OPTIMIZATION OF KRI ASSIGNMENTS IN PUSHIDROSAL TO SUPPORT THE INDONESIAN SEA MAP SURVEY

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ABSTRACT

Scheduling is an assignment activity that deals with a number of constraints. A number of events can occur in a time period and place / location so that the objective function is as close as possible to be fulfilled. In the decision-making hierarchy, scheduling is the last step before the start of an operation. The scheduling of KRI assignments at Pushidrosal is an interesting topic to discuss and find solutions to using mathematical methods. The scheduling process for the KRI Pushidrosal assignment is carried out to produce an annual ship movement schedule. This process not only requires fast follow-up, but also requires systematic and thorough steps. Where assignment scheduling is a quite complex combinatorial problem. Meanwhile, the current assignment schedule is considered inadequate because the calculations are carried out in a conventional manner. The ship assignment scheduling process in this study uses Integer Programming modeling to obtain an alternative operation scheduling. Scheduling observed was 7 ships in carrying out N number of operations for 52 weeks (1 year). This research begins with determining the scheduling decision variables and the constraints faced. Hard constrain limitations include: ship maintenance schedule, time and duration of each survey operation, the class of ships assigned to carry out operations and the number of vessels executing each operation. Meanwhile, soft constrain is the length of the operating vessel in a row. The mathematical formulation of the Integer Programming model consists of three indicators, one decision variable, two measuring parameters and five constraint functions. Furthermore, the determination of the best alternative scheduling is done using Microsoft Excel's Solver computation program.

Keywords: *Assignment, Integer Programming, Solver.*

1. INTRODUCTION

1.1 Background

The Indonesian Navy's Hydrographic and Oceanographic Center (Pushidrosal) is the main command for guidance and operations. In the field of development, Pushidrosal is in charge of compiling and planning programs for the development of elements of the Indonesian Warship (KRI), hydro-oceanographic surveys and supporting facilities and infrastructure in Pushidrosal's ranks. Meanwhile, in the operational field, Pushidrosal is tasked with compiling plans and carrying out survey programs and making Indonesian marine maps for the entire Indonesian marine archipelago. The survey is both a marine map for the benefit of public shipping and strategic tactical, namely making military maps and humanitarian aid and disasters in all Indonesian waters. The elements of KRI Pushidrosal can be operated both during war and peacetime in order to support shipping safety and can be implemented individually or in formation.

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operated both during war and peacetime in order to support shipping safety and can be implemented individually or in formation.

Pushidrosal's annual operation plan was drawn up with the TNI Headquarters and the Indonesian Navy Headquarters. Ship operational planning is adjusted between the number of personnel, materials, and the area that will be the objective of the survey data collection and ship class. So that the ship to be driven is in accordance with the needs of the task to be carried out, both in terms of ship class and number. Based on the annual operation plan, Pushidrosal, in this case the Operation Staff (Sops) Pushidrosal, makes a KRI assignment schedule in one year (52 weeks) to support operational tasks. This schedule is made to meet the planned supply (posting) of operations so that it reflects what vessels are carrying out operations and vessels carrying out maintenance.

So that all planned operational activities do not experience ship readiness problems, both in terms of ship class and quantity required, an operation schedule and maintenance schedule need to be drawn up and drawn up before the operation is carried out. So that in making the assignment schedule and ship preparation needed to carry out operational activities, Sops Pushidrosal calculates the needs for the class of ships and the number to be operated and always takes into account the ship maintenance schedule. In this case the Sops coordinates with the Pushidrosal Ship Maintenance Service as the ship maintenance schedule maker. The warship assignment schedule is made by taking into account the ship maintenance schedule so that the ship is in prime condition and ready to operate, so that all operational tasks run effectively and efficiently.

Currently, scheduling operation assignments still causes program crashes which result in violations of operating rules and restrictions. Among them resulted in delays in ship maintenance schedules. As well as a violation of the time constraint for maximum operation. There is a ship that gets a new order to carry out further tasks when the ship has finished carrying out operations, even though it has exceeded the maximum time limit for carrying out the operation.

