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RISK ASSESSMENT OF SAFETY AND SECURITY OF BALI COASTAL AND ASSIGNMENT OF DENPASAR NAVAL BASE ELEMENTS

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ABSTRACT

The management of Bali's coastal waters is one of the priorities of the Bali provincial government as one of the drivers of the community's economy. The aspect of marine security and safety is one of the important factors that must be maintained to support the effective management of a waters. Therefore, mitigation measures are needed in dealing with various types of threats with the level of risk posed in the management of the Bali Coastal Sea waters. Denpasar Naval Base as one of the institutions tasked with maintaining security and safety in the territorial waters of Bali. The title of marine security operations element of the Denpasar Lanal is one of the main forces in maintaining security and safety stability in Bali's waters. In this research, identification of the types of threats and measurement of the risks posed will be carried out, which are measured from the perspective of maritime security and safety. From the results of the risk analysis, optimization modeling for the assignment of Denpasar Naval Base elements was carried out as a mitigation measure for various types of threats to be assigned to several Naval Post located in the coastal area of Bali. Identification of the types of threats is carried out by involving several experts in the field of maritime security and safety, measuring the value of risk is carried out using the Relative Comparison method. The assignment of Denpasar Naval Base elements is carried out using the Hungarian assignment method with the risk cost as a minimized aspect. The results of the risk assessment measurement show that the biggest risk faced in the management of the Bali Coastal is on the safety aspect of 67% and the security aspect with a proportion of 33%. The Assignment Optimization Model succeeded in optimizing the assignment of 6 (six) elements of the Denpasar Naval Base to 6 (six) Naval Post in the Bali Coastal Area.

***Keywords*: Maritime Security and Safety, Risk Assessment, Hungarian Methods Assignment Model

1. INTRODUCTION.

The management of the Bali Coastal Area is regulated based on Law Number 1 of 2014 concerning the Management of Coastal Areas and Small Islands (PWP-3-K) and the Governor of Bali Regulation to regulate the planning of the Zoning Plan for the Management of Coastal Areas and Small Islands (RZPWP-3-K) in 2020-2040. Bali's coastal waters are managed in several management zones, namely the tourism zone, fishery zone, harbor zone, salt zone, mangrove zone, mining zone, energy zone and other zones (DPR 2014). The management of coastal areas is directed at achieving effectiveness and productivity in managing marine areas in encouraging economic growth in Bali, especially in the tourism industry sector. Because the tourism industry is the main driver of the economy in Bali (Central Bureau of Statistics 2022). Ensuring the effectiveness of maritime management is heavily influenced by maritime security and safety factors. Security and safety at sea for tourists also influence the tourism industry sector in Bali (Sanjaya, Sumertha dan Nuriada 2018).

Maritime security and safety has different meanings depending on who uses the term or in what context it is being used at the time. From a military point of view, maritime security has traditionally focused on national security in the sense of protecting a country's special territorial integrity from armed attacks or other forces and building state interests elsewhere (Natalie Klein, 2010). Threats to state security may not only be military, but also political, economic, social and ecological (Buzan 1991).. The International Maritime Organization (IMO) distinguishes between maritime safety and maritime security. Maritime Security is related to the protection of ships from unlawful actions, whether intentional or planned. Meanwhile Maritime Safety refers to preventing or reducing the occurrence of accidents at sea caused by ships whose conditions are below standard and crew members or operators who are incompetent.

Risk is uncertainty that comes that can disrupt, damage plans and cause losses due to unknown sources, delays prevent and sometimes too late to effectively reduce the impact (Sidorendko 2017). Risk management aims to create a system or mechanism so that risks that can be detrimental can be anticipated and managed (Hairul 2020). Risk management is basically carried out through the process of identifying sources, evaluating and measuring, and managing risks (Hanafi 2017). Efforts to maintain the stability of security and safety of the sea are steps to manage and control the risk of managing the sea. The risk management approach can be used to determine the right decisions in managing security and safety in the coastal waters of Bali.

Denpasar Naval Base has the function of supporting Navy operations and is also tasked with carrying out maritime security operations and assisting the National SAR Agency in rescue actions at sea (Putri Amelia 2022). In optimizing the assignment of patrol elements to Lanal Denpasar, it is necessary to calculate the ability of elements to deal with various types of threats that exist. In determining the capability of marine SAR elements, it is measured from the indicators of Speed, Endurance, Stability, Maneuver and Equipment (IAMSAR 2006) and the ability to deal with risks of other sea security threats. Types of threats to maritime security and safety can be in the form of interstate disputes, terrorism, piracy, smuggling, illegal activities, environmental pollution, accidents and natural disasters alam (Buzan 1991).

