International Journal of ASRO
Volume 13, Number 04, pp.122-128
December 2022

ASSIGNMENT OPTIMIZATION OF WARSHIPS TO SUPPORT ELEMENTS AT THE SEA NORTH NATUNA

Budi Prasetyo[1], Iwan Vanany [2], Ayip Rivai Prabowo[3]

[1] Indonesian Naval Technology College,Bumimoro-Morokrembangan, Surabaya 60187, Indonesia
[2] Institut Teknologi Sepuluh Nopember,Kampus ITS Sukolilo, Surabaya 60111, Indonesia
Email: Buset54@gmail.com

ABSTRACT

Base limitations in implementing fuel oil support and security demands in the North Natuna Sea waters security operation sectors require an analysis of the optimal distribution of fuel support, in order to minimize operating fuel costs so that the support is timely, effective, and on target in the title of warship operations in securing the working area of the North Natuna Sea. The current problem is that in the working area of Lantamal A, there is no overall support system for refueling at the wharves to support operations in the waters of the North Natuna Sea, so warship elements operating in the waters of the North Natuna Sea can only fill up fuel at the Lantamal A Tanjung pier. Pinang, Lanal Batam and Lanal Ranai. Therefore, real steps are needed to overcome this problem. Because this will not only reduce efficiency and effectiveness but also cause a void for warship elements operating in the waters of the North Natuna Sea. By using the Linear Programming method to determine the warship operating sector in the North Natuna Sea and the Center of Gravity (CoG) method to determine the position of KRI B in optimizing the ability to distribute fuel to KRI elements in the North Natuna Sea waters operation sector so as to obtain efficiency fuel consumption of 17.36% (2,789,565 liters).

Keywords**:** *Linear Programming, Center of Gravity, Fuel Distribution, Operations, North Natuna Sea.*

1. INTRODUCTION.

As the largest archipelagic country in the world, it has 17,499 large and small islands, with a national area of more than 5 million km², of which two-thirds are waters. The potential for abundant natural resources in Indonesian waters is a potential violation and threat both from within and from outside. The Natuna Islands are one of the Indonesian islands whose sovereignty was violated by China. The wealth of Natuna waters is proven by the presence of natural gas in one of the D-Alpha gas fields located 225 km north of the Natuna Islands which holds a total reserve of 112,356,680 barrels with a volume of 222 trillion cubic feet (TCT). Coupled with oil reserves in the Natuna Islands which are estimated to reach 14,386,470 barrels. (Purwatiningsih dan Masykur, 2018).

The South China Sea conflict is a regional security issue that has yet to reach a settlement point and is prone to disrupting regional stability in the future. This dispute was initiated by China's unilateral claims that expanded its territorial waters to reach the territorial waters of the Philippines, Taiwan, Vietnam, Brunei Darussalam, and Malaysia. Limitations on the capabilities of warships, liquid logistic support, and the budget provided by the state as well as the demands of securing the NKRI sea area in the assignment of ships in the Maritime Security Operations Sectors in the western region resulted in the need for thinking about the optimal distribution of liquid logistics support, so as to minimize the costs incurred. exist so that the liquid logistics support is timely, effective, and right on target in supporting Patrol Boat operations. Currently, the Indonesian Navy already has several elements of the warship type Liquid Oil Assist which have been assigned according to the existing Fleet Command.

The Linear Programming (LP) model is an analysis tool for problems that have deterministic (measurable) variables and each has a linear relationship with one another. Linear Programming (LP) was discovered by George Dantzig (Dantzig, 1997) .This analytical technique develops amazingly and is able to solve various problems (problem-solving) that exist in real life (real life). The assignment method in general is a method used to allocate tasks or assignments optimally so as to obtain maximum benefits. The assignment method is a method that can be used to find the most efficient assignment of jobs to machines or machines to jobs. Clausewitz developed the concept of Center of

Gravity which is defined as the center of all activities and movements. a center of power and movement will form itself, on which everything depends; and against this center of gravity of the enemy, the concentrated blow of all the forces must be directed. He explained that determining the CoG would have a huge impact, so military leaders must be able to identify the CoG and concentrate all their strength on that point. (Howard, 1989).

