function as intended (Tiddens, 2018). Other definitions include maintenance objectives such as providing services to enable the organization to achieve its objectives and maintaining the system's ability to provide services. Although the definition is quite broad, five specific maintenance responsibilities are generally recognized (Alhouli, 2011):

a. Keep assets and equipment in good condition, properly configured and safe to perform their intended functions;

b. Perform all maintenance activities including preventive, predictive and corrective maintenance, repair, design modification and emergency maintenance in an efficient and effective manner;
c. Preserving and controlling the use of spare parts and materials;
d. Commissioning of new factories and expansion of factories;
e. Operate utilities and save energy.

maintenance concept to apply, which maintenance policy to choose, and so on. Viewed from top to bottom, for example from the strategic level to the operational level, these levels can be classified by the following questions (DeWitt, 1991), 1) What is achieved by maintenance?; 2) How can this goal be achieved?; 3) What triggers the maintenance action?; 4) What is the preferred Maintenance approach?; 5) How is it treated?; 6) How well is the maintenance done?

2.2. Ship Maintenance

Ship maintenance is basically considered in the early stages of ship

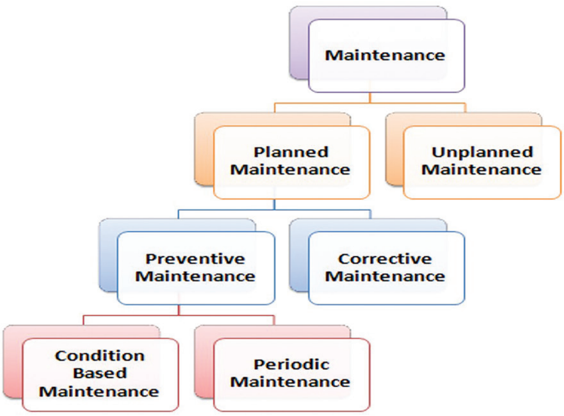

Fig. 1. Philosophy of maintenance (Goossens & Basten, 2014)

Technical maintenance can be divided into several levels, from the strategic level to the operational level. At each level, decisions are made, for example, what the purpose of maintenance is, which

design. Each component in the ship is scheduled to be maintained separately in the maintenance scheduling plan to maximize the functionality of the ship. A ship can be ready if all its major components are operational, such as propulsion, power, air conditioning and cargo engines. If one of the main components is not operational, the ship will be classified as unprepared, and maintenance will be required (Goossens & Basten, 2014).

In the marine industry, ship maintenance and ship repair can be accomplished in two different ways. First, it can be done at the ship repair site when the ship is scheduled to dry dock to survey underwater sections. Second, when is the time for the classification survey (Aldous, 2015).

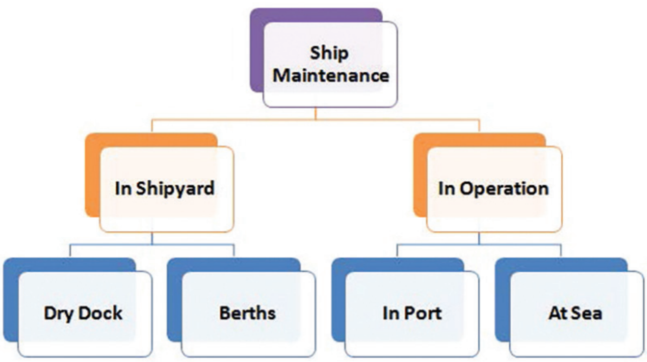

Fig. 2. Ship Maintenance
(Alhouli, 2011)

Ship maintenance, like maintenance other industries, usually uses two types of policies, namely corrective maintenance policies and preventive maintenance policies. A breakdown maintenance policy is usually carried out without preventive maintenance, except for essential lubrication and making minor adjustments. Preventive maintenance involves maintenance to reduce the number of breakdowns, and can take the form of time-based or condition-based maintenance (Alhouli, 2011).