This research will identify the types of threats and measure risks from various sources of threats to the safety and security of the Bali coastal sea, followed by assigning elements of the Denpasar Naval Base to deal with various threats in the region. The Hungarian method can be used to select several workers who have different abilities to occupy a position optimally (Aritonang, Hasibuan dan Hondro 2020). This method can be used to assign Denpasar Naval Base elements to get element assignments with minimal risk costs.

2. MATERIALS.

2.1. Relative Comparison Analysis (RCA).

Relative Comparison Analysis is a technique that involves a comparison between the relative values of several objects to obtain a comparison of the interests and relationships between the objects being compared. The stages used in the use of relative comparison analysis techniques are as follows:

a. Specifies the object to be compared.

b. Define comparative indicators.

c. Determine the relative value intervals for each indicator.

d. Comparison value calculation.

e. Interpretation of the results of comparison values.

In this study, this method was used to compare indicator values to carry out a Risk Assessment on maritime safety and security variables. The objects being compared are several sources of risks that pose a threat in managing and controlling marine security and safety. Furthermore, the calculation of the Relative Comparison value uses the Risk Assessment Worksheet formulation issued by NATO. From comparative calculations on each indicator can produce an assessment as well as the relationship between the objects being compared.

Indicators for assessing risk sources consist of*: Probability (P), Onset Speed (F1), Forewarning (F2), Duration (F3), Intensity (F4) and Impact (I)* (NATO 2015). Furthermore, the formulation used to determine the relative value of threats is the result of multiplying the Probability value by the SUM factor value and multiplied by the Impact value according to the following formula as follow:

RV= $P\sum(F)I$ ....(i)

2.2. Hungarian Methods.

The goal of developing an assignment model is to determine the minimum cost of assigning workers to jobs (Taha 2017). This method is the development of the transportation method. The assignment table shows the assignment of worker i to job j where i,,j =1,2,3.....n as shown in the following table:

Table.1 *Assigment Model*.

Assigment	***Job 1***	***Job 2***	**........**	***Job n***
Worker 1	C_{11}	C_{12}		C_{1n}
Worker 2	C_{21}	C_{22}		C_{2n}
....	....	......	....	....
Worker n	C_{n1}	C_{n2}	....	C_{nn}

The Hungarian method is a classic method for solving assignment problems. There are several steps in solving problems with the Hungarian Method according to work (Taha 2017) as follows:

a. Step 1: Find pi, the minimum cost element of row i in the original cost matrix, and subtract all elements of row i, i = 1, 2, 3...n.

b. Step 2: For the matrix created in step 1, determine qj, the minimum cost element of column j, and subtract from all elements of column j, j = 1, 2, 3...n.

c. Step 3: From the matrix in step 2, try to find a feasible assignment among all the resulting 0 (zero) entries. If such an assignment can find the optimal/feasible solution then the process is declared complete. However, if no optimal solution is found, then additional calculations are needed in steps 4 and 5.

d. Step 4: Draw the minimum number of horizontal and vertical lines in the last reduced matrix to cover all zero entries.

e. Step 5: Select the smallest uncovered entry, subtract from each uncovered entry, then add to each entry at the intersection of the two lines.

f. Step 6: If no proper assignment can be found among the resulting null entries, repeat step 1.

The Hungarian Simplex explanation of the assignment formula where n workers are assigned to n jobs can be represented as an LP model in the following way:

Let Cij be the cost of assigning worker i to job j, and determine:

Xij= $\begin{Bmatrix} 1, \ if\ worker\ i\ job\ j \\ 0, \ else \end{Bmatrix}$

Then the LP model can be written as follows:

Minimize $Z = \sum_{i=1}^{n} \quad \sum_{i=1}^{n} cijxij$

Subject to :

$$\sum_{j=1}^{n} xij = 1, j = 1,2,3 \ldots\ldots n$$

$$\sum_{i=1}^{n} xij = 1, i = 1,2,3 \ldots\ldots n$$

Xij = 0 or 1

2.3 Method

The research procedures carried out in this study were divided into 2 (two) stages, namely the Risk Assessment stage and the Assignment Model Stage. The risk assessment stage consists of identifying risk factors, determining risk assessment indicators, calculating relative comparison values and analyzing the results of calculations. It is continued at the stage of compiling the optimization model for the assignment of Lanal Denpasar elements starting with the identification of model variables, compiling the cost matrix, matrix iteration to get the minimum assignment cost and ending with the interpretation of the results of the optimization model. The research steps are shown in Figure 1.1 below:

