MODEL OPTIMIZATION OF PATROL ASSIGNMENT AT NORTH NATUNA SEA TO SUPPORT OPERATION TASK OF INDONESIAN NAVY

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ABSTRACT

The South China Sea conflict is a regional security issue that has not yet reached the point of completion, and is prone to disrupting regional stability in the future. There are 3 (three) basic things that are the main reasons why countries are involved in the South China Sea conflict. First, it contains enormous natural resources, including oil and gas, biodiversity and fisheries and other marine resources. To operate patrol boats and logistics vessels so that the distribution of liquid logistics support is appropriate, timely, and in the right place, in solving the problem of liquid logistics distribution, the "Linear Programming" approach will be used to optimization the distribution of liquid logistics for patrol boats in the Security Operations sector sea. From the description of the formulation of the problem above, this research was carried out by aiming at the objectives to be achieved, including: formulating a logistic distribution optimization model and optimizing the ability of Naval Warship B9 in supporting the elements of the title at sea. Data processing in this research activity is data that has been obtained from data collection activities and processed using the help of an excel solver. the results of the running of the spreadsheet solver program, the running results stated that in order to carry out operations in the Natuna sea for one year it required 7 Naval Warship (1 K3; 5 K4; and 1 K5), then the central point of operation is sector A, the optimal refuel point is in R17 because it is closest to operation in sector A.

Keywords: Distribution logistics, spreadsheet solver, Linear Programming.

1. INTRODUCTION

The Maritime Security Patrol is an operation at sea that has a strategic value for the existence of national sovereignty and maritime security in Indonesia's national jurisdiction. The Natuna Islands are one of the Indonesian archipelagos whose sovereignty has been violated by China. The Natuna Islands are located in the Riau Islands Province and are in the middle of the South China Sea. The Natuna Islands have been part of Indonesia since 1956, having previously been part of the territory of Malaysia. (Tampi, 2017) The Natuna Islands cover an area of 264,198.37 Km2, of which 2,001.30 Km^2 island while 262.197.07 Km^2 is water. The limited capabilities of the KRI, liquid logistics support,

Currently the Indonesian Navy has several elements of the Naval warship type of Auxiliary Liquid Oil (BCM) which have been assigned according to the existing Fleet Command. In relation to the North Natuna Sea sector, there is naval warship B9 which is assigned to carry out liquid logistics support in the waters of the North Natuna Sea. With the operation of naval warship B9 in Koarmada I, overall the Indonesian Navy Satban operates several tankers, such as naval warship T9, BL9, S9, A9, G9, and S9. Because the main task This KRI is in the distribution of fuel, then B9 will help to supply fuel. So that regional defense operations by Indonesian Navy ships in particular can last longer at sea.

2. MATERIALS AND METHODS

2.1 Maritime Security

Mahan in (Rath, 2007) said "Control/Security of the Sea is carried out by expelling enemy ships and pirates so that sea lanes can be used for commercial purposes". Mahan's opinion has become a universal understanding of the need for the deployment of military force in the efforts of a country to maintain its existence and protect its interests. Currently, various things appear to be a threat to the use of the sea in Indonesia. Conelley sees that tensions in the South China Sea will pose a threat to Indonesia in the form of potential violations of territory and fisheries that are backed up by the government (Connelly, 2016).

2.2 Microsoft Excel Solver

With Solver, you can find the optimal (maximum or minimum) value for a formula in one cell called the objective cell that satisfies the constraint (boundary), or limit, value in another formula cell on the worksheet. Solver processes a group of cells called decision variable cells which are part of the calculation formula for the objective and constraint cells. Solver™ adjusts the values in the decision variable cells to meet the limits on the constraint cells and produce the results you want for the objective cells. The cells of the objective variables, constraints and interrelated decisions and formulas make up the Solver model; the final value found by Solver is the solution for this model. Solver uses a variety of methods, from linear programming and optimization nonlinear to genetic and evolutionary algorithms, to find solutions. Solver is part of a series of commands that are often called what-if analysis tools. This facility works with cells of a group that are connected, either directly or indirectly (directly-indirectly), for formulas on target cells. Solver consists of three parts:

a. Adjustable cells/regulator cell. Solver manages to change the value of a specific cell, to produce results it is necessary to specify the formula on the target.

b. Constrained cells/cell constraint Constraints are used to limit the solver values that can be used in a particular model and constraint refers to other cells that affect the formula in the target cell.

c. Target cells/target cell. Is part of the solver as a place where the final result of processing / execution of a formula is placed.

d. Solver is used to determine the maximum and minimum values in a cell by changing another cell.