2.3. Repair and Maintenance on KRI

The life cycle of the KRI can be measured in decades. Thus, operational demands and expectations change both strategically and tactically over its lifetime. Combine this adaptability with the length of time required with similar vessels, to design, build and maintain. Life cycle maintenance includes depot maintenance, intermediate maintenance, and maintenance at the organizational level (Resobowo, et al., 2014). Depot maintenance, or D-level, includes "a major overhaul or complete rebuild parts, assemblies, subassemblies, and final goods, including the manufacture of parts." This complex level of repair is carried out at a depot level facility, such as a shipyard. Any work that requires the boat to be out of the water (e.g. In dry dock) is usually D-level maintenance (DeWitt, 1991).

Intermediate maintenance, or level-I maintenance, includes smaller repair work that is usually done on the dock side. Organizational level maintenance is carried out by the crew on board and consists of preventive maintenance and day-to-day servicing. Vessel maintenance is carried out at three separate levels based on the resources and capabilities required to carry out maintenance: Organizational, Intermediate, and Depot Levels (Resobowo, et al., 2014).

Depot level maintenance (D-Level) consists of maintenance that requires resources or capabilities that exceed Tier-I capabilities. D-Level maintenance must be carried out by a naval shipyard or private shipyard. For submarines, this usually includes maintenance that requires the vessel to be in a dry dock facility. The ship's D-Level maintenance period is identical to the approval of the CNO (The Chief of Naval Operations) or the Chief of Naval Staff and is exclusively scheduled at a naval shipyard unless the naval shipyard is at capacity limit. For the purposes of this analysis, all analyzed D-Level maintenance is carried out by the general shipyard (Bates, 1978).

3. MATERIAL/METHODS

3.1. Analytical Hierarchy Process (AHP)

AHP describes complex multi-factor or multi-criteria problems into a hierarchy, according to Saaty hierarchy is defined as a representation of a complex problem in a multi-level structure, where the first level is the goal, followed by the factor level, criteria, sub-criteria and so on down until the last level of alternatives with a hierarchy of a complex problem can be described in groups which are then arranged into a hierarchy as the problem will appear more structured systematically (Kurian & Tech, 2016).

One of the main advantages of AHP that distinguishes it from other decision-making models is that there is no absolute consistency requirement. So that the existing problems can be felt and observed, but the completeness of the numeric data does not support quantitative modeling of the problem (Muinde, et al., 2014).

There are 7 pillars that are used and must be considered in AHP modeling, including 1) Ratio scale is a comparison of two values (a/b) where the values of a and b are the same type (unit); 2) Pairwise comparisons; 3) Conditions for the sensitivity of the eigenvectors; 4) Homogeneity and clustering;

5) Synthesis; 6) Maintaining and reversing the order of weighting and ordering in the hierarchy; 7) Group considerations (Ozsoy & Yilmaz Ozsoy, 2018).

Humans instinctively can estimate simple quantities through their senses. The easiest process is to compare two things with a reliable comparison accuracy. For this reason, Saaty, set a quantitative scale of 1 to 9 to assess the comparison of the importance of an element to another (Saaty, 1990)

The steps of the AHP method include (Mutmainah, et al., 2017):

a. Create a pairwise comparison matrix.

b.

$$A = a_{im} = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{bmatrix} \quad (1)$$

i, m = 1, 2, ... , n = related criteria index.

Table 1. AHP Scale.

Interest Scale	Definition	Explanation
1	Equal Importance	Two activities contribute equally strongly to the goal
3	Weak Importance	One activity is slightly more important than the other
5	Strong Importance	One activity is more important than the other
7	Very Strong Importance	One activity is very important compared to other activities
9	Absolute more Importance	One activity is very, very important compared to other activities
2, 4, 6, 8	Middle value	
Reciprocal	Describing the dominance of the second alternative over the first alternative	

(Saaty, 1990)

c. Create a criterion value matrix.
d. Create a Sum Matrix for Each Row.
e. Assessment of Consistency Index (CI) and Consistency Ratio (CR).

$$CI = \frac{\lambda maks - n}{n}; \quad (2)$$

$$CR = \frac{CI}{RI} \quad (3)$$

N = Number of Elements,

RI = Random Consistency Index.