So that the schedule for the assignment of warships is made by considering the limited factors of infrastructure that are faced with each task and the rules for implementing warship operations. These limitations and regulations include: ship class according to task requirements, ship maintenance according to schedule, start and duration of carrying out predetermined tasks, one ship only carries out one task at the same time and the maximum time for carrying out the ship's tasks in succession. is 3 months (12 weeks).

This research has various references, including: (Solekan, 2016) conducted research on the KRI assignment schedule at Pushidrosal using the Binary Integer Programming (BIP) method approach with the aim of minimizing penalties for violating soft constraints (consecutive length of operating vessels) which are completed computing using LINGO 11.0. (Šeda, 2007) uses the Mixed Integer Programming (MIP) method, by presenting a mathematical model for flow shop scheduling changes and the proposed job shop scheduling problem. (Hidayat, 2018) research that aims to find the best alternative in order to optimize the ship assignment plan schedule in order to produce a JOG / JOP by developing an optimization model and applying the Integer Linear-Zero One Programming method.

KRI scheduling model is a quite complex combinatorial problem with many variables so it is difficult to process manually. Therefore, the authors are interested in conducting research to create an Integer Programming model with a solution using the

Microsoft Exel Solver computation program from the KRI assignment schedule at Pushidrosal to get the best alternative scheduling solution. So as to get the best scheduling by increasing the benefits of the infrastructure owned by Pushidrosal, TNI AL or other agencies.

2. LITERATURE REVIEW

2.1 Battleships

Warships are ships that are used for military or armed forces. Generally divided into aircraft carriers, combatants, patrol boats, transport ships, submarines and support ships.

At this time Pushidrosal operates various types of KRI and survey units for marine mapping surveys, including: Hydro Oseonography Assistance class (KRI Spica and KRI Rigel), Kondor class / Mine Sweeper (KRI Romang and KRI Rempang), Hecla class (KRI Twin Gods). Warship grouping is intended to focus on the priority scale of ships according to needs with support according to the functions and capabilities of each ship (TNI-AL, 2005). In this research, Pushidrosal has 5 KRI elements and 8 marine mapping survey units.

Scheduling problem solving must answer at least two forms of questions, namely which resources will be allocated to work on the operation and when each operation starts to finish. Scheduling is one of the important aspects in operations management because good scheduling will enable the organization to use its assets or resources more efficiently and have a positive effect on achieving its goals (effectively). In other words, resource utilization will be better when early the organization can know when and how much capacity is still idle.

With the same resources it causes the organizational capacity to be "bigger" with more output. From these potential benefits, the organization will be able to have a competitive advantage by doing good scheduling. Even this one concept of scheduling can contribute to achieving better, faster, cheaper, and reliable service at the same time. A good schedule should be simple, easy to understand and can be implemented by management or whoever uses it. Scheduling rules should be strong enough but have realistic goals, so that they are flexible enough to solve unpredictable problems and allow for re-planning.

This research belongs to the activity level of Middle-range planning scheduling, which is in the span of 1 - 2 years. The scheduling approach used in this study is the forward scheduling approach, where a job is scheduled from the moment it arrives, or when it is ready or when it is zero (time zero) and moves forward towards the due date in weeks. Where an operation is scheduled when the ship is ready to carry out operations for a certain duration and by using all available resources to the maximum without violating the rules that have been made.

2.3 Integer Programming (IP)

Integer Programming (IP) is Linear Programming (LP) with integer (round) type variables. The IP model was chosen for more difficult problems than the LP model. This is due to the large number of integer value combinations that must be tested, and each combination requires a normal LP or NLP solution. The main idea in IP is to clearly define the problem using the amount of information available. And the following steps are to translate the problem into a mathematical model.

Optimal scheduling can be obtained by using the IP scheduling technique and using the Heuristic Priority Dispatching approach. Priority Dispatching method rules are used to fulfill which task will be done first. Classification of assignment priorities based on dynamic information. Different priority is given to each ship on a task. The highest priority is given to the ship that has the greatest success rate in an operational task, and so on.