2.3 Linear Programming

Linear programming (LP) is an analytical tool that supports the success of operations research in solving various problems so that the right decision can be taken. In general, the Linear Programming problem model can be formulated in the following example:

Maximize or Minimize Z = Cij Xij (2.1)

$\sum_{i=1}^{n}\sum_{j=1}^{n}$ description :

Zmin/max=The objective function (Z) of the results of Cij and Xij

Cij = Decision variables

Xij = Limit function

2.4 Optimization Model

Optimization Model is the activity of modeling problems with mathematical models to make it simpler and easier to understand with steps, namely identification of decision variables (*decision* variables), identification of barriers / constraints (*constrain*) and determination of objective functions.

2.4 Research methodology

The research begins with the identification of problems followed by goal setting and benefits which are all related to the subject matter of this study. Problem formulation and goal setting are the directions for the research to succeed as expected. The formulation of the problem and the setting of goals chosen by the author are in accordance with the conditions of urgency that occur in the title of Marine Security Operations, namely in planning the composition of the elements of ships and maritime patrol aircraft of the Navy that are optimal in the context of securing the seas of the eastern region of the Republic of Indonesia. It is hoped that this research will be useful for the Navy institution .

The outline of all research activities is depicted in a flowchart as shown in Figure 1 below:

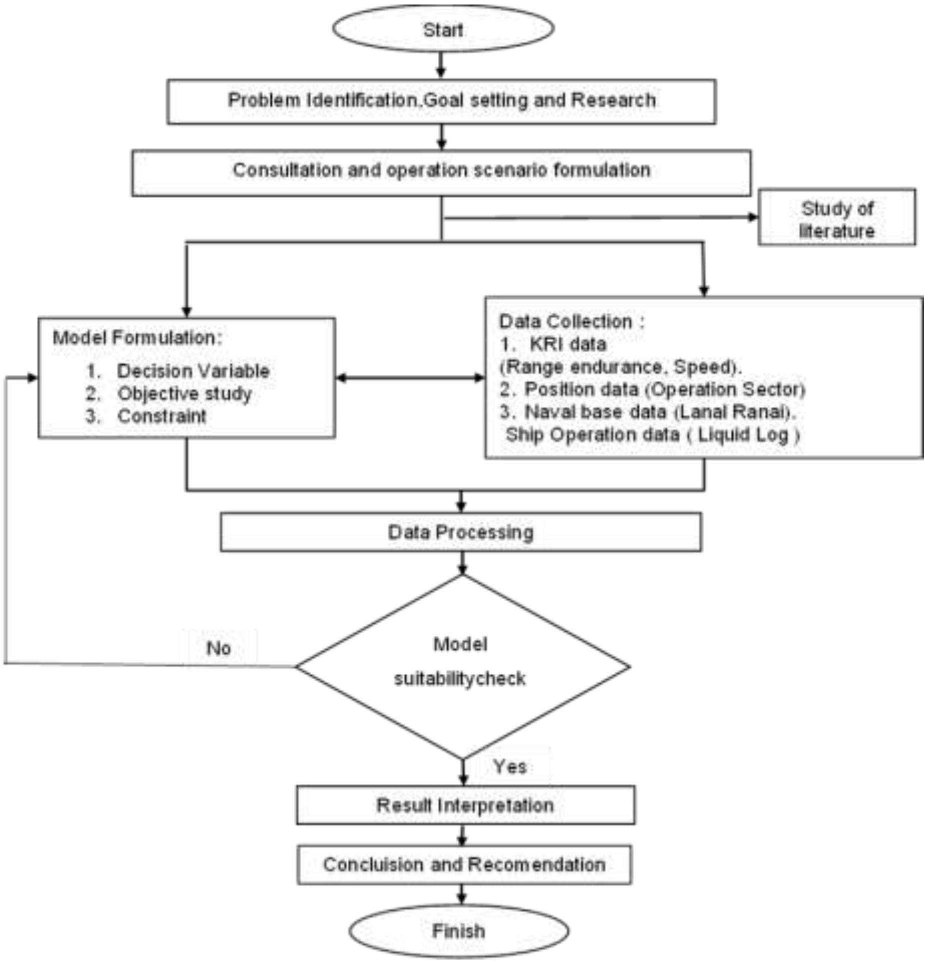

Figure 1. Research Method Flowchart

(Source: Research Data Processing, 2022)