If the CR ratio is 0.1 (ie 10%), the matrix is said to be consistent and the decision W is accepted. On the other hand, CR beyond that implies too many contradictions in the matrix. Anticipation of the latter situation is to review the matrix, then revise the weights loaded by the vector.

and Hwang in 1981. This method uses the principle that the chosen alternative must have the closest distance from the positive ideal solution and the farthest from the ideal solution. Negative from a geometric point of view. Determination of the relative proximity of an alternative to the optimal solution is done by calculating the Euclidean distance. The TOPSIS method considers the distance to the positive ideal solution and the negative ideal solution by taking the value of relative proximity to the positive ideal solution (Walaszczyk, 2016).

The positive ideal solution itself is defined as the sum of all the good values that can be achieved for each attribute, while the negative-ideal solution consists of all the worst values achieved for each attribute. This method is widely used to complete practical decision

Table 2. Random Consistency Index Value.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

(Saaty, 1980)

3.2. TOPSIS (Technique for Others Reference by Similarity to Ideal Solution)

TOPSIS (Technique For Others Reference by Similarity to Ideal Solution) is a multi-criteria decision-making method introduced by Yoon

making. This is because the concept is simple and easy to understand, computationally efficient, and has the ability to measure the relative performance of decision alternatives (Basahel & Taylan, 2016).

The following are the steps of the TOPSIS algorithm in making conclusions (Husin, et al., 2019):

a. Define the problem to be solved using the TOPSIS method.
b. Make a decision matrix according to the problem to be solved, then normalize the matrix with the equation.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (4)$$

Where rij is the normalized matrix of the basic matrix of the problem, with i = 1,2,3,....m, and j = 1,2,3 ... n. While xij is the basic matrix to be normalized. For each i denotes the rows of the matrix, and for each j denotes the columns of each matrix.

c. Normalize the rij matrix using the weight rating so that a normalized weight rating matrix is obtained, the equation used is as follows

yij = wi x rij …………………………

(2) where yij is the rating matrix weighted, wi is the weight of the ith rating, and rij is the matrix normalized in the second step. For i = 1,2,..., m, and j = 1,2, .., n. In this case, the rating's weight must be determined based on the number of decision variables being completed.

d. Determine the positive ideal solution (A+) and negative ideal solution (A-) based on the weighted rating matrix value in step 3. The following equation is used to find the value of the positive ideal solution +=(y1+,y2+,…,yn+).. (3) and to find the value of the negative ideal solution, the following equation is used =(y1−,y2−,… ,yn−) provided that:

$$y_i^+ = \begin{cases} \max y_{ij}: \ if\ i\ is\ benefit\ attribute \\ \min y_{ij}: if\ j\ is\ a\ cost\ attribute \end{cases}$$

$$y_i^- = \begin{cases} \max y_{ij}: \ if\ i\ benefit\ attribute \\ \min y_{ij}: if\ j\ is\ benefit\ attribute \end{cases}$$

e. Determine the distance between the weighted value of each alternative to the positive ideal solution and the negative ideal solution. To determine the distance between the weighted value of each alternative to the positive ideal solution, the following equation is used:

$$D_i^+ = \sqrt{\sum_{i=1}^{n} \left(y_i^+ - y_{ij}\right)^2} \qquad (5)$$

Meanwhile, to calculate the distance between the weighted value of each alternative to the negative ideal solution, the following equation is used:

$$D_i^- = \sqrt{\sum_{i=1}^{n} \left(y_{ij} - y_i^-\right)^2} \qquad (6)$$

f. The last step is to calculate the preference value for each alternative with the equation:

$$V_i = \frac{D_I^-}{D_I^- + D_I^+} \quad (7)$$

3.3. Steps

The research method used in this research is to use a quantitative approach. The main data come from interviews and questionnaires from six selected Experts. In addition, there are also several secondary data sources that come from books, journals, planning policies (Jakren), as well as compilations of regulations related to research. Experts are selected according to the needs of the relevant research object in supporting the depot level maintenance system with a total of three personnel and having work experience of 20 years.