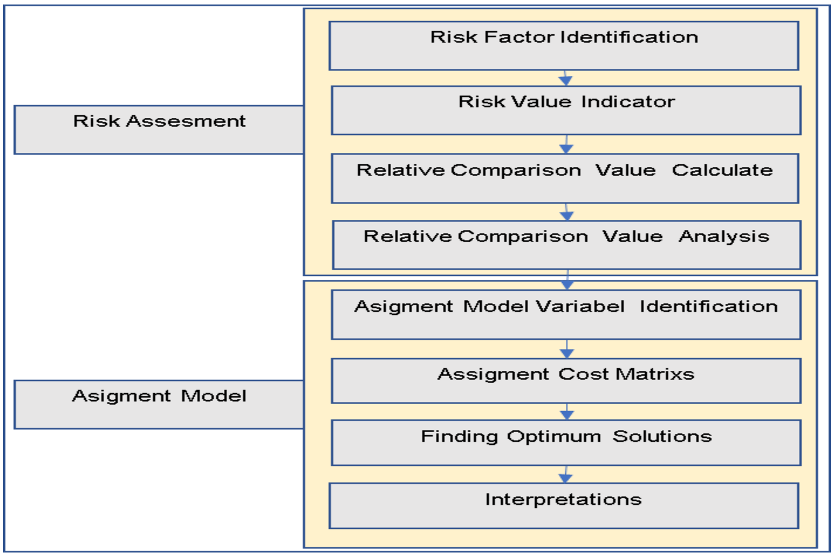

Figure 1. Research Method Algorithm.

3. RESULT AND DISCUSSION.

3.1 Risk Assessment of Marine Security and Safety Aspects.

Identification of aspects of the source of threats to sea security and safety was carried out by in-depth interviews with several experts and observation of data in intelligence analysis reports on operational areas and data on the results of SAR operations by the Denpasar SAR Agency. From the results of observational data and in-depth interviews with experts in the field of marine security and safety, it has been possible to identify the source factors of threat risk in the aspects of marine security and safety in Table. 2 as follows:

Table 2. Maritime Safety and Security Treats Factors.

Security Aspect	Safety Aspect
Illegal Fishing (SE1)	Ship Aground Hazards (SA1)
Illegal Oil (SE2)	Trouble Engine Ship Hazards (SA2)
Illegal Mining (SE3)	Lost Contak Ship Hazards (SA3)
Illegal Loging (SE4)	Medical Evacuatios (SA4)
Illegal Migran (SE5)	Lost Of Fisherman Hazards (SA5)
Illegal Survey (SE6)	Tourist Accidents at Sea (SA6)
Shipping Violations (SE7)	Man Over Board (SA7)
Destruction of natural resources (SE8)	Ship Fire Hazards (SA8)
Smuggling (SE9)	Angler Dragged by the Waves (SA9)
Fights between fishermen (SE10)	Danger of Ship Leakage (SA10)
Marine Pollution (SE11)	Ship Hit by Waves (SA11)
State Territory Violation (SE12)	Sinking Ship (SA12)
Sabotage From The Sea (SE13)	Ship Crash (SA13)

In this stud,y the Relative Comparison method was used to calculate the relative risk value for each threat source in the aspect of maritime security and safety. The measurement indicators are taken from the NATO risk assessment worksheet model which consists of Probability, and Factor Elements which consist of Onset Speed, Forewarning, Duration, Intensity, and Impact. The computation of the relative risk value is generated by multiplying the probability value with the factor element SUM value and multiplying by the Impact value. Assessment of each indicator of the threat factor is carried out by interviewing and distributing questionnaires to the experts. The risk assessment indicators used in this study can be seen in Table. 3 as follows:

Table 3. Risk Assessment Value Indicator.