3. RESULTS AND DISCUSSION

The optimization process in this ship class assignment uses a spreadsheet solver program from Microsoft Office Excel. The resolution steps are as follows:

a. Modeling (Developing)

Developing the model in the form of input for compiling all problem data, compiling decision variables, constraints, and objective functions is carried out by means of Spreadsheet Solver program operations. The sequence of steps is as follows:

1) Data Input and Compilation

a) Data for 7 operating sectors (route length, sector area and operation map).

b) Capability of 5 KRI Classes (speed, radar, cruising distance, coverage area, endurance and cost).

c) Compatibility 5 Class patrol boats in 7 operating sectors.

Table 1. Fuel Capacity at Base

PATROL FORCES	CAPACITY (Liters)
K1	500,000
K2	300,000
K3	150,000
K4	400,000
K5	100,000

Table 2. Distance from Operation Point to Base

REFUEL POINT	DISTANCE (Nautical Miles)						
	A	B	C	D	E	F	G
P17	317	308	163	79	16	110	114
B7	327	326	191	110	36	115	128
T4	151	182	166	182	160	64	71
R17	36	82	212	277	283	197	183
DS	368	340	167	75	94	181	173

(Source: Data Processing, 2022)

Table 3. Patrol Vessel Class Competitiveness in Operation Sector

Route	FROM	DESTINATION	DISTANCE (NM)	PKR	PK	FPB	KCR	PC
A1	A	P17	317	1	1	1	1	1
A2	A	B7	327	1	1	1	1	1
A3	A	T4	151	0	1	0	1	1
A4	A	R17	36	1	1	1	1	0
A5	A	DS	368	0	0	1	1	1
B1	B	P17	308	1	1	1	1	1
B2	B	B7	326	1	1	1	1	1
B3	B	T4	182	0	1	0	1	1
B4	B	R17	82	1	1	1	1	0
B5	B	DS	340	0	0	1	1	1
C1	C	P17	163	1	1	1	1	1
C2	C	B7	191	1	1	1	1	1
C3	C	T4	166	0	1	0	1	1
C4	C	R17	212	1	1	1	1	0
C5	C	DS	167	0	0	1	1	1
D1	D	P17	79	1	1	1	1	1
D2	D	B7	110	1	1	1	1	1
D3	D	T4	182	0	1	0	1	1
D4	D	R17	277	1	1	1	1	0
D5	D	DS	75	0	0	1	1	1
E1	E	P17	16	1	1	1	1	1
E2	E	B7	36	1	1	1	1	1
E3	E	T4	160	0	1	0	1	1
E4	E	R17	283	1	1	1	1	0
E5	E	DS	94	0	0	1	1	1
F1	F	P17	110	1	1	1	1	1
F2	F	B7	115	1	1	1	1	1
F3	F	T4	64	0	1	0	1	1
F4	F	R17	197	1	1	1	1	0
F5	F	DS	181	0	0	1	1	1
G1	G	P17	114	1	1	1	1	1
G2	G	B7	128	1	1	1	1	1
G3	G	T4	71	0	1	0	1	1
G4	G	R17	183	1	1	1	1	0

G5	G	DS	173	0	0	1	1	1

(Source: Data Processing, 2022)

2) Preparation of Decision Variables
   a) Matrix zero-one patrol boat assignments.
   b) Deviation Value