In this study, the distribution of questionnaires was used to identify the criteria related to the determination of depot level maintenance and to analyze the determination of priorities in the implementation of depot level maintenance on KRI Parchim class. This research used unstructured/open interview method. Unstructured interviews are flexible, the structure of the questions and the wording of each question can be changed during the interview, according to the needs and conditions of the interview. Observation activities in this study were carried out to collect data: infrastructure, HR activities, security level, instruments, related to determining the depot level maintenance and to analyze priority setting in the implementation of depot level maintenance at KRI.

In this study, data analysis used AHP and TOPSIS methods assisted by Expert Choice software and Microsoft Excel. Microsoft Excel is used to identify and analyze ratio coefficients and to accumulate the weighting of each expert in the research subject.

3.4. Research Goal

In this study, the research objective is to identify and analyze criteria with weighting related to determining the maintenance level of the Depot.

a. In this step, the interview method is used to identify the criteria and the AHP method is used to give weighting of the criteria.
b. The second step is to analyze the determination of priorities in the implementation of depot level maintenance at the KRI. In this step the priority determination uses the TOPSIS method.

3.5. Flowchart

This research consists of two stages in solving research questions according to the framework diagram in Figure 3. The first stage begins with the identification of the problem formulation and continues with the analysis of the criteria related to the maintenance of the depot level at the KRI in the working area of Koarmada I in supporting the task of marine operations. The second stage aims to provide an analysis of determining priorities in the implementation of depot level maintenance on KRI.

in the KRI then related models and instruments would be made. Based on the research results, it is explained that this system has 8 (eight) main criteria. In order to get the value of the criteria, various types of tests are carried out. The initial weight value of the sub-criteria is obtained by dividing the weight of the main criterion by the number of sub-criteria below it. The initial weight of this sub-criteria is used as a reference

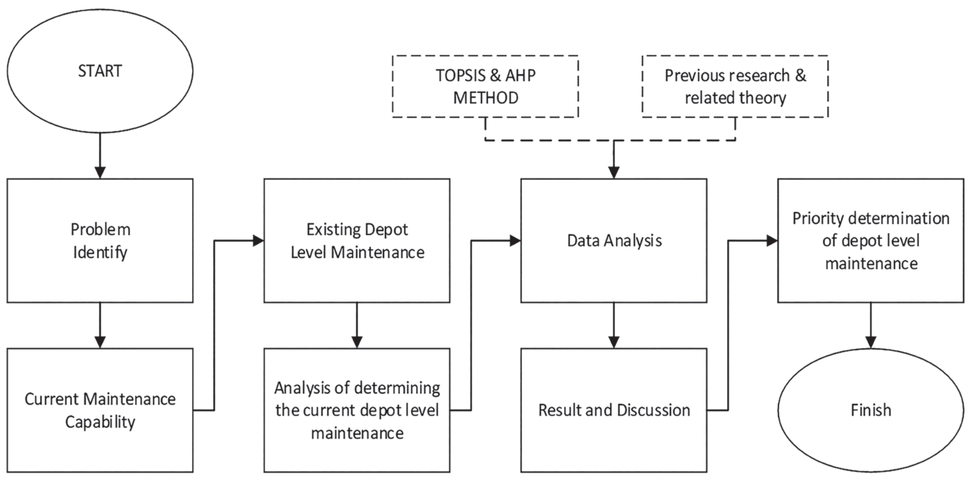

Fig. 3. Flowchart of research.

4. RESULT

4.1. Identification and weighting of criteria

In determining these criteria, literature studies were carried out from several books and Technical Instructions from units regarding the planned maintenance system in determining the weight of the assessment of the overall score after the main criteria weighting process is completed. The identification stage of the criteria that will be used to determine the depot maintenance KRI is the result of an agreement with several experts with initial proposals from researchers.