Indicators	Description	Relatve Value
*Probability (**P**)*	An assessment of the relative likelihood of the threat occurring.	1"Low" 2"Medium) 3"High"
*Onset Speed (**F1**)*	The speed between the warning/warning until the event occurs.	1"Low" 2"Medium) 3"High"
*Forewarning (**F2**)*	Opportunity to mitigate after a warning.	1"Adequate" 2" Enough" 3" Not enough"
*Duration (**F3**)*	The length of time an event takes place.	1"Short" 2"Medium" 3"Long"
*Intensity (**F4**)*	The intensity level of the hazard during the incident.	1"Low" 2"Medium) 3"High"
*Impact (**I**)*	The impact caused by the incident.	1"Low" 2"Medium) 3"High"

Risk assessment is divided into several value categories, namely low, medium, high and extreme. The risk category is "low" if the relative risk value is ≤ 337, the "medium" category is if the 338 ≤ relative value ≤ 728, the "high" category is if 729 the relative value is ≤ 1079 and the extreme category is if 1080 ≤ the relative value ≤ 1404. each assessment indicator on each source of threat/risk. The results of the assessment by experts and the results of calculating the relative risk values are shown in Table. 4 following:

Table 4. Relative Comparison Value.

Treat Factors	Rate (**P**)	Elements Factor Rate (**F1**)	(**F2**)	(**F3**)	(**F4**)	Rate (**I**)	Relative Risk (**P**)*SUM(**F**)*(**I**)	Weight
SA1	2,33	1,00	2,16	2,33	1,83	2,50	42,77	0,123
SA2	2,33	1,00	2,00	2,16	1,33	2,66	40,44	0,116
SA3	1,00	1,16	1,83	1,83	1,16	2,33	14,00	0,040
SA4	1,00	1,00	2,16	2,00	1,00	2,16	13,36	0,038
SA5	1,16	2,00	2,00	1,66	1,00	2,33	18,14	0,052
SA6	1,16	2,00	1,83	2,00	1,33	3,00	25,08	0,072
SA7	2,66	1,00	1,16	2,00	2,00	1,66	27,40	0,079
SA8	1,33	1,00	2,00	2,00	1,00	2,33	18,66	0,054
SA9	2,00	2,00	2,00	2,33	2,00	3,00	50,00	0,143

SA10	1,00	2,33	2,00	1,00	1,33	2,16	14,44	0,041
SA11	1,00	1,00	2,00	3,00	1,00	2,50	17,50	0,050
SA12	2,00	2,00	2,00	2,00	1,00	2,66	37,33	0,107
SA13	1,33	2,33	2,00	2,00	1,00	3,00	29,33	0,084
Total Relative Risk Security Aspects							**348,5**	
SE1	2,58	2,54	2,54	2,58	2,54	2,58	68,101	0,093
SE2	2,22	2,25	2,25	2,29	2,29	2,32	47,027	0,064
SE3	2,38	2,38	2,38	2,38	2,41	2,41	55,330	0,076
SE4	2,03	2,03	2,03	2,03	2,03	2,06	34,10	0,047
SE5	2,64	2,64	2,61	2,64	2,64	2,61	72,90	0,100
SE6	2,48	2,51	2,48	2,51	2,51	2,55	63,50	0,087
SE7	2,58	2,54	2,54	2,54	2,51	2,55	66,82	0,091
SE8	2,38	2,45	2,41	2,41	2,45	2,48	57,76	0,079
SE9	2,25	2,25	2,25	2,29	2,25	2,29	46,88	0,064
SE10	2,16	2,16	2,16	2,16	2,12	2,16	40,23	0,055
SE11	2,61	2,61	2,61	2,58	2,58	2,58	70,04	0,096
SE12	2,32	2,35	2,38	2,35	2,38	2,38	52,58	0,072
SE13	2,38	2,45	2,41	2,41	2,45	2,45	57,01	0,078
Total Relative Risk Safety Aspects							**732,305**	

Based on the results of measuring the risk aspects of the Maritime Security aspects of the Bali Coastal Waters using the Relative Comparison Method, it can be seen that Bali's waters are at risk of smuggling (SE9) with a relative score of 50.00 with a risk weight of 0.143, followed in second position Bali's Coastal waters are vulnerable to illegal fishing (SE1)) with a relative score of 42.778 with a risk weight of 0.123. In third place, the vulnerability that occurs is illegal oil (SE2) with a relative score of 40.44 and a weight of 0.116, followed by Regional Violations (SE12) with a relative score of 37.333 and a risk weight of 0.107. The risk category for marine security aspects is included in the "medium" category.

