International Journal of ASRO
Volume 13, Number 04, pp.01-10
December 2022

OPTIMIZING THE ASSIGNMENT OF KRI AS AN AMMUNITION AUXILIARY SHIP IN AMMUNITION DISTRIBUTION TO SUPPORT THE DUTIES OF THE INDONESIAN NAVY

Adi Wirasmo [1], Udisubakti Cipto Mulyono[2], Yoyok Nurkaya Santoso[3], Azi Wadiana[4]

[1,3,4] *Indonesian Naval Technology College, Bumimoro-Morokrembangan, Surabaya 60187, Indonesia*
[2] *Department of Industrial and Systems Engineering, Institute Technology Ten November, Surabaya, Indonesia*
E-mail: awirasmo46@gmail.com

ABSTRACT

The distribution of ammunition is not optimal because there is only one Arsenal and must serve Navy Bases spread throughout Indonesia and have been specially transported ammunition so the process of distributing ammunition depends on the element of the title. Selection of the right type of KRI in an assignment as an ammunition auxiliary ship using the Analytic Network Process (ANP) method approach gave rise to two main criteria, namely the criteria of operational requirements with five sub-criteria: safety, geographical conditions, mobility, ship feasibility, sailing resilience, and technical requirements criteria with five sub-criteria: machinery, navigation, platform safety. equipment and also sensors. For ammunition,and distribution errors use the Vehicle Routing Problem method. Route optimization is approached with the Saving Matrix method. The results of this study are an alternative priority for selecting ships in assignments as ammunition auxiliary ships to carry out the distribution of ammunition throughout the Navy Base. The best alternative based on the main criteria and sub-criteria is the type of personnel transport auxiliary ship (BAP) with a score of 0.341260. Sequentially, the alternative priorities in the selection of ammunition auxiliary ships are BAP Type Ships, BRS Type Ships, LST / M Type Ships, AT Type Ships, and the last priority is MA Type Ships. Meanwhile, the Saving Matrix method is able to improve the ammunition distribution route into two routes so as to reduce distribution operational costs. The use of the Nearest Insert and Nearest Neighbor methods was able to shorten the distance traveled by the ship from 13004 Nm to 9667 Nm.

Keywords: Analytic Network Process (ANP), Vehicle Routing Problem (VRP), Saving Matrix, Nearest Insert, Nearest Neighbor

1. INTRODUCTION

The Indonesian Navy as an integral part of the Indonesian National Armed Forces must be able to support the main tasks of the TNI as mandated in law number 34 of 2004. Based on the Regulation of the Chief of Naval Staff number Perkasal/69/XI/2010 the logistics of the Indonesian Navy are all activities aimed at preparing and providing materials and carrying out logistical support needed and used in the implementation of the entire Navy development system so that a force capable of carrying out the Navy's tasks is realized. One of the operational capabilities of logistical support that is expected is to be able to provide sufficient supply support during planned operations and to be able to support basic supplies and supplies, one of the index norms is class V supplies (ammunition). The pattern of developing ammunition that is oriented towards facilitating the process of supplying and supporting ammunition for TNI units, is essentially influenced by sources, facilities and infrastructure as well as procedures for managing them (Panglima TNI, 2011).

The main problem with the distribution of ammunition is that there is only one arsenal, and there is no special ship to transport ammunition so the distribution of ammunition is very dependent on the elements of the title (KRI) that will be operated, the Lantamal-Lantamal dislocations which are spread all over Indonesia. Thus causing the problem of erratic distribution time. With the existing conditions and realities, the main problem that can be formulated in this study is how to determine the selection of the type of KRI under the ranks of Koarmada II which is suitable for assignment as an ammunition auxiliary ship, what is the right ammunition distribution model to distribute ammunition to Lantamal-Lantamal by using sea transportation and how to optimize the distribution of ammunition by using KRI as an ammunition auxiliary ship in order to minimize the distance and cost of distributing ammunition. The purpose of this research is to determine the priority of alternative types of ships that are most appropriate for assignment as ammunition auxiliary vessels that meet operational requirements and technical requirements using the Analytic Network Process (ANP) method and solve the optimal distribution model problem by sparing distance and cost efficiency by using the Vehicle Routing Problem (VRP), Saving Matrix.