Table 3. Data Expert Results of KRI Maintenance Level Criteria.

CODE	CRITERIA	CODE	CRITERIA
C-1	Characteristics	C-5	Operational time
C-2	Reliability	C-6	Cost
C-3	Use of technology	C-7	Resource Availability
C-4	Security level	C-8	Human Resources

The next step is to calculate the weight of the criteria from the pairwise comparison matrix between criteria. The results of the comparison of the level of importance between the criteria are then entered into the pairwise comparison matrix. In order to obtain the weight of the assessment of each variable, a paired comparison rating scale table is made.

Table 4. The value of the weight of the KRI maintenance level criteria.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	Weight
C1	1	1	1/2	1	2	3	1/2	1/2	0.124
C2	1	1	1	1/2	2	2	1/2	1/2	0.111
C3	1	2	1	1	2	1	2	2	0.158
C4	1	2	1	1	2	2	2	3	0.181
C5	1/2	1/2	1/2	1/2	1	1/2	1/2	1/2	0.061
C6	1/3	1/2	1	1/2	2	1	2	3	0.131
C7	2	2	1/2	1/2	2	1/2	1	1	0.120
C8	2	2	1/2	1/3	2	1/3		1	0.114
CR =	0.093								1.000

Table 5. The value of weights and rankings on the KRI's maintenance level criteria.

NO	CRITERIA	WEIGHT	RANK
1	Characteristics	0.124	4
2	Reliability	0.111	7
3	Use of technology	0.158	2
4	Security level	0.181	1
5	Operational time	0.061	8
6	Cost	0.131	3
7	Resource Availability	0.120	5
8	Human Resources	0.114	6

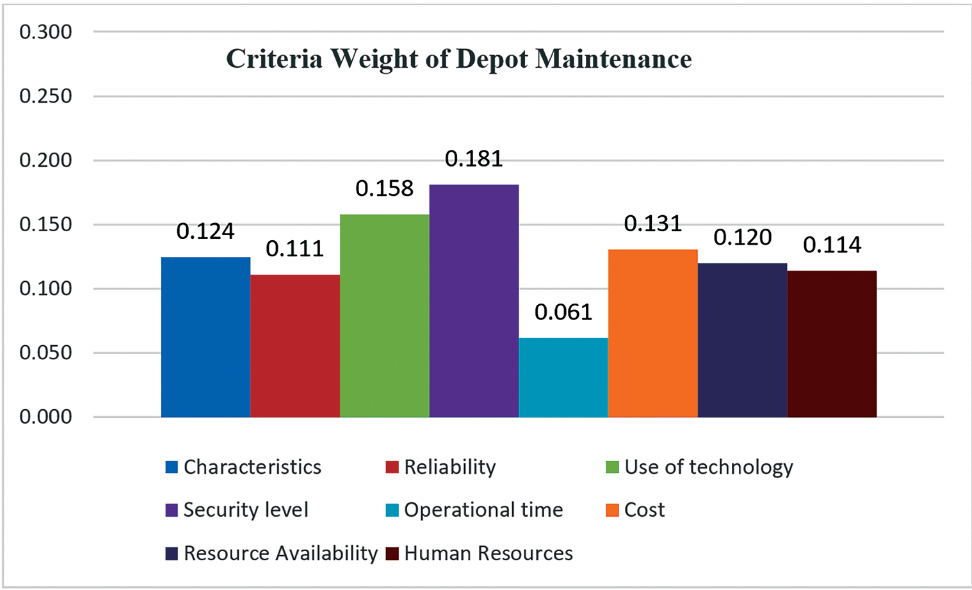

Fig. 4. Histogram of the weight values of the KRI maintenance level criteria.

Based on Table 5 and Figure 4 above, the selection criteria for the Security Level shows that these criteria have the highest weight of 0.181 with a consistency ratio (CR) of 0.093. Then the criteria for the use of technology have a weight of 0.158 as the second criterion. Cost criteria as the third criterion with a weight of 0.131. While the operational time criteria have a weight of 0.061 as the criteria with the lowest weight.