Furthermore, from the results of the safety aspect risk measurement, it can be seen that the Bali Coastal waters are at high risk of missing fishermen (SA5) with a relative risk value of 72.906 and a risk weight of 0.100. The second highest risk is Ship Accident due to Waves (SA11), with a relative risk value of 70.040 and a risk weight of 0.096. Followed by the third highest risk of Ship Aground (SA1) with a relative risk value of 68.101 and a weight of 0.093. Man Over Board/MOB (SA7) is in fourth place with a relative risk value of 65.115 and a risk weight of 0.099, and in fifth position is Tourist Accident (SA6) with a relative risk value of 63.503 and a weight of 0.093. The risk assessment category on the safety aspect is included in the "high" category with a relative risk value of 732.305.

The average aggregate relative risk value for security and safety of the Bali coastal sea is 540.4. This shows that the coastal waters of Bali have a risk in the "medium" category with the proportion of threats to security aspects being 33% and safety aspects 67%.

3.1 Assignment of Denpasar Naval Base Elements.

Based on the resulting risk identification, a model for the assignment of operational elements to the Denpasar Naval Base was developed as a mitigation and control measure for the risks encountered. The approach used in the preparation of the element assignment model is carried out by prioritizing the safety function in this case as a Search and Rescue element. Identification of Assignment Variables in the Hungarian optimization model consists of Element Variables (Worker), Assignment Area (Job) and Assignment Cost aspects.

Element U1 is 47 m long and 1.5 m wide. This boat is equipped with a 40 PK outboard motor booster capable of traveling at a speed of 14 knots for 2 hours, and is capable of transporting 8 personnel. Currently, the U1 element is assigned to the territorial waters of Benoa Harbor. The U2 element is a boat that has a relatively shorter length than U1, which is 4.5 meters long and 2.1 meters wide. This boat is equipped with a 15 PK thruster and is only able to go at a speed of 12 Knots for 2 hours. Only able to carry 6 people. Currently the U2 element is assigned to Benoa Harbor. The U3 element is an element of the Denpasar Naval Base whose hull is made of aluminum which has a length of 18 meters and a width of 4.5 meters with a draft depth of 0.75 m. Equipped with 2 1136 HP Caterpillar thrusters. Able to go at a speed of 25 knots for approximately 10 hours. This ship is capable of carrying 16 people including the crew. Currently, the U3 element is assigned to the territorial waters of Benoa Harbour.

The U4 element is made of aluminum and is 7.5 meters long and 3 meters wide. In full loading condition it has a draft of 1.2 meters, this boat is equipped with 2 boosters, each with a capacity of 85 HP, has a maximum speed of 20 knots. RHIB 1 is currently assigned to Posal Gilimanuk, to be precise at the Gilimanuk Crossing port. The U5 Element is made of aluminum and is 7.5 meters long and 3 meters wide. In full loading condition, it has a draft of 1.2 meters, equipped with 2 thrusters, each with a capacity of 150 HP, has a maximum speed of 30 knots. Currently the elements are assigned to the territorial waters of the Port of Benoa. The U6 element is made of aluminum with a length of 12 meters and a width of 3.3 meters. In full loading condition, it has a draft of 1 meter, made in 2022. This boat is equipped with 2 thrusters, each with a capacity of 300 HP, and has a maximum speed of up to 35 knots. This element is assigned under the Pengambengan Navy Post.

The overall data for elements of the Denpasar Naval Base which are currently in a ready-to-operate condition are shown in the table below:

Table 5. Denpasar Naval Base Elements.

Elements	Tonage (ton)	Long (m)	Width (m)	Draught (m)	Speed (knot)	Endurance (hour)
U1	1,2	4.7	1.5	0,25	14	2
U2	1,1	4.5	2.1	0,25	12	2
U3	20	18	4.5	0,75	25	10
U4	3	7,5	3	1.2	20	4
U5	3	7.5	3	1.3	30	6
U6	4	12	3.2	1	35	11

The Variable Area Assignments are 6 (six) Naval Posts under the ranks of the Denpasar Naval Base, namely the Celukan Bawang Naval Post (W1), Karangasem Naval Post (W2), Nusa Penida Naval Post (W3), Benoa Naval Post (W4), Pengambengan Naval Post (W5)) and Gilimanuk Naval Post (W6). The Celukan Bawang Naval Post (W1) is a post located in the northern coastal area of Bali waters. The vulnerability of maritime security aspects that occur in this region includes illegal fishing, illegal oil, illegal migrants, illegal logging, and smuggling. Meanwhile, the vulnerabilities in the aspect of marine safety in this region include tourist accidents, ship engine failures, ship aground, and missing fishermen.