This research will discuss the distribution of liquid logistics support that is appropriate, timely and appropriate, using the "Linear Programming" approach and the Center of Gravity (CoG) method to optimize the distribution of KRI liquid logistics in the Maritime Security Operations (Opskamla) sector.

2. DATA AND METHODOLOGY

2.1 Sea State

In this case, the North Natuna Sea waters consist of 7 (seven) points in the operating sector, these points are based on the TGM Operational Plan PANGARDA 1 PAM ALKI 1 TA 2021 TW 31.1000 December 2020 Regarding the sea task arrangement (SATGASLA) on securing the ALKI work area 1. These points are to facilitate the reporting system and division of operational work areas for KRI carrying out ALKI 1 security operations with an area of operation = 262,197.07 Km2 equal to 101,234.85 Nm2. Operating sector data is shown in table 2 below

Table 1. Operation Sector Coordinate Point

NO	POINT OF OPERATION	COORDINATE POINT		WAVE HEIGHT	SEA STATE
		LATITUDE	LONGITUDE		
1.	**A**	04°30'00" U	108°23'00" T	5	5
2.	**B**	02°50'00" U	109°15'00" T	4	5
3.	**C**	00°35'00" U	107°10'00" T	3	3
4.	**D**	00°15'00" U	105°35'00" T	2	3
5.	**E**	01°04'00" U	104°36'00" T	2	3
6.	**F**	02°26'00" U	105°30'00" T	2	4
7.	**G**	01°55'00" U	106°05'00" T	2	4

The operating sector data in the table above includes coordinate points of operations and the area of the operating sector that must be covered by the Indonesian Navy's patrol boats in square nautical miles. Not all of the ships in the first naval fleet command could operate in all of these operating sectors. For PKR / MRLF, BCM, PK/class ships, KCR to FPB until they can operate in all marine sectors in the North Natuna Sea area, specifically for patrol boats PC and below are not designed to operate on the high seas (Point A and B) due to limited endurance and material capabilities of the ship, but can still operate other than at that point, based on the sea state for the capabilities of each ship as shown in table 2. From the table above the sea state scale data and operating sector are based on references from the Douglass Sea Scale A variety of qualitative and quantitative scales have been developed to provide estimates of sea surface conditions in terms of wave roughness and height. (Owens, 2014) and the tendency of wave height in the North Natuna Sea waters as a result of research from a research journal (Pury, 2018) obtained the sea state scale grouping mentioned above

2.2 Operation Trip Days

OTD (Operation Trip Days) is the number of days needed for the KRI to sail one operation route from the base of the Lantamal X working area to points in the operating sector in the North Natuna Sea. Operation Trip Days can be seen in Table 2 which shows how long (hours) the KRI carried out operations at each point of the operating sector for one trip route. To calculate the OTD, the formula below is used:

$$OTD = \frac{(Route\ Length\ /\ Speed)}{24} \qquad 1)$$

Table 1. OTD KRI to the operation point

NO	POINT OF OPERATION	BASE	DISTANCE (NM)	OPERATION HOURS (HOURS)				
				MRLF	PK	FPB	KCR	PC
1.	A	TJ. PINANG	317	22,67	31,74	26,45	21,16	31,74
2.	A	BATAM	327	23,33	32,67	27,22	21,78	32,67
3.	A	RANAI	36	2,60	3,64	3,03	2,42	3,64