4.2. Depot-level Maintenance Priority Analysis

Decision-making involves certain criteria in determining the maintenance of the KRI Depot level, there is no systematic way of making decisions, causing the consideration of each of the existing criteria to be unclear so that it can result in wrong decisions. TOPSIS method is proposed as an alternative method of decision making that is multi-criteria. Clear decision-making criteria are needed in this method.

In this case, the determination of the maintenance level of the KRI Depot for the Parchim class was carried out by surveying the relevant stakeholders at random. From the survey results, it was found that eight criteria were taken into consideration in determining the maintenance of the KRI Depot level, which would later be calculated using the TOPSIS method.

The steps for calculating TOPSIS in this study are as follows:

a. Build a decision matrix.

Table 6. Paired Decision Matrix.

CRITERIA	C1	C2	C3	C4	C5	C6	C7	C8
PTX	4.6	4.2	4.2	2.6	4.1	4.4	5.0	2.9
CNX	4.4	4.2	4.2	2.7	4.1	4.9	5.0	3.0
STX	4.3	4.1	4.2	2.1	4.0	4.1	4.4	2.7
STX	4.5	4.5	4.6	2.5	4.0	4.4	4.5	2.4
SSX	4.6	4.3	4.5	2.4	4.0	4.7	4.8	2.7
WIX	4.7	4.1	3.9	3.1	3.9	4.6	4.8	3.3
TUX	4.3	4.0	4.0	2.6	3.5	4.7	4.6	3.1
TPX	4.7	4.1	4.2	2.9	4.2	4.6	4.8	3.7
IBX	4.3	3.6	3.8	1.9	4.0	4.4	4.7	2.8
SRX	4.4	4.2	4.3	3.2	3.4	4.6	5.0	3.4

In the decision matrix, the matrix column states the attributes, namely the existing criteria, while the matrix rows represent the alternative, namely school data. The decision matrix refers to m alternatives that will be evaluated based on n criteria. The design of the decision matrix can be seen in Table 6.

Table 7. Criteria preference weight.

	C1	C2	C3	C4	C5	C6	C7	C8
Divide	9.842	9.093	9.266	5.684	8.785	10.035	10.791	6.641

The next step is to determine the preference weight of each of the criteria used in the TOPSIS method. The weight of preference is obtained from the results of the analysis of how important these criteria affect the results. The bigger the effect, the bigger it is or vice versa, the smaller the value, the smaller the value.

b. Normalized matrix calculation.

Table 8. Normalized decision matrix calculation.

	C1	C2	C3	C4	C5	C6	C7	C8
PTX	0.467	0.462	0.453	0.457	0.467	0.438	0.463	0.437
CNX	0.447	0.462	0.453	0.475	0.467	0.488	0.463	0.452
STX	0.437	0.451	0.453	0.369	0.455	0.409	0.408	0.407
STX	0.457	0.495	0.496	0.440	0.455	0.438	0.417	0.361

	C1	C2	C3	C4	C5	C6	C7	C8
SSX	0.467	0.473	0.486	0.422	0.455	0.468	0.445	0.407
WIX	0.478	0.451	0.421	0.545	0.444	0.458	0.445	0.497
TUX	0.437	0.440	0.432	0.457	0.398	0.468	0.426	0.467
TPX	0.478	0.451	0.453	0.510	0.478	0.458	0.445	0.557
IBX	0.437	0.396	0.410	0.334	0.455	0.438	0.436	0.557
SRX	0.447	0.462	0.464	0.563	0.387	0.458	0.463	0.422

The calculation results are based on Table 7, then used to obtain the results of normalization of the decision matrix by calculating the performance rating of each alternative Ai on each Ci criteria. The results of normalization (R) can be seen in Table 8. Normalization Matrix, which has been calculated according to the normalized performance of each alternative on the criteria.

c. Weighted normalized matrix calculation.

