

# DEVELOPING STRATEGY OF MAINTENANCE, REPAIR AND OVERHAUL OF WARSHIPS IN SUPPORT OF NAVY OPERATIONS READINESS

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## ABSTRACT

*Maintenance, Repair, and Overhaul is an action to control, know and ensure the life of a defense equipment. Indonesia should have a concept for maintenance, repair and overhaul in the defense industry. The problem in this research is how to determine priority weighting and development strategy plan for Maintenance, Repair and Overhaul warships implemented by Fasharkan Surabaya to support the readiness of marine operations. The purpose of this study is making a strategic plan for the development of Maintenance, Repair and Overhaul warships carried out by Fasharkan Surabaya in support of marine operations readiness. The method used in this study is the determination of criteria by hierarchy using the Analytical Hierarchy Process (AHP). The results of the study show that Strategic priorities using the AHP concept obtained 5 strategies, namely 1) Cooperation in Higher Education related to technology with the highest weight, 0.42. 2) Improving the quality of Human Resources with a weight of 0.23. 3) Improve Education and Training with a weight of 0.18. 4) Fulfillment of Human Resources according to the List of Personnel Arrangement with a weight of 0.11. 5) Cooperation with the defense industry with a weight of 0.06.*

**Keywords:** Maintenance, Repair and Overhaul, Warships, AHP, Marine Operation Readiness.

## 1. INTRODUCTION

Overall Indonesia has a national Jurisdiction area with an area of  $\pm 7.8$  million km<sup>2</sup> where two thirds of its territory are an area of  $\pm 5.9$  million km<sup>2</sup>, which consists of the Indonesian Exclusive Zone (ZEE) area of  $\pm 2.7$  km<sup>2</sup> and the Regional Sea, Islands and inland waters cover  $\pm 3.2$  million km<sup>2</sup>. Besides that, it has a coastline of  $\pm 81,000$  km, and has 17,499 islands consisting of 5,698 named islands and 11,801 no/unnamed islands. As an archipelago, it is very natural that the sea has a very important meaning for the State of Indonesia (Ralahalu & Jinca, 2013). Where the political sea can give birth to a concept of unity and unity not only in, but can also come out as stated in UNCLOS 1982. As part of the Indonesian National Army, the Navy has a role as a major component of the defense of the sea dimension to carry out its duties based on policies, politics in upholding the country's sovereignty, defending the territory of the Unitary State of the Republic of Indonesia (NKRI), in addition to that the Navy also conducts Military Operations for War (OMP) and Military Operations Other than War (OMSP). Based on this phenomenon, the Navy uses all the strength of its warship fleet to carry out its main tasks in maintaining the sovereignty of the Republic of Indonesia. In carrying out its main tasks the

elements used often experience constraints related to Maintenance, Repair and Overhaul of the engine when experiencing trouble or damage, so that it greatly affects the operating tasks it carries (Manda, Dr.Vidhu, & Chaitanya, 2017).

Maintenance is a process of activities that must be carried out in accordance with the scheduled time in the manufacturing world (Frase, Hvolby, & Tseng, 2015). Maintenance of a very complete system, is a necessity to carry out a very complete and sequential activity and lead to an objective as desired, so that manufacturing can function optimally, functioning within the limits required (Baluch, Sobry, & Shahimi, 2010). The defense industry has a strategic role in defense organization, so when it comes to independence for Indonesian defense, it must also include the independence of the defense industry (Hartati, Muhammad, Kartib, & Muhammad, 2014). Independence in the defense industry means that the domestic defense industry must be able to produce, maintain, operate and be free from the embargo and dictation from other countries. Maintenance, Repair, and Overhaul (MRO) is an action to control, know and ensure the age of Defense and Security as well as the quality of service obtained from the Defense Industry, one of which is the MRO industry.

Although the Indonesian Navy is able to provide maintenance and repair support to its warship elements, there are still a number of obstacles caused by limited facilities and infrastructure as well as the current low work ethic and human resource capabilities. These constraints are the task of the Fasharkan (Maintenance and repair facility) Surabaya which is a work unit that has the main task of organizing and carrying out the repair and maintenance support needed by warships or elements of the Navy that are undergoing repairs in the Surabaya area.