Table 4. Decision Variables

PATROL FORCES/KRI	SECTOR						
	SA	SB	SC	SD	SE	SF	SG
1	X 1.1	X 1.2	X 1.3	X 1.4	X 1.5	X 1.6	X 1.7
2	X 2.1	X 2.2	X 2.3	X 2.4	X 2.5	X 2.6	X 2.7
3	X 3.1	X 3.2	X 3.3	X 3.4	X 3.5	X 3.6	X 3.7
4	X 4.1	X 4.2	X 4.3	X 4.4	X 4.5	X 4.6	X 4.7
5	X 5.1	X 5.2	X 5.3	X 5.4	X 5.5	X 5.6	X 5.7

(Source: Data Processing, 2022)

3) Constraints
   a) System boundary data.
   b) Base capability to carry out fuel to operating ships.
   c) Demand for fuel oil supplies, does not exceed the supply of fuel for the destination base.
   d) Restocking must not exceed the ship's capacity.
   e) For the value of the ship's utility operating less than 1.
   f) The fuel consumption (endurance) of the ship does not exceed the capacity of the ship's fuel.

Table 5. Constraints

REFUEL POINT	CLASS				
	K1	K2	K3	K4	K5
P17	✓	✓	✓	✓	✓
B7	✓	✓	✓	✓	✓
T4	-	✓	-	✓	✓
R17	✓	✓	✓	✓	-
D5	-	-	✓	✓	✓

(Source: Data Processing, 2022)

Table 6. Demand

KRI	TOTAL	OPERATION	NEEDS
K1	230000	<=	230,000
K2	97500	<=	97,500
K3	97500	<=	97,500
K4	146000	<=	146,000
K5	68000	<=	68.000

(Source: Data Processing, 2022)

Table 7. Base Fuel Supply

KRI	TOTAL	OPERATION	CAPACITY
K1	230,000	>=	500,000
K2	97,500	>=	300,000
K3	97,500	>=	150,000
K4	146,000	>=	400,000
K5	68.000	>=	100,000

(Source: Data Processing, 2022)

b. Preparation of Objective Function

At this stage is the achievement of assignments in the operating sector in the Natuna area, minimizing the distance to the freezing point of fuel oil, then determining the number of KRI classes of at least 2 operating sectors and determining bases that can support the provision of fuel oil (BBM).

Min Z = (u-e)j

(minimize under and upper deviation coverage area of each operating sector -j)

Min Z =

(u - e)1,sector 1

(u - e)2,sector 2

....

(u - e)5, sector 7

Information:

Min Z = Minimize operating costs

Min Z = (u - e)j (minimize under and upper deviation of each sector)

Cij = Value of coverage areaeach ship i (1-5) in sector j (1-7)

Bij=Operating costs per vessel i(1-5) in sector j (1-7)

Eij =Number of days carrying out operations per vessel (1-5) in sector (1-7)

Uij = Valueutility per vessel (1-5) in sector (1-7)

Pij : Valueprobability of each ship(1-5) in sector (1-7)

Xij =Ship type i (1-5) assigned to sector j (1-7)

Xi(1-17), j(1-4) = Ship i (1-5) assigned to sector j (1-7)

i = 1,...5 ; j = 1,...,7

c. Program Running (Running)

The program starts by entering the following data:

1) Set target cells / objective function
2) By changing cells / decision variable
3) Subject to the constraint / constraint function
4) Option select assume linear model, select non negative variable
5) Solve / program is executed.

Table 8. Optimization Results in assignments in the North Natuna Sea

Code	Number of Ships	quantity. Ship (rounding
K1	-	-
K2	-	-
K3	1.0	1
K4	4.4	5
K5	1.0	1
AMOUNT		**7**

(Source: Data Processing, 2022)

4. CONCLUSION

After carrying out the entire process of working on the thesis, conclusions can be made based on the results of data analysis and discussions that have been carried out. The result of running the solver program in this problem is the obtaining of a decision variable (zero-one decision variable) which indicates the optimization of the assignment of 5 (five) Class naval warship 7 (seven) operating sectors in the Natuna area, namely the optimization results show an illustration of the assignment of patrol boats in the sector. operations, that patrol boats on duty can cover all sectors and there is no buildup in any of the operating sectors. And all ships operate in accordance with their technical capabilities and compatibility in each sector of operation. It is stated that in order to carry out operations in the Natuna Sea for one year it requires 7 naval warships.

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