2. LITERATURE REVIEW

2.1 Duties of the Navy

The Navy is one of the national defense instruments and an integral part of the TNI, based on Law Number 34 of 2004 concerning the TNI, it is emphasized that the Navy's task is to carry out the duties of the TNI in the maritime dimension in the field of defense, enforcing the law and maintaining security in the region. maritime national jurisdiction in accordance with the provisions of national law and international law that have been ratified, carry out the duties of naval diplomacy in order to support the foreign policy set by the government, carry out the duties of the TNI in developing and developing the strength of the maritime dimension, and carry out the empowerment of the maritime defense area.

2.2 Distribution and Logistics Planning

Distribution and logistic planning are interdependent organizations involved in the processes that make a product or service available for use or consumption. They are the set of paths that a product or service follows after production, culminating in the buyer and use by the end user (Keller, 2007).In a new concept, logistics problems are problems that have a very long process, starting from raw materials to finished products used by consumers. Logistics is the process of strategically the procurement, movement, and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the coast-effective fulfillment of orders (Cristopher, 2005).

2.3 Optimization

Optimization is an action to get the best results. The purpose of this optimization is to minimize the effort required or to maximize the desired result. In doing optimization it is necessary to state the function of the decision variable, to be able to define the process to get the maximum or minimum value of a function (Jabidi, 2012).

2.4 TNI Logistic Support Operations

Logistical support operations in joint TNI operations are adjusted to the operations being carried out and the interests of the organization being formed. Logistical support operations at the TNI Opsgab aim to provide logistical support to the TNI Kogab so that the implementation of the Opsgab can be efficient and effective and achieve goals and objectives. The target to be achieved is the fulfillment of logistical support in carrying out Opsgab activities quickly and precisely (quality, quantity, type, time and target) according to their needs.

2.5 Analytic Network Process

Analytic Network Process(ANP) is a method that produces a framework for solving decision-making problems without involving assumptions related to independence between higher and weaker levels of elements and the independence of elements in one level. In ANP also used the method of pairwise comparisons as in AHP. This pairwise comparison process uses a number/scale that reflects the level of importance/preference of a decision element with other decision elements at the same hierarchical level. This helps decision-makers in comparing each of the decision elements because in each pairwise comparison, they only concentrate on two of them (Saaty, 1990).

Table 1. Paired Comparison Scale

Interest Level	Definition
1	Both elements are equally important
3	One element is slightly more important than the other elements.
5	One element is actually more important than the other elements.
7	One element is clearly more important than the other elements.
9	One element is absolutely more important than any other element.
2, 4, 6, 8	The mean value between 2 adjacent assessments.

Overall ANP is a better decision-making tool than AHP, but ANP requires more work to capture facts and interactions. So for decisions that are simple in nature and must be done quickly, the extra work to capture the facts and interactions complicates their use.

a. Feedback Network

This feedback structure does not have a straight form from top to bottom as in a hierarchy but rather resembles a network with cycles connecting the components in it to the components themselves. This structure also has sources and sinks. The source node is the origin of an influence path and never the destination of that path. The sink node is the opposite of the source node, which is the destination of the influence path and will never be the source of the existing path.

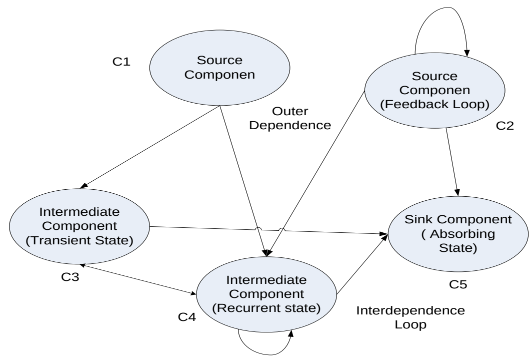

Figure 1. The Structure of the Feedback Network

The components in the node above are a set of criteria and alternatives. Components, where there are no arrows entering the node are called source components such as C_1 dan C_2 Components where there are no arrows coming out of the node are called sink components such as C_5. Components, where there are arrows going in and out of the node are called transient components such as C_3 and C_4. In addition, C_3 and C_4 form a cycle between the two components because the two components give feedback to each other. C_2 and C_4 have loops connecting those components to themselves. The loop is also known as innerdependent while the other connections between components are then called interdependent.