1.2 Research Methods

This research uses a case study of the KRI Pushidrosal assignment schedule. The research approach uses a quantitative approach by developing mathematical models and theories related to empirical observations. The approach of this research is to create an Integer Programming (IP) model to find the best alternative in order to obtain a more optimal scheduling.

3.1 Variable Exploration

At this stage, identification of influencing variables is carried out by observing problems related to the model. The ship assignment model variables are as follows:

Indicator.

i = Ship carrying out operational tasks (1 …… 5).

j = Operational task performed (1 …… n).

k = Schedule period / length of time in weeks (1 …… 52)

Decision Variables.

= 1, If the i-th ship is scheduled to carry out the j-th operation assignment in the k-week.

= 0, otherwise.

Parameter.

Cijk = 1 …… 5, priority of the i-th ship to carry out the j-th operation in the k-week.

= 1000, if not prioritized and if collided with the ship maintenance schedule in the k-week.

= The number of ships in the jth operation assignment.

3.2 Model Formulation

Integer Programming (IP) is an approach used in solving linear programming problems but requires additional limitations, namely that some or all decisions are integers. The IP model of the ship assignment scheduling problem consists of an objective function and a constraint function. The objective function is a function that is used to formulate goals to be achieved, both the goals of maximizing and minimizing. Meanwhile, the constraint function is a limiting function related to the limited resources available and existing rules.

a. First step

This research method aims to optimize the assignment of 5 ships to each assignment with an IP optimization model which can be formulated as follows:

1) Decision Variable

The variable of the optimization decision in this study is the assignment of one or several ships to each operational task. The form of the decision variable is Binary 0-1 (zero-one). Result 0 means ship i was not assigned to task j and result 1 means ship i was assigned to task j.

2) Purpose Function

Minimizing Z to get the highest ship priority in carrying out an operational task.

Minimum:

$$Z = \sum_{(i=1)}^{13} \sum_{(j=1)}^{n} \sum_{(k=1)}^{52} \langle\!\langle c_{ijk} X_{ijk} \rangle\!\rangle$$

3) System Boundary Function (Constrain)

In planning the operation, there are several obstacles that must be faced, both hard and soft constrains. These obstacles include:

a) Class of ships carrying out operations. The class constraints of the ship carrying out the operation mean that the ship that carries out each operation has a certain class of capability or characteristics tailored to the needs of the operational task. In this study using the Priority Dispatching method.

b) Schedule constraints on ship maintenance. Every ship must carry out maintenance according to the ship maintenance schedule that has been planned by Disharkap, , namely the week in which maintenance starts and the length of

time for implementation.

c) Operational task schedule constraints. Each operational task has been determined or planned from the TNI Headquarters and the Indonesian Navy Headquarters, namely what week the operation will start and the length of time it will be carried out.

d) Constraints on clashing operating schedules. Each ship only carries out one operational task at a time, in other words, the ship does not carry out more than one operation at the same time.

e) Constraints on the number of vessels needed in one operation. In carrying out a training operation task sometimes requires more than one ship according to training needs.

f) Time constraints for the maximum operation of the ship in succession. Each ship in carrying out operations must not exceed 3 months or 12 consecutive weeks in an effort to maximize the achievement of the task.

b. Second Step

Data from the mathematical formulation of the first step is then carried out computational calculations from the Microsoft Excel Solver computer program. The computer program aims to quickly obtain optimal results from the data obtained from the first step. And then implementing a computer program in the case example in completing the KRI assignment scheduling at Pushidrosal

4. RESEARCH RESULTS

The IP model of the ship assignment schedule problem consists of an objective function and a constraint function. The objective function is a function that is used to formulate the objectives to be achieved, namely to minimize the priority of ships carrying out operational tasks. Meanwhile, the constraint function is a limiting function that is needed with respect to the limited resources available, for example the number of ships, available time, vessel capacity, task load and is adjusted to the maintenance plan that will and must be carried out.