4.	B	TJ. PINANG	308	22,00	30,80	25,67	20,53	30,80
5.	B	BATAM	326	23,32	32,65	27,21	21,76	32,65
6.	B	RANAI	82	5,85	8,19	6,83	5,46	8,19
7.	C	TJ. PINANG	163	11,67	16,34	13,62	10,89	16,34
8.	C	BATAM	191	13,68	19,15	15,96	12,76	19,15
9.	C	RANAI	212	15,11	21,15	17,63	14,10	21,15
10.	D	TJ. PINANG	79	5,64	7,90	6,58	5,27	7,90
11.	D	BATAM	110	7,83	10,97	9,14	7,31	10,97
12.	D	RANAI	277	19,82	27,74	23,12	18,50	27,74
13.	E	TJ. PINANG	16	1,16	1,63	1,36	1,09	1,63
14.	E	BATAM	36	2,60	3,64	3,03	2,42	3,64
15.	E	RANAI	283	20,19	28,26	23,55	18,84	28,26
16.	F	TJ. PINANG	110	7,87	11,02	9,18	7,34	11,02
17.	F	BATAM	115	8,18	11,45	9,55	7,64	11,45
18.	F	RANAI	197	14,07	19,69	16,41	13,13	19,69
19.	G	TJ. PINANG	114	8,15	11,42	9,51	7,61	11,42
20.	G	BATAM	128	9,15	12,82	10,68	8,54	12,82
21.	G	RANAI	183	13,10	18,34	15,28	12,23	18,34

2.3 OPTIMIZATION AND COG

In this study the process of calculating the optimization of assignments on warships uses Solver Excel where the steps for completion are as follows:

1. Modeling
2. Running the Program (Running)
3. Results of Program Implementation

Troubleshooting is carried out with the following steps:

a. Determine Decision Variable

The decision on this issue is whether a / several Patrol Boats are assigned to the operating sectors. The form of the decision variable is an integer and 0-1 (zero-one). The decision variables consist of 24 KRIs allocated to 7 operating sector points

b. Determine of Objective Function

In this problem, the objective function is to maximize the ship's endurance. This problem will be solved by the Linear Programming method. The concept of the Linear Programming method is to maximize or minimize the objective function against the constraints of the decision variables, so that optimal results are obtained.

Objective Function

Maximizing Ship / KRI endurance

model matematis :

Max Z = Cij Xij $\sum_{i\in I}^{n}\sum_{j\in J}^{n}$ (2)

Keterangan:

Max Z = Maksimasi tujuan endurance Kapal di sektor operasi

Cij = Nilai Coverage tiap Kapal (1-24) di sektor operasi (1-7)

Xij = Jenis Kapal (1-24) ditugaskan di sektor operasi (1-7)

Xi(1-24), j(1-7) = Kapal ke i (1-24) ditugaskan ke Lantamal j (1-7)

i = 1,...24 ; j = 1,...,7

c. Determination of System Constraints

The limitation/constraint is the number of ships assigned to the operating sector is:

Limitation

- The total fuel consumption in the operating sector is at least the same as the total budget requirement

$$\sum_{i}^{n} \quad \mathbf{Xij \geq Nij}$$

Information:

Nij = KRI needs in each operating sector in the unit

Xij = Ship Type i (1-24) which will be assigned to operating sector j (1-7)

- KRI that have been placed in one operating sector simultaneously cannot occupy other sectors.

X ij **≥ 1 (1,0)**

In the next stage, after it is known that the optimization of the assignment on ships or KRIs carrying out operations in the Natuna Sea will be carried out calculations using the Center of Gravity (CoG) method, CoG is a mathematical technique used to find the best location for a single distribution point that serving several areas or operating sector points within the working area of the North Natuna Sea. The procedure for calculating the use of the CoG method in research. The steps are as follows:

4. Determination of the amount of fuel needed from the point of origin to the destination to be located
5. Determine the coordinates of the location of the PAM ALKI 1 sector point on a map with a coordinate system with the point of origin of Lantamal IV Tanjung Pinang as the basis
6. Calculate the accumulation to get the Center of Gravity.

3. RESULT AND DISCUSSION

3.1 Optimization of Ship Assignments

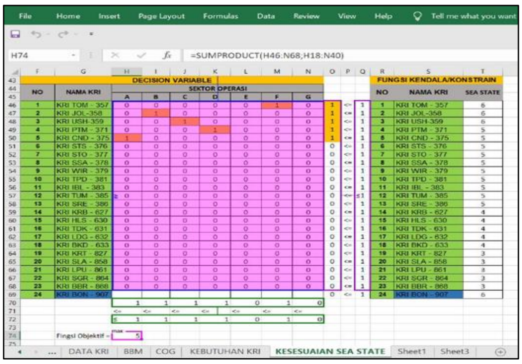

Figure. 1 Optimization with the help of Excel Solver

Using the Excel Solver The result of running the excel solver program on this issue is obtaining the Objective Function value (maximizing the ability of the KRI in the North Natuna Sea Waters sector) and the Decision variable. As in picture 4.