The decision network component is denoted by Ch, where h = 1, 2, …, m, and it is assumed that the component has nh elements denoted by eh1, eh2, …, ehnh. The effect of a given set of elements in a component on each element in the system is symbolized by the priority vector resulting from pairwise comparisons in a general way in AHP. From these priority vectors a matrix can be formed that reflects the flow of influence of a component element both with the element itself and with other elements. The influence of elements in the network on other elements in the network can be seen in equation 1.

$$W = \begin{array}{cc} & \begin{array}{cccc} C_1 & C_1 & \cdots & C_n \\ e_{11}e_{12}\dots e_{1m_1} & e_{11}e_{22}\dots e_{2m_2} & & e_{n1}e_{n2}\dots e_{nm_n} \end{array} \\ \begin{array}{cc} C_1 & \begin{array}{c} e_{11} \\ e_{12} \\ \vdots \\ e_{1m_1} \end{array} \\ C_2 & \begin{array}{c} e_{21} \\ e_{22} \\ \vdots \\ e_{2m_2} \end{array} \\ \vdots & \vdots \\ C_n & \begin{array}{c} e_{n1} \\ e_{n2} \\ \vdots \\ e_{nm_n} \end{array} \end{array} & \begin{pmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{pmatrix} \end{array} \quad \text{(Equation 1)}$$

In equation 1, the first row and first column are the priority vector values for the C_1 component which consists of elements e_{11}, e_{12},…e_{1nj}. The second row and second column are the priority vector values for the C2 component which consists of elements e_{21}, e_{22},….e_{2n2}. The last row and last column are the priority vector values for the C_m component which consists of elements e_{m1}, e_{m2},…$e_{mnm.}$ W_{ij}'s input data in the supermatrix is called a block. The block is a matrix with the arrangement as in Equation 2.

$$W = \begin{bmatrix} W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \cdots & W_{i1}^{(j_{n_j})} \\ W_{i2}^{(j_1)} & W_{i2}^{(j_2)} & \cdots & W_{i2}^{(j_{n_j})} \\ \cdots & \cdots & \cdots & \cdots \\ W_{in_i}^{(j_1)} & W_{in_i}^{(j_2)} & \cdots & W_{in_i}^{(j_{n_j})} \end{bmatrix} \quad \text{(Equation 2)}$$

Equation 2 above shows how much influence one element has on another. Some values can be null. This means that the element does not have any effect on a particular element. For elements that affect the element itself has an identity matrix value I.

b. Priority In Supermatrix

To produce the priority limit of the supermatrix, the supermatrix must be converted into a matrix where each column has a uniform number. A supermatrix that has the same number of values for each column is called a stochastic matrix. The priority of an element in a component is an indicator of the priority of that component in the overall component arrangement. For this reason, it is necessary to compare these components according to the influence of each component in the supermatrix. Each comparison produces a priority vector from the influence of all the components on the left side of the supermatrix on every component that is at the top of the supermatrix. This is done for each component. The resulting vector is used as a matrix block weighting in the column that is in a component. The first input is multiplied by all the elements in the first block of the column, the second input is multiplied by the elements in the second block and so on. The result of this process is known as a weighted supermatrix which is stochastic. This stochastic matrix can be used to produce the desired priority by turning it into a limit matrix. The supermatrix needs to be asserted to capture the transmission of influences in every possible path from a supermatrix. The input value in the weighted supermatrix describes the influence of an element on other elements, but an element can affect other elements indirectly. All effects considered indirectly are obtained by squaring the matrix many times.

W^k, k=1,2,….n.

2.6 Vehicle Routing Problem (VRP)

According to (Goetschalckx, 2011) defines VRP as the problem of determining the shortest route of vehicles starting from one depot to several destinations to meet customer needs. Where vehicles have a certain capacity, each vehicle starts from the depot and returns to the depot. Each customer can only be visited once. The goal of VRP is to meet the needs of every customer at minimum cost. Cost is proportional to the total distance traveled by all vehicles so VRP determines the shortest distance.

The following are some of the limitations or limitations that must be met in VRP

a. The vehicle route starts from the depot and ends at the depot.

b. Each customer must be visited once with one vehicle.

c. Vehicles used are homogeneous with a certain capacity so that consumer demand on each route traversed may not exceed the capacity of the vehicle.

d. If the vehicle capacity has reached the limit, then the next customer will be served by the next shift.