4.1 Schedule of ship maintenance

In making a maintenance schedule, each ship that is planned to carry out the repair / maintenance process in that week is given a large number, for example 1000.While ships that do not carry out repairs/ maintenance in that week are given number 1.

4.2 Operation plan schedule

In making the operational plan schedule, each operational task plan from the beginning to the end of the task in that week is given the number 1. While ships that do not carry out operations in that week are given the number 0.

4.3 Priority of Ships carrying out Operational Tasks

Giving priority to the task force means that the ship has a class of capability or characteristics that are tailored to the needs of the operational task. In making priorities for ships that are planned to carry out operational tasks, each ship in each task that has been planned for that week is assigned a number according to priority. The main priority is given number 1 and so on until the last priority number 10 according to the number of ships. Or given the number 1000 if the ship is not prioritized in that task.

Priority ships that have been made are faced with ship repair schedule constraints and other constraints as well as assignment rules.:

4.4 Final Results

The final result of the processing of activity

scheduling for each KRI for one year (52 weeks).

4.5 Model Validation

Validation is carried out between the conceptual models made by the researcher on the current ship assignment scheduling in Pushidrosal. Currently, the ship assignment schedule occurs that the assignment schedule still violates the existing constraints, first on the hard constrain (violating the ship maintenance schedule) and violating the soft constrain (the maximum length of time the ship carries out operations in succession). Meanwhile, the scheduling of the ship assignment from the results of running modeling made by the researcher can be used as an alternative to actualization. The model created has advantages compared to the existing scheduling, namely the ship assignment scheduling does not violate hard or soft constraints.

4.6 Sensitivity Analysis

The scheduling of the KRI assignment in Pushidrosal uses 7 KRI elements (4 ships operating and 3 ships with conservation status), to carry out 33 operational tasks and a maintenance schedule for 52 weeks. A different pattern will occur if the operating vessels are reduced. The results after changes are made to the operating schedule and compared with the operating schedule with the total number of ships. In addition, an analysis of changes / reduction in the elements of the KRI is being analyzed. How many vessels can be operated so that the results obtained are still optimal without breaking hard and soft constraints.

Scenario 1: the ship is reduced by 1 element from the BHO class so that there are 2 ships operating, the results obtained by the ship can still carry out operations optimally.

Scenario 2: the ship is reduced by 1 element from the Condor class so that there are 2 ships operating, the results obtained by the ship are still able to carry out operations optimally.

Scenario 3: the ship is reduced by 1 element from the unit survey so that there are 8 units survey operating, the results obtained by the ship can still carry out operations optimally.

The scheduling of KRI assignments using the model created by the researcher can be carried out with optimal results or in other words, no constraints are violated when the minimum number of ships is 5 ship elements. However, if the number of ships operating is only 3 elements, then there will be obstacles that are violated.

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

From a series of data processing and analysis carried out in this study, the following conclusions can be drawn:

a. Making a schedule of operational tasks at Pushidrosal by fulfilling all the constraints can be applied using IP.

b. The scheduling of KRI assignments using the IP program is better in meeting all applicable constraints, because it produces a schedule that is compromised with all related constraints and meets applicable regulations.

c. The time required for the preparation of the ship assignment schedule and the time for the creation of several ship assignment schedule scenarios that still meet the applicable regulations are more efficient than the current ship assignment scheduling.

d. This ship assignment scheduling model can be used as an alternative in making a ship schedule in Pushidrosal.

5.2 Suggestions

IP is a method used to model problems where the variables are not real numbers. Meanwhile, the decision of the IP in the form of a binary number is

worth 0-1. For further development of the implementation of this scheduling are as follows:

a. The author only needs a ship assignment schedule and has not included the operating cost factor, both the logistics costs for the ship and the logistics costs for the manning personnel and the personnel transported, so that this can be continued for the next research study to include these costs because by knowing the costs involved used it can be found the most cost efficient in an operation.

b. The author also does not discuss the additional operation assignments that can affect the existing scheduling that has been made. So that it can be seen how many additional assignment limits can be imposed on Pushidrosal.

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