Solving this model produces an assignment table with zero-one numbers (0-1). Xij = 1 means that the i-KRI is assigned to sector j point and Xij = 0 means that the i-th KRI is not assigned to sector j point. With the help of software solver, get the results of the KRI assignment to sector points as shown in Table 3 as follows

Table 1. KRI Assignment Zero-One Matrix

NO	KRI NAME	OPERATION SECTOR						
		A	B	C	D	E	F	G
1	357	0	0	0	0	0	1	0
2	358	0	1	0	0	0	0	0
3	359	0	0	1	0	0	0	0
4	371	0	0	0	1	0	0	0
5	375	1	0	0	0	0	0	0
6	376	0	0	0	0	0	0	0
7	377	0	0	0	0	0	0	0
8	378	0	0	0	0	0	0	0
9	379	0	0	0	0	0	0	0
10	381	0	0	0	0	0	0	0
11	383	0	0	0	0	0	0	0
12	385	0	0	0	0	0	0	0
13	386	0	0	0	0	0	0	0
14	627	0	0	0	0	0	0	0
15	630	0	0	0	0	0	0	0
16	631	0	0	0	0	0	0	0
17	632	0	0	0	0	0	0	0
18	633	0	0	0	0	0	0	0
19	827	0	0	0	0	0	0	0
20	858	0	0	0	0	0	0	0
21	861	0	0	0	0	0	0	0
22	864	0	0	0	0	0	0	0
23	868	0	0	0	0	0	0	0

Table 3 shows the zero-one matrix resulting from the optimization of the KRI assignment at the North Natuna Sea waters sector. From this matrix it can be seen that several types of KRI have received assignments to sector points according to the optimization results. The complete optimization results are presented in table 4 below

Table 2. KRI Assignment Results of Optimization

NO	KRI NAME	TYPES	POINT OPERATION SECTOR
1.	KRI TOM - 357	PKR/MRLF	F
2.	KRI JOL - 358	PKR/MRLF	B
3.	KRI USH - 359	PKR/MRLF	C
4.	KRI PTM - 371	PK/PARCHIM	D
5.	KRI CND - 375	PK/PARCHIM	A

The maximum total KRI based on sea state suitability in the North Natuna Sea Working Area is 5 (five) KRIs consisting of 3 PKR/MRLF classes and 2 PK/PARCHIM classes where the five KRIs based on endurance capability and coverage area will secure the Area of Operation 101,234.85 NM^2.

3.2 Center of Gravity (COG)

Determination of the amount of fuel needed from the point of origin to the destination to be located. In this case, the fuel consumption calculation has been carried out in the PAM ALKI 1 sector in the North Natuna Sea along with the KRI class type (3 PKR/MRLF and 2 PK/PARCHIM). Includes calculation of fuel consumption based on ship endurance. Can be seen in table 5.

Table 3. Fuel consumption to the point According to Optimization Results i

POINT ORIGIN	POINT OPS	DISTANCE (Nm)	FUEL REQUIREMENT (Liter)
LANTAMAL IV TANJUNG PINANG	A	317	1.774.775
	B	308	1.722.104
	C	163	913.695
	D	79	441.667
	E	16	91.140
	F	110	616.008
	G	114	638.317

Table 6 is the distance from each sector point in the PAM ALKI 1 operation in the North Natuna Sea, obtained point A with CoG 140; 82Nm; point B with CoG 88.96 Nm; Point C with CoG 145.72; point D with CoG 232.1 Nm; Point E with CoG 238.18; point F with CoG 223.39 Nm while point G with CoG is 135.05 Nm