Saving Matrixis one technique used to schedule a limited number of vehicles from a facility and the number of vehicles in this fleet is limited and they have different maximum capacities. The aim of this method is to choose the best possible vehicle assignment and routing (Bowersox, 2002).

To apply the Saving Matrix method, it is necessary to take the first steps beforehand, namely tfirst determine the coordinates of the distance from the factory/warehouse to each customer.

Table 2. Destination Location and Order Size

customers Destination	x coordinate	y coordinate	Order Size
customers1 (C1)	X_1	Y_1	A Units
customers2 (C2)	X_2	Y_2	B Units
customers3 (C3)	X_3	Y_3	C Units
.			
customersn(Cn)	X_n	Y_n	N Units

The following are the steps of the Saving Matrix method which aims to minimize the distance traveled, namely:

1) Identify the Distance Matrix

In this step, the distance between the factory and each customer is needed. so that it uses the shortest path as the distance between locations. So by knowing the coordinates of each location, the distance between the two locations can be calculated using the standard distance formula. The following can be seen in table 3.

Table 3. Matrix of Distance from Factory to Customer and Between Customers

	Factory/ Warehouse	C1	C2	C3	… Cn
C1					
C2					
C3					
.					
C_n					

Suppose two locations each with coordinates (x1,y1) and (x2,y2) then the calculation of the distance matrix for the two locations is:

$$J(2,1) = \sqrt{(x1 - x2)^2 + (y1 - y2)^2}$$

The results of this distance calculation are used to determine the saving matrix that will be carried out in the next step.

2) Identifying the Saving Matrix

saving matrix represents the savings that can be realized by aggregating two customers onto a single route. For example, combining customer 1 and customer 2 into one route, the distance to be visited is from the warehouse to customer 1 then to customer 2 and from customer 2 back to the warehouse.

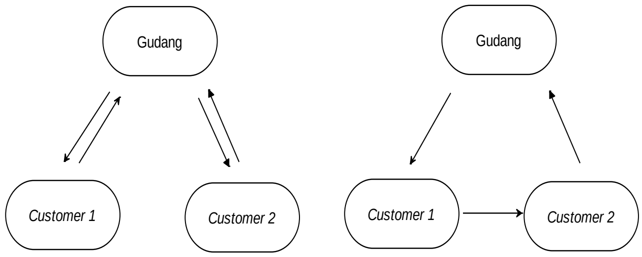

Figure 2. Merging Into One Route

From the picture above, the change in distance is equal to the left distance minus the total right distance, the magnitude of which is like the formula below:

2J (G,1) + 2J (G,2) – [J (1.2) + J (2,G)]
= J (G,1) + J (G,2) – J (2,G)
With distance (x,y) = (y,x)
S (x,y) = J (G,x) + J (G,y) – J (x,y)

where :

S(x,y) = Distance savings (Savings) obtained by Merge x and y routes into one
J(G, x)= Distance from warehouse to customer x
J(G,y) = Distance from warehouse to customer y
J(x,y) = Distance from Customer x to Customer y

Then a distance-saving matrix table is made by combining two different routes

Table 4. Distance Matrix Combining two different routes

	C1	C2	C3	… Cn
C1				
C2				
C3				
.				
C_n				

1) Allocate customers to vehicles or routes

This step allocates customers to vehicles or routes. in merging customer routes, combined up to the capacity limit of the existing truck or fleet, by looking at the largest savings value in the distance saving matrix table, for example, the distance saving matrix is obtained as follows:

Table 5. All Customers Have Separate Routes

	Factory /Warehouse	C1	C2	C3	… Cn
C1	route a	0.0			
C2	route b	20.2	0.0		
C3	route c	17.3	7.2	0.0	
C4	route d	24.5	9.3	14.1	0.0
	Order	200	90	180	105

From the table above, the biggest savings are obtained for customers 1 and 4 of 24.5 so that customer 4 joins route an (assuming sufficient truck capacity).