This paper has many literatures to support the research, such as literature with title A supporting framework for maintenance capacity planning and scheduling: Development and application in the aircraft MRO Industry (Duarte, Povoá, & A.P, 2018), Management Changes in MRO Business through Product Lifecycle (Jaakko & JosuTakala, 2016), Optimization of Preventive Maintenance Cycle of Ship Mechanical and Electrical Based on MRO System (Cui, 2019), Flexibility in Service Parts Supply Chain: A Study on Emergency Resupply in Aviation MRO (Aghil, Sean, Fariborz, & Songlin, 2017), Innovating the Maintenance Repair and Overhaul Phase through Digitalization (Marco, Mariangela, & Lorenzo, 2019), Toward the strategic adoption of Lean in aviation Maintenance Repair and Overhaul MRO) Industry (Peter & Ball Peter, 2016).

This research is organized as follows, chapter 1 introduction, chapter 2 shows material and methodology, chapter 3 shows the results of data and discussion, chapter 4 conclusion.

## **2. MATERIAL AND METHODS**

### **2.1. Theory of Defense Science.**

Defense is a face to get to know a country (Ersoz & Karaman, 2011). Defense is a reality that determines the sovereignty and safety of a nation and state. In addition, defense is a national necessity that truly exists in and primary since the sovereignty of a State is recognized. According to Budiarto, State defense grows and develops in a political system related to the implementation of the State defense function within the framework of the political system. There are three important issues that need to be raised in the topic of Defense Science in the international system dimension. First, the existence of defense science must be able to accommodate the interests of the state so that it can be accepted as a theoretical, conceptual and systematic reference by academics. Second, the existence of defense science can take the principles of interaction between relevant countries such as international cooperation for the development of defense science. Third, defense

science develops security concepts, especially human security as a reinforcing factor of defense science in the position of national defense and security.

### **2.2. Strategic Management Theory.**

Good strategy management can bring the organization to be able to implement its strategy through program planning, budgeting processes, performance management systems, changes in organizational structure, and program and project management (Gibbons, Scott, & Cormac, 2015). In addition, strategic management theory can be connected with a strategic planning carried out to plan a strategy in making decisions in order to realize a desired goal.

Another definition of strategic management is a series of fundamental decisions and actions made by top management and implemented by all levels of an organization in order to achieve the goals of the organization (Rastislav & Silvia, 2015).

### **2.3. The Concept of Warship Maintenance.**

Maintenance is a planned maintenance system that is carried out by carrying out all forms of activities and actions as well as programs with the aim of guaranteeing a material during its life cycle (Bozorgpour, Omarae, & asadi, 2017). In the implementation of this planned maintenance system is a form of a systematic effort with the aim that the maintenance of the reliability level of an aircraft equipment on a warship can be used during its life cycle.

Preventive maintenance is a maintenance system that must be carried out based on the aircraft's rotating schedule or operation while the corrective maintenance is carried out when damage occurs outside of preventive maintenance on an aircraft or material. According to the level of difficulty, maintenance is classified as: (1) Maintenance of the organic level, which is supported by the capabilities of the Ship Men, materials and equipment on the ship; (2) Maintenance at the intermediate level, the difficulty level at this stage requires the ability of experts, materials and equipment on the ship so it must be supported by BMT / fasharkan; (3) Depo Level Maintenance, the level of difficulty increasingly requires the help of experts, spare parts and materials that are not supported from BMT / fashars so that they need to be carried out by the shipyard; improve the ability of surgery in the framework of Extension of Use Life based on the results of the study.

#### 2.4. Delphi Analysis Concepts.

The Delphi method is a method that is carried out through the making of a series of questionnaires given to experts to reach a consensus of their opinions (Habibi, Sarafrazi, & Izadyar, 2014). The Delphi method was developed in the early 1950s by Derkley and his associates at Rand Corporation, California. This method is recommended as a form of structured group communication process. Because repeated questionnaires that are used as the main tool can reduce the dominance of individuals in an effort to develop consensus on a matter. This technique aims to avoid friction that occurs due to the prominence of one's ideas that are better than other people's ideas in a forum to reach a concession.

The Delphi concept, expert panelists are chosen and their identity is kept confidential. This group of expert panelists was selected selectively and their position represented a severe number of experts who understood the problem to be found consensus. The expert panelists were then asked to fill in the questionnaire in writing and collect it. After gathering this first result, the panelists' answers will be combined to create new questions in the next round of the questionnaire. The process of taking the answers to the questionnaire will be repeated several times until a consensus is reached on the answers of the expert panelists.