Table 4. Distance between OPS-COG

DISTANCE POINT OPS-COG	
DISTANCE OPS	CoG (Nm)
A	140,82
B	88,96
C	145,72
D	232,1
E	238,18
F	223,39
G	135,05

In Table 7, it is obtained that the overall amount of fuel consumption based on solver data processing obtained 5 (five) KRI consisting of KRI TOM-357 with the assignment of 2 operating sector points F and G, KRI JOL-358 with the assignment of sector B points, KRI USH-359 on sector C point, KRI PTM-371 assigned 2 sector points D and E, and KRI CND-375 with sector A point assignment, the total fuel consumption per year is 20,384,136 liters which is then multiplied by the cost of the fuel price per liter of Rp. . 22,350.- according to the HSD Industry price, the total cost is Rp. 455,585,439,600 (four hundred and fifty-five billion five hundred and eighty-eight five million four hundred thirty-nine thousand six hundred rupiah).

Table 5. Fuel Consumption Based on Operating Sector per Year

ROUTE	DESTINATION	DISTANCE (NM)	KRI	FUEL REQUIREMENT		TOTAL FUEL REQUIREMENT (LTR)	TOTAL COST/YEARS (Rupiah)
				SAIL	MOOR		
A	COG	140,82	KRI CND - 375	1.573.241	48.510	1.621.751	36.246.135.744
B	COG	88,96	KRI JOL - 358	1.251.623	247.500	1.499.123	33.505.392.792
C	COG	145,72	KRI USH - 359	2.050.208	247.500	2.297.708	51.353.763.519
D-E	COG	315,18	KRI PTM - 371	3.521.191	48.510	3.569.701	79.782.816.456
F-G	COG	259,39	KRI TOM - 357	3.649.488	247.500	3.896.988	87.097.672.972
LANT IV TPI	COG	263	KRI-BON - 907	244.853	148.500	393.353	8.791.439.550
						13.278.623	**296.777.221.033**

4. CONCLUSION.

The KRI Bontang-907 liquid logistics distribution optimization model in order to support the degree of elements in the North Natuna Sea, namely the suitability of the sea state of the capabilities of the selected KRI and KRI Bontang - 907 as a logistics ship that distributes fuel in the working area or operating sector area of the North Natuna Sea achieving maximum coverage area, maximizing endurance and minimizing operating costs. By using the Microsoft Office Excel solver, optimization of the KRI assignment based on endurance capabilities and coverage area will secure an Operational Area of 101,234.85 Nm^2. With the results of the existing optimization, KRI Bontang-907 in carrying out refueling in the operating sector of the North Natuna Sea without having to carry out sea crossings to the freezing point and this is strengthened by the Center of Gravity method where KRI Bontang-907 is determined as the center of distribution in this sector. operation which is located at coordinates 02°27'44'' N - 107°48'44'' T. Fuel consumption efficiency is an element in the North Natuna Sea with the presence of KRI Bontang-907, namely the use of fuel efficiency of 2,789,565 liters of fuel consumption of 16,068,188 liters to 13,278,623 liters.

REFERENCES

Dantzig, G. B., 1997. *Linear Programming Introduction.* New York USA: Spinger-Verlag New York, Inc..

Howard, M., 1989. *On War.* New Jersey : Princeton University Press.

Owens, E. H., 2014. *Douglas scale; Peterson scale; Sea state Sea conditions.* Washingtin D.C: Springer, New York.

Purwatiningsih dan Masykur, 2018. Eksplorasi dan Eksploitasi Pertambangan Minyak dan gas Bumi di Laut Natunan Bagian Utara Laut Yuridiksi Nasional untuk Meningkatkan kesejahteraan Masyarakat di Kepulauan Natuna. *Jurnal Reformasi,* p. 2.

Pury, A., 2018. ANALISIS KARAKTERISTIK GELOMBANG LAUT GUNA MENDUKUNG DATA INFORMASI OPERASI KEAMANAN LAUT DI WILAYAH LAUT NATUNA DAN LAUT NATUNA UTARA. *IOP Conference Series: Earth and Environmental Science,* pp. 107-131.