After getting the data for calculating the normalized decision matrix, the next step is to start making a weighted normalized decision matrix (y) whose elements are determined. This step is done by multiplying each row of the matrix from each coordinate matrix by the weight of the importance of each selection criteria or determining the level of improvement of the KRI. The result of the multiplication will be the weighted normalized decision matrix value in Table 9.

Table 9. Calculation of the weighted normalized decision matrix.

	C1	C2	C3	C4	C5	C6	C7	C8
PTX	0.058	0.051	0.072	0.083	0.029	0.057	0.056	0.050
CNX	0.056	0.051	0.072	0.086	0.029	0.064	0.056	0.051
STX	0.054	0.050	0.072	0.067	0.028	0.053	0.049	0.046
STX	0.057	0.055	0.078	0.080	0.028	0.057	0.050	0.041
SSX	0.058	0.052	0.077	0.076	0.028	0.061	0.053	0.046
WIX	0.059	0.050	0.066	0.099	0.027	0.060	0.053	0.057
TUX	0.054	0.049	0.068	0.086	0.029	0.064	0.056	0.053
TPX	0.059	0.050	0.072	0.067	0.028	0.053	0.049	0.064
IBX	0.054	0.044	0.065	0.060	0.028	0.057	0.052	0.064
SRX	0.056	0.051	0.073	0.102	0.024	0.060	0.056	0.048

d. Determining the Matrix of Positive Ideal Solution (A+) and Negative Ideal Solution (A-).

Table 10. Distance between the positive and negative ideal solutions.

	C1	C2	C3	C4	C5	C6	C7	C8
A+	0.054	0.055	0.065	0.060	0.024	0.053	0.049	0.041
A-	0.059	0.044	0.078	0.102	0.029	0.064	0.056	0.064

The positive ideal solution (A+) and the negative ideal solution (A-) can be determined based on the normalized weight rating. The positive ideal solution (A+) can be calculated as follows. This step is done by finding the smallest and largest values of each matrix column in Table 10.

e. Calculating the Distance of Positive Ideal Solution (D+) and Negative Ideal Solution (D-).

Table 11. The preference weight of each alternative.

NO	D+	D-
1	0.027	0.026
2	0.032	0.023
3	0.012	0.042
4	0.024	0.035
5	0.023	0.032
6	0.043	0.016
7	0.032	0.023
8	0.026	0.038
9	0.026	0.044
10	0.044	0.019

f. Weighting and ranking.

After getting the results of the relative proximity value, the last step is to rank the alternatives that have been calculated. As Table 12 below:

Table 12. Alternate ranking and maintenance strategy determination.

NO	TYPE OF WARSHIP	WEIGHT	RANK	EXPLANATION
1	PTX	0.587	4	
2	CNX	0.580	5	
3	STX	0.495	6	
4	STX	0.418	7	
5	SSX	0.274	10	
6	WIX	0.305	9	
7	TUX	0.772	1	PRIORITY
8	TPX	0.415	8	
9	IBX	0.633	2	PRIORITY
10	SRX	0.600	3	

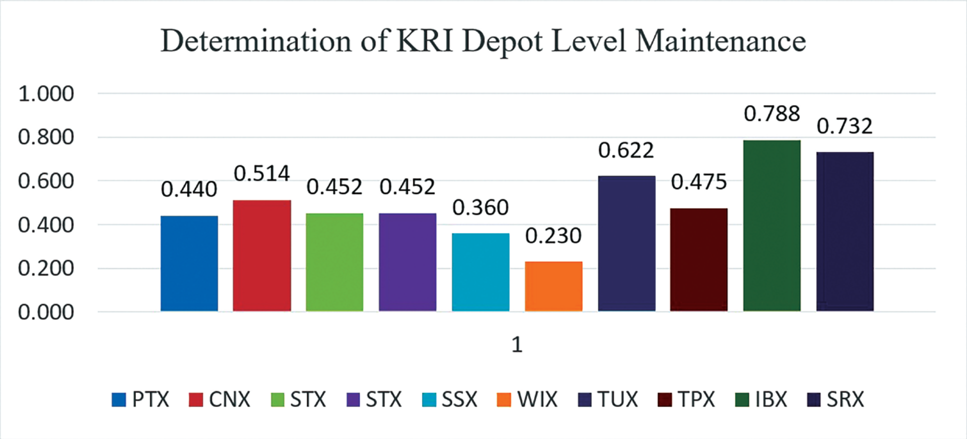

Fig. 5. Histogram Determination of depot level maintenance on KRI.