#### 2.5 AHP Analysis Concept.

AHP analysis or Analytical Hierarchy Process is an analytical method developed to find priority order or ranking of various alternatives contained in problem solving efforts (Damdinsuren & Ishdamba, 2017). This analysis was developed by Prof. Thomas Lorie Saaty from Wharston Business School. In complex circumstances, decision making is influenced by many factors that cover a variety of levels and interests. So it is necessary to determine priorities and test the consistency of various options. AHP is basically a general theory of measurement used in an effort to find the ratio scale from discrete or continuous pair comparisons. This comparison can be obtained from the actual size and the basic scale that reflects the strength of feelings and relative preferences.

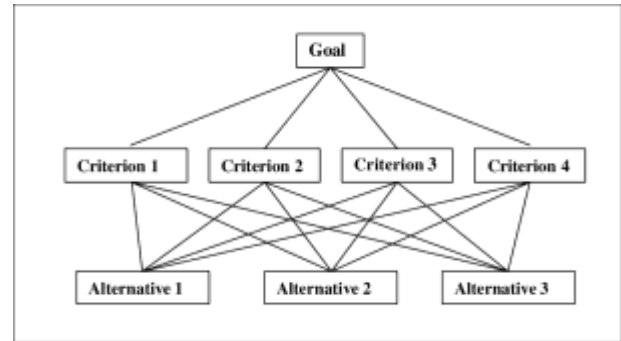


Figure 1: A typical AHP hierarchical structure

AHP itself has four axiomatic bases. The first foundation is the reciprocal comparison, where the pairwise comparison matrix formed must be the opposite. The second foundation is Homogeneity, which is the similarity in making comparisons. The third foundation is dependence, which means that each level or level has a link (complete hierarchy), although there may be an imperfect relationship (incomplete hierarchy). While the fourth foundation is Expectation, which means highlighting assessments that are expectations and preferences from decision making, where this assessment can be either quantitative or qualitative data.

#### 2.6. Navy Operations Readiness

The increased capability of national defense is indicated with increasing defense equipment readiness (Dejan, Zdravko, & Stevo, 2018), and the implementation of joint military training in accordance with the plan. However, overall the development of new national defense produces a posture of national defense with still strength below the standard level of deterrence ability. Stabilization the strength of the Indonesian National Army is carried out through the development of a centralized force, territory, combat units, combat assistance units, units supporters, and the implementation of individual exercises to training a combination of the Indonesian National Army in order to increase the professionalism of the Indonesian National Army personnel.

Increasing the strength of the Indonesian Navy is prioritized for readiness, operational battleships and transports, aircraft and Marine aircraft that are integrated into the Armada Weapon System Integrated. So that in the context of the readiness of marine operations requires conditions where warships can carry out their duties properly without any interruption.

## 2.7. Research Methodology

To solve problems in the observed research, steps are needed and determined to describe the approach and model of the problem. The steps taken are:

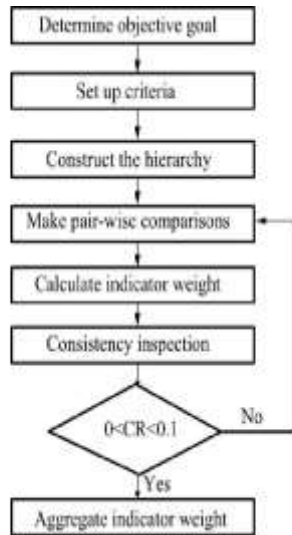


Figure 2: Research Methodology Flowchart.

Target: The purpose of this study is to obtain a strategy that can be implemented in the framework of maintenance, repair and overhaul of warships arranged in order of priority.

Steps: The step of this research is: step 1 filter all criteria that affect the process of maintenance, repair and overhaul of warships with the Delphi method, step 2 conducting the analysis, step 3 analyzing system using AHP, step 4 giving suggestions for improvement and conclusions.

## 3. RESULT AND DISCUSSION

### 3.1. Delphi Analysis to find out the criteria.

The main reason in the development of Maintenance, Repair and Overhaul of warships is the basic impetus that moves the relevant stakeholders in making decisions.

In this case make the best and efficient effort in carrying out Maintenance, Repair and Overhaul of the Navy Warship. So that satisfactory and maximum results can be obtained by utilizing the capability of Fasharkan with the aim that Indonesia does not always depend on a third party, namely the executor of the appointed contractor.