Table 6. Customer 4 goes to route a and Customer 3 goes to route C

	Factory/ Warehouse	C1	C2	C3	… Cn
C1	route a	0.0			
C2	route b	20.2	0.0		
C3	route c	17.3	13.6	0.0	
C4	route d	24.5	9.3	14.1	0.0
	Order	200	90	180	105

Then we look for the second largest savings, we get 13.6 (customers 2 and 4) go to route b, and so on until the nth customer. If there are customers who have been allocated, there is no merging, then the number of routes is obtained according to the existing fleet capacity and the allocation distance from the factory to the customer is saved.

2) Sort customers in a route has been defined. There are many methods that can be used to determine the order of visits, but in this study, the Nearest Insert and Nearest Neighbor methods were used.

a. Distribution Area Code and Data

To facilitate data processing, coding was carried out for Arsenal and each Lantamal. The code list can be seen in the table below.

Table 7. *Codes and List of Lantamal Distribution Areas*

No	Name	Code
1	Arsenal	D
2	Lantamal I/BLW	C1
3	Second Floor/PDG	C2
4	Lantamal IV/TPI	C3
5	Lantamal XII/PTK	C4
6	Lantamal XIII/TRK	C5
7	Lantamal VI/MKS	C6
8	Lantamal VIII/MDO	C7
9	Lantamal XIV/SRG	C8
10	Lantamal IX/AMB	C9
11	Lantamal X/JPR	C10
12	Lantamal XI/MKE	C11
13	Floor VII/KPG	C12

3. RESULTS AND DISCUSSION

3.1 Making ANP Network Models

After determining the assessment criteria, sub-criteria, and alternatives, then an ANP network model is created as shown in Figure 4. Below.

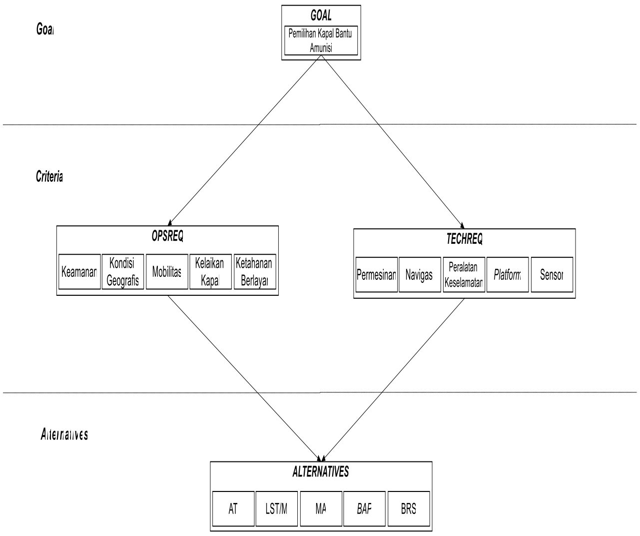

Figure 4. ANP Hierarchical Model

From the existing model concept, a model was then created using Super Decisions 2.10 software version 2.10, to identify any logically influential relationships. There is 1 (one) goal with 2 clusters of criteria, namely Operational Requirements (Opsreq) and Technical Requirements (Techreq), each of which has 5 (five) sub-criteria so that there are 10 (ten) sub-criteria. For each creteria and sub-creteria are interconnected. As for the alternative, it is only depicted with a one-way arrow which means that the alternative is influenced by creteria and sub-creteria but the alternative does not affect the creteria. Figure 5 is an ANP Network model using Super Decisions 2.10 software.

3.2 Pairwise Comparison Matrix

After the network model is created, the value of pairwise comparisons between criteria and between sub-criteria can be determined for each alternative. The pairwise comparison values were obtained using a questionnaire. Priority weight values for each category obtained based on pairwise comparison values will be compared to obtain the final priority weight values.

The data that has been obtained from distributing the questionnaires is in the form of pairwise comparison values between criteria and between alternatives for each sub-criteria.

Respondents' ratings will be unified using the geometric mean formula (geometric mean) is as follows:

$$\sqrt[n]{\prod_{i=1}^{n} X_i} \qquad (4.1)$$

Decision on the comparison of the 1_{st} criterion X_i One of the calculations of the geometric average pairwise comparison values from the questionnaire results can be seen in table 8 which is the geometric average of the pairwise comparisons on the Opsreq criteria.