Based on Table 12 and Figure 5, it can be concluded that the results of calculations using the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method can be concluded that the first rank comes from TUX with a weight of 0.772. IBX as the second alternative with a weight of 0.633. SRX as the third alternative with a weight of 0.600. PTX as the fourth alternative with a weight of 0.587. While SSX with a weight of 0.274 as the last alternative because currently (2021) is carrying out maintenance at the depot level.

5. DISCUSSIONS

Based on Table 5 and Figure 4, in the process of weighting the criteria from the results of the study, it was found that the weight range of several criteria did not have a wide range. The highest score is the Security Level Criteria (C4) with a weight of 0.31. While the criterion with the lowest weight is the Operational Time Criterion (C5) with a weight of 0.061. This condition indicates that from the eight there is no significant difference. These criteria have their respective effects on determining alternative maintenance strategies for KRI.

Based on Table 12 and Figure 5, it can be concluded that the results of calculations using the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method can be concluded that the first rank comes from TUX so that KRI needs to be maintained at the Depot level. As for the second priority for depot level maintenance, namely IBX.

Compared to determining the maintenance of KRI at the depot level in several previous studies, this study provides several advantages, namely providing the determination of the criteria first and giving weight to the criteria for maintaining depots so that it can be seen which criteria have the highest influence value in determining depot level maintenance. Second, in this study it is provided as objective value as possible in determining alternative KRIs that will carry out depot level maintenance activities through the TOPSIS method by asking questionnaires from several related personnel. Third, this depot level maintenance selection model can be tested on other ships in the amphibious ship unit or in the patrol boat unit with notes on similar ships and re-identified for adjustment of the criteria.

6. CONCLUSIONS

Based on the results and discussion in the previous chapter on the analysis of determining the maintenance of the Depot level at KRI using the Analytical Hierarchy Process (AHP) and TOPSIS methods. In the assessment and determination model of the KRI Depot level Maintenance, the first stage is weighting to determine the value of each criteria. The identification stage of the criteria that will be used to determine the KRI depot level maintenance is the result of an agreement with several experts with an initial proposal from the researcher which obtained 8 (eight) criteria. Based on the results of the study, the Criteria for selecting the Security Level showed that these criteria had the highest weight of 0.181 with a consistency ratio (CR) of 0.093. Then the Criteria for the Use of Technology has a weight of 0.158 as the second criteria. Criteria Cost as the third criteria with a weight of 0.131. While the Operational Time Criteria has a weight of 0.061 as the criteria with the lowest weight.

Decision-making involves certain criteria in determining the maintenance of the KRI Depot level, which is carried out by surveying stakeholders. Based on the results of research using the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method, it can be concluded that the first rank comes from TUX with a weight of 0.772. IBX as the second alternative with a weight of 0.633. KRI SRE as the third alternative with a weight of 0.600. PTX as the fourth alternative with a weight of 0.587. While SSX with a weight of 0.274 as the last alternative because currently (2021) is carrying out maintenance at the depot level

Future Work

This study provides several advantages, namely providing the determination of the criteria first and giving weight to the criteria for maintaining depots so that it can be seen which criteria have the highest influence value in determining depot level maintenance. In future research, this model can be used for determining the mid-level maintenance strategy. Second, in this study it is provided as objective value as possible in determining alternative KRIs that will carry out depot level maintenance activities through the TOPSIS method by asking questionnaires from several related personnel. Third, this depot level maintenance selection model can be tested on other ships in the amphibious ship unit or in the patrol boat unit with notes on similar ships and re-identified for adjustment of the criteria.

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