Assessment of the reasons for the need for a strategy of developing Maintenance, Repair and Overhaul of warships in supporting marine operations Based on Research Stages Using the Delphi Concept. Obtained several criteria for the development of Maintenance, Repair and Overhaul of warships, namely: Cooperation with Universities related to technology, Fulfillment of Human Resources according to the List of Personnel Arrangement, Improvement of the quality of Human

Resources, Cooperation with the Defense Industry, Enhancing Education and Training.

From the results of the criteria obtained from the Delphi results, then the priority order will be determined using the AHP.

### 3.2. Determination of Strategy Weight with AHP (Analytical Hierarchy Process)

Prioritize strategy through the Analytical Hierarchy Process method and in this data processing process is done using Excel Software, with the data processed is questionnaire data which is the respondent's / expert's perception of the Criteria of the Maintenance, Repair and Overhaul Development Strategy of the Navy in supporting marine operations. At this stage the weighting of pairwise comparisons of criteria for the development of Maintenance, Repair and Overhaul of warships is weighted between criteria of Cooperation in Higher Education related to technology (X1), Fulfillment of Human Resources according to Personnel List (X2), Improvement of Quality of Human Resources (X3), Cooperation with the defense industry (X4), Enhancing Education and Training (X5).

Table 1: Results of the Normalization Matrix of Criteria.

Criteria	X1	X2	X3	X4	X5
X1	1	5	3	5	2
X2	0.2	1	0.25	4	0.5
X3	0.333333	4	1	5	1
X4	0.2	0.25	0.2	1	0.5
X5	0.5	2	1	2	1

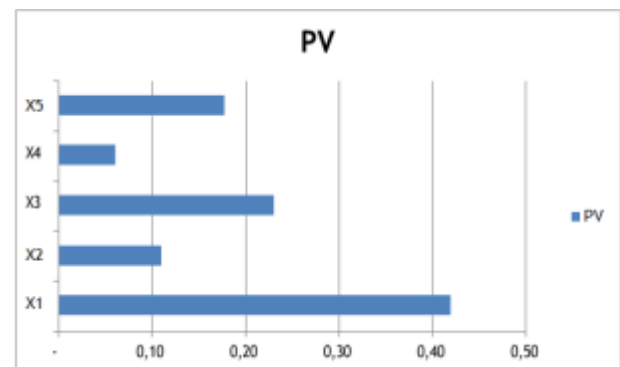


Figure 3: Graph of the results of the Pairwise Comparison Criteria

Based on the results of the total weight value in Figure 3 above, it can be seen that the development strategy which has a large influence in determining the development of Navy Maintenance, Repair and Overhaul in supporting marine operations is: 1) Cooperation in Higher

Education related to technology with the highest weight, 0.42. 2) Improving the quality of Human Resources with a weight of 0.23. 3) Improve Education and Training with a weight of 0.18. 4) Fulfillment of Human Resources according to the List of Personnel Arrangement with a weight of 0.11. 5) Cooperation with the defense industry with a weight of 0.06.

### 3.3. Strategy Formulation

After the results of the various stages of analysis that have been carried out, the next step is to formulate a naval warship Maintenance, Repair and Overhaul Development strategy in order to support marine operations, which includes strategies for fulfilling Human Resources, enhancing the quality of Human Resources, and several collaborative Strategies in terms of improving naval warship Maintenance, Repair and Overhaul. The strategy was made so that in the development of Maintenance, Repair and Overhaul, Navy warships would be able to support marine operations. The following are recommendations for the formulation of the maintenance, repair and overhaul of the naval warships in Fasharkan.

Table 2: Fasharkan Development Table

Fasharkan Development			Road Map (*month)		
No	Code	Strategy Steps	Time	Start	Finish
1		Performing Human Resources in accordance with adjusted qualifications with a List of Existing Personnel	60	0	60
2		Supply of aluminum welding equipment to support ship procurement policies aluminum	12	6	18
3		Upgrade workshop equipment with technology adaptation up to date	24	12	36
4		Improve the ability of slip way up to 500 Tons	24	24	48
5		Improving the ability of Human Resources by carrying out training and Science and Technology Education	36	24	60
6		Establish cooperation with the domestic related shipping industry in the construction and repair of ships	36	24	60
7		Carry out technology transfer in accordance with shipping and technology industry policies marine membership	36	24	60
8		Fasharkan development is aligned with procurement policies the latest defense equipment	12	48	60