Table 8. The Geometric Average of Pairwise Comparison Values

for O	
O1 vs. O2	3.71
O1s vs O3s	4.78
O1 vs O4	2.45
O1 vs O5	3.14
O2 vs. O3	1.78
O2 vs. O4	2.14
O2 vs. O5	1.20
O3 vs O4	3.05
O3 vs O5	2.33
O4 vs O5	1.76

After all the geometric averages are known, both criteria and criteria, criteria and sub-criteria, between sub-criteria and even alternatives. And below is an example as in solid table 9 which shows a pairwise comparison matrix between sub-criteria in the Opsreq criteria.

Table 9. Pairwise Comparison Matrix on Opsreq Criteria

O	O1	O2	O3	O4	O5
O1	1.00	3.71	4.78	2.45	3.14
O2	0.27	1.00	1.78	2.14	1.20
O3	1.00	0.56	1.00	3.05	2.33
O4	1.78	1.00	0.33	1.00	1.76
O5	0.32	0.83	0.43	0.57	1.00

After obtaining a pairwise comparison value for each relationship, the calculation of local priority weights is carried out. This calculation aims to determine the weight of each element that is interconnected. Every time a local priority is weighted, what must be considered is the consistency value, the inconsistency value cannot exceed 0.1 As an example, it can be seen in table 17 which shows the inconsistency value of pairwise comparisons between sub-criteria on the Opsreq criteria shows that the Inconsistency Index is 0.01344. This value is still below 10% or 0.1 which means that the answers given by the respondents in this questionnaire are consistent.

Table 10. Inconsistency Index

Inconsistency	0.01344	
name	normalized	idealized
1. O1	0.46241386	1
2. O2	0.121982009	0.263794015
3. O3	0.071379225	0.154362209
4. O4	0.214627707	0.464146354
5. O5	0.129597199	0.280262359

3.3 Processing with Super Decision Software

After entering all the geometric means into the questionnaire format in the Super Decisions software, the software performs all stages of the ANP method by running Synthesize, which contains, among other things, alternative weight values as shown in the red circled values in Figure 5.

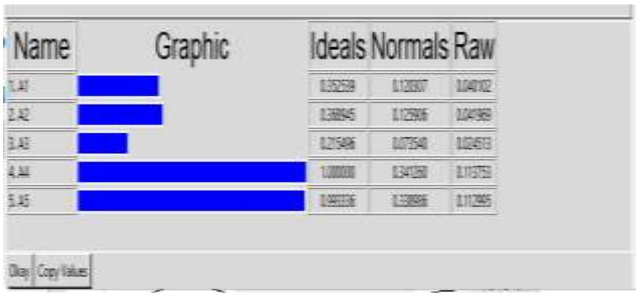

Figure 5. Alternative Weight Values

Meanwhile, to find out the overall priorities, both alternative priorities and criteria, you can run Priorities in the Super Decisions software so that you get the weight values of the alternatives and criteria as shown in table 11.

Table 11. Alternative Weight Values and Criteria

Icon	Name	Normalized by Cluster	Limiting
No Icon	1. A1	[illegible]	0.040102
No Icon	2. A2	[illegible]	0.041969
No Icon	3. A3	0.07354	0.024513
No Icon	4. A4	0.34126	0.112753
No Icon	5. A5	[illegible]	0.112895
No Icon	PEMILIHAN KAPAL BANTU AMUNISI	0.00000	0.000000
No Icon	1. O1	[illegible]	0.131200
No Icon	2. O2	[illegible]	0.050328
No Icon	3. O3	0.08127	0.027089
No Icon	4. O4	[illegible]	0.084896
No Icon	5. O5	[illegible]	0.040021
No Icon	1. T1	[illegible]	0.137968
No Icon	2. T2	[illegible]	0.049825
No Icon	3. T3	[illegible]	0.025412
No Icon	4. T4	[illegible]	0.076971
No Icon	5. T5	0.12947	0.043157

From data processing using Super Decisions 2.10 software, the result is that the highest ranking for the opsreq criteria is O1 (Security) with a weight of 0.39360 while the techreq criteria is T1 (Machinery) with a weight of 0.41390 so the alternative chosen from all existing criteria and sub-criteria with the highest weight is A4 (BAP) that is with a weight of 0.34126.