### 4. CONCLUSION

With the weighting value obtained in the AHP analysis, the main priority in this development

strategy is the scope of technology, which includes collaboration with related parties in the effort to develop Maintenance, Repair and Overhaul of warships by Fasharkan Surabaya. So the strategy that must be carried out by collaborating with universities related to conducting direct courses in Fasharkan Surabaya both theory and practice with the intention that with limited personnel, but having more ability each individual in carrying out their duties and from the priority is expected Fasharkan Surabaya, able carry out Maintenance, Repair and Overhaul independently without involving a third party, so that the results of the work are as expected and the confidentiality of the warship engine can be maintained.

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### REFERENCES

- Aghil, S., Sean, A., Fariborz, J., & Songlin, C. (2017). Flexibility in Service Parts Supply Chain: A Study on Emergency Resupply in Aviation MRO. *International journal of Production Research*, 7-15.
- Baluch, N., Sobry, C., & Shahimi. (2010). Maintenance Management Performance – An Overview towards Evaluating Malaysian Palm Oil Mill . *The Asian Journal of Technology Management*, 1-4.
- Bozorgpour, R., Omarae, B., & asadi, M. V. (2017). Study and Analysis of Obstacle and Challenges Facing Ship-Repair Industry in Iran. *Journal of Marine Science*, 485-493.
- Cui, H. (2019). Optimization of Preventive Maintenance Cycle of Ship Mechanical and Electrical Based on MRO System. *Journal of Coastal Research*, 953-959.
- Damdinsuren, M., & Ishdamba, B. (2017). Application of the AHP in Choosing Project Manager. *International Journal of English Literature and Social Sciences (IJELS)*, 155-160.
- Dejan, B., Zdravko, M., & Stevo, B. (2018). Analysis of Operational Readiness and Reliability of the paper Machine System after Implementation of Model of Influence. *Journal of Maintenance and reliability of technical systems*, 21-29.
- Duarte, D., Povoas, B., & A.P, T. (2018). A supporting framework for maintenance

- capacity planning and scheduling: Development and application in the aircraft MRO Industry. *International Journal of Production Economics*, 1-15.
- Ersoz, F., & Karaman, A. (2011). Development of Defence Capability from an Innovation Perspective: The Case of Turkey. *Journal of Economic Cooperation and Development*, 19-38.
- Frase, Hvolby, & Tseng, B. (2015). Maintenance management models: a study of the published literature to identify empirical evidence A greater practical focus is need. *International Journal of Quality and Reliability Management*, 635-658.
- Gibbons, P., Scott, S., & Cormac, F. (2015). Strategic Management: A perspective on the development of the field of strategic management and the contribution . *the Irish Journal of Management*, 1-10.
- Habibi, A., Sarafrazi, A., & Izadyar, S. (2014). Delphi Technique Theoretical Framework in Qualitative Research. *The International Journal of Engineering and Science*, 08-13.
- Hartati, Muhammad, A., Kartib, B., & Muhammad, T. (2014). Indonesian Defense Industry Model Concept: A study framework for Defense Industry Building. *Journal of Advanced Management Science*, 260-266.
- Jaakko, S., & JosuTakala. (2016). Management Changes in MRO Business through Product Lifecycle. *Management and Production Engineering Review*, 87-93.
- Manda, Dr.Vidhu, & Chaitanya. (2017). Aircraft Servicing, Maintenance, Repair & Overhaul-The Changed Scenarios Through Outsourcing. *JOUR*, 249-270.
- Marco, E., Mariangela, L., & Lorenzo, Q. (2019). Innovating the Maintenance Repair and Overhaul Phase through Digitalization. *Journal of Aerospace*, 1-14.
- Peter, A., & Ball Peter, B. T. (2016). Toward the strategic adoption of Lean in aviation Maintenance Reair and Overhaul MRO) Industry. *Journal of Manufacturing Technology Management*, 38-61.
- Ralahalu, K. A., & Jinca, M. ( 2013). The Development Of Indonesia Archipelago Transportation. *International Refereed Journal of Engineering and Science (IRJES)*, 12-18.
- Rastislav, R., & Silvia, L. (2015). Strategic Management of Business Performance Based on Innovations and Information Support in Specific Conditions of Slovakia. *Journal of Competitiveness*, 3-21.