3.4 Initial Distance Calculation

In determining the route to minimize the route is done by the saving matrix method. This method is able to form a route and a sequence of stop points in one route. The initial step taken was to identify the distance matrix between Arsenal as a depot which would distribute to 12 (twelve) Lantamal and the distance matrix between one Lantamal and another Lantamal. The route referred to in this study is the port-to-port or port-to-port route with distance units of Nm (Nautical Miles). Following below is the distance data between Arsenal and each Lantamal and the distance between each Lantama

Table 12. Distance Table

c	D	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1	1166	0											
C2	1001	1405	0										
C3	799	423	960	0									
C4	515	755	900	310	0								
C5	860	2005	1724	1460	1724	0							
C6	494	1339	1411	965	837	600	0						
C7	1105	2278	1994	1540	1994	525	765	0					
C8	1276	2284	2085	1860	2085	970	880	549	0				
C9	1024	2029	1832	1540	1832	880	608	390	390	0			
C10	1905	2879	2713	2440	2312	1550	1825	384	629	968	0		
C11	2129	2749	2927	2275	2145	1700	1370	1170	853	825	149	0	
C12	730	2181	1640	1744	1640	1165	515	795	887	497	1493	1060	0

Based on data from table 20, the author tries to depict it on a map of Indonesia with the aim of being able to provide an overview of the distance between Arsenal as a depot and Lantamal-Lantamal and the distance between Lantamal can be explained in Figure 6 below.

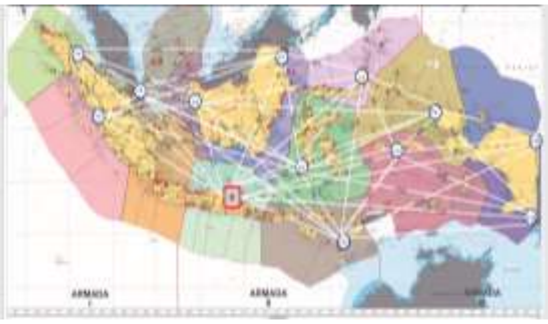

Figure 6. Distance Network

The research process carried out by researchers is the process of distributing weapons and ammunition from the Arsenal to user units, in this case, Lantamal, which are located outside Java Island, and their distribution using ship transport.

3.1. Savings Distance Calculation Results

The next step is to carry out an identity matrix with savings on the assumption that each base will be visited by ships supporting ammunition exclusively or visited by all and none will not be visited. In this case, it is certain that the ammunition support ship will visit all twelve Lantamals without one being missed. So there will be 12 different routes with one destination each. An example of calculating the saving distance from D to C1 to C2 is as follows:

S(x,y) = J(G,x) + J(G,y) – J(x,y)
S(x,y) = 1166 +1001 – 1405 = 762 Nm

So the distance savings from C1 to C2 is 762 Nm. By using the formula above, savings are generated as shown in table 13.

Table 13. Result of Saving Distance Calculation (Saving)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1	0											
C2	762	0										
C3	1542	840	0									
C4	926	616	1004	0								
C5	21	137	199	-349	0							
C6	321	84	328	172	754	0						
C7	-7	112	364	-374	1440	834	0					

C8	158	192	215	-294	1166	890	1832	0				
C9	161	193	283	-293	1004	910	1739	1910	0			
C10	192	193	264	108	1215	574	2626	2552	1961	0		
C11	546	203	653	499	1289	1253	2064	2552	2328	3885	0	
C12	-285	91	-215	-395	425	709	1040	1119	1257	1142	1799	0

Based on the calculation results above use the saving matrix method to save distance. After all the savings calculations are complete, the next step is to classify which routes will be passed for the distribution of weapons and ammunition. There is an important thing that must be guided in merging groups, namely allocating the volume of demand for each Lantamal can be combined up to the load capacity limit of the ammunition auxiliary ship. The combination will start from the largest savings value with the aim of maximizing savings.

3.2. Route Sequence, Method and Total Distance

Based on calculations in allocating request destinations (Lantamal) into routes. After the combined calculation is carried out, the allocation of shipments is carried out with 2 (two) shipping routes:

a. Route 1 : C10 – C11 – C8 - C9 - C6- C12 with a volume of 22.55 m3

b. Route 2 : C7 – C5- C1 – C3 – C4 - C2 with a volume of 9.96 m3.

After the grouping of routes has been completed, the next phase is to determine the order of delivery. Determination of the delivery order using the Nearest Insert and Nearest Neighbor methods, the results can be seen in the table below.

Table 14. Recapitulation of Route Sequences, Methods and Total Distances

route	Delivery Order	Method	Total Distance
Route 1	D-C6-C12-C9-C8-C10-C11-D	Nearest Insert	4430 Nm
Route 2	D-C4-C3-C1-C2-C5-C7-D	Nearest Insert	5237 Nm
Route 1	D-C6-C12-C9-C8-C10-C11-D	Nearest Neighbor	4430 Nm
Route 2	D-C7-C5-C1-C3-C4-C2-D	Nearest Neighbor	5763 Nm

From the table above next can be described as the nearest path. The routes generated from the two methods can be seen in Figure 9 and Figure 10.

Figure 9. *Routes using the Nearest Insert method*

Figure 10. *Routes using the Nearest Neighbor method*

From the results of calculations using two methods, namely Nearest Insert and Nearest Neighbor, the minimum total distance results have been obtained. From the table above, it can be calculated that the total route distance for Route 1 is calculated using both methods, which have the same result, namely 4430 Nm. Whereas Route 2 has a different total distance value of 5237 Nm using the Nearest Insert method and 5763 Nm using the Nearest Neighbor method. From the recapitulation of the table above, we can analyze the recapitulation of determining the most efficient sequence and total delivery distance as shown in the table below.

Table 11. Recapitulation of Order of Delivery and Distance

route	Delivery Order	Total Distance
Route 1	D-C6-C12-C9-C8-C10-C11-D	4430 Nm
Route 2	D-C4-C3-C1-C2-C5-C7-D	5237 Nm

The data obtained from the above calculations, the next step is to calculate the costs by comparing the total or total expenses made between the initial route and the proposed route to find out how efficiently the budget or costs are spent and how effective the method used is in solving the problem of speed distributing weapons and ammunition from Arsenal to Lantamal-lantamal. The following can be seen in the table below regarding the comparison between the initial total distance and savings using the calculation of the saving matrix by determining the order of the route using the Nearest Insert and Nearest Neighbor methods.

4. CONCLUSION

Based on the results of data collection and processing as well as carrying out the analysis and interpretation of data processing results, the following conclusions can be drawn:

a. Selection of KRI under the ranks of Koarmada II for assignment as an ammunition auxiliary shipping two main criteria, namely operational requirements and technical requirements and each criterion consists of five sub-criteria from the five existing alternatives, the alternative that gets the highest priority weight value is KRI type BAP (Personnel Transport Assistance) with a weight value of 0.34126. Based on priority weights sequentially, the right alternative in the assignment as an ammunition auxiliary ship is BAP Type Ship, BRS Type Ship, LST/M Type Ship, AT Type Ship, and the last priority is MA Type Ship.

b. The right ammunition distribution model for distributing ammunition to the Main Base of the Indonesian Navy (Lantamal) using sea transportation is with the model of assigning ships as auxiliary vessels for ammunition distribution problems. The method approach used is the Vehicle Routing Problem (VRP) method. For distance savings with the Saving Matrix method approach. And determining the sequence of routes using the Nearest Insert and Nearest Neighbor methods. The modeling aims to streamline the distance from Arsenal to Lantamal-Lantamal by optimizing the order of the route because optimizing the route will automatically reduce distribution costs.

c. Optimizing the distribution of ammunition by using KRI as an ammunition auxiliary ship in order to minimize the distance and cost of distributing ammunitionnamely based on the approach of the Vehicle Routing Problem method, solving distance savings with the Saving Matrix method is able to improve ammunition distribution routes into two routes so as to reduce distribution operational costs which were originally Rp. 34,620,769,403, - to Rp. 33,751,716,083, - so as to save distribution operational costs of Rp. 869.052.600,- As for the distance by using the Nearest Insert and Nearest Neighbor method it is possible to shorten the distance from 13004 Nm to 9667 Nm so that the difference in distance obtained is 3337 Nm.

ACKNOWLEDGEMENT

The authors greatly acknowledge the support from Indonesia Naval Technology College STTAL Surabaya Indonesia for providing the necessary resources to carry out this research work. The authors are also grateful to the anonymous reviewers and journal editorial board for their many insightful comments, which have significantly improved this article.

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