Karangasem Naval Post (W2) is the eastern coastal area of the northern part of Bali waters. The East Coast region is directly adjacent to the International ALKI II shipping lane which is also a busy sea traffic lane with a high risk of sea accidents, so IMO designated this strait as the TSS (Traffic Separation Scheme) to regulate the passage of ships. The vulnerability aspects of maritime security in this region include illegal mining, illegal surveys, shipping violations, and illegal oil. Meanwhile, threats to the safety aspect of the sea consist of ship collisions, ship aground, capsized ships due to crashing waves, missing fishermen, medevac, MOB, tourist accidents, lost contact ships, and fires and leaks.

Nusa Penida Naval Post (W3) is located in the southeast of Bali waters which is bordered by the Lombok Strait on the east side and the Indonesian Ocean on the south side. Characteristically, the waters are similar to the working area of the Karangasem Naval Post. The vulnerability of sea security aspects in this region includes illegal fishing, illegal surveys, illegal oil, shipping violations, and territorial violations. Meanwhile, the threats to the safety aspect of the sea consist of ship collisions, ship aground, ships overturned due to waves, missing fishermen, medevac, MOB, lost tourists as well as fires and leaks. Furthermore, the Benoa Naval Post (W4) is in the form of a beach tourism zone, a port zone, an aviation zone, and a fishing zone. The vulnerability of sea security aspects in this region includes illegal fishing, illegal oil, shipping violations, destruction of natural resources, sea pollution, sea sabotage, and smuggling. Meanwhile, the threats to the safety aspect of the sea consist of ship collisions, ship aground, ships overturned due to waves, missing fishermen, medevac, MOB, lost tourists as well as fires and leaks.

Pengambengan Naval Post (W5). The vulnerability of sea security aspects in this region includes illegal fishing, illegal oil, shipping violations, and smuggling. Meanwhile, threats to the safety aspect of the sea consist of capsized boats due to the crashing of the waves, missing fishermen, MOB, missing tourists as well as fires and leaks. Gilimanuk Naval Post (W6) is located on the west side of Bali waters. The character of the waters is a narrow strait that has heavy tidal currents. It has quite dense water traffic because it is the area of the Java-Bali crossing port and ship traffic in and out of the Banyuwangi public port. The vulnerability of maritime security aspects in this region includes illegal oil, illegal migrants, illegal fishing, shipping violations, destruction of natural resources, and smuggling. Meanwhile, threats to marine safety aspects consist of a ship aground, ship collision, MOB as well as fires and leaks.

The preparation of the Assignment Cost Matrix is carried out by measuring the ability aspects of the Denpasar Naval Base elements on several indicators, namely Speed, Endurance, Stability, Maneuver, and Equipment. The assessment is carried out by the Expert, with the results of the assignment cost matrix as shown in Table 6 below:

Table 6. Assignment Cost Matrix Hungarian Methods.

Unsur	**Naval Post under Denpasar Naval Base**					
	W1	***W2***	***W3***	***W4***	***W5***	***W6***
U1	13,00	18,00	17,75	17,25	14,00	12,25
U2	13,00	18,00	19,25	17,25	14,25	12,00
U3	13,00	13,25	14,25	13,25	13,25	10,00
U4	13,00	14,50	13,25	14,00	13,25	9,00
U5	14,00	15,25	14,00	14,25	13,00	11,00
U6	13,00	13,25	13,00	15,50	14,25	10,00

Calculation of the optimization model with the Hungarian method is carried out to get the assignment of elements of the Denpasar Naval Base with the minimum possible assignment cost. The model is declared optimal if 1 element is correctly assigned to 1 assignment place. The calculation of the Hungarian method uses the Exel Solver application with the assignment results as shown in Table 7. Based on the computational results of the Hungarian method on Microsoft Exel Solver, it shows that the Hungarian model has found an optimal solution, with a minimum relative cost of 76.75. Each element is appropriately assigned to 1 (one) area of operation.

Table 7. Computational Assignment Optimization Hungarian Method.

	Naval Post under Denpasar Naval Base								
Unit/Elements	***W1***	***W2***	***W3***	***W4***	***W5***	***W6***	Row Sum		Supply
U1	1	0	0	0	0	0	1	=	1
U2	0	0	0	0	1	0	1	=	1
U3	0	0	0	1	0	0	1	=	1
U4	0	0	0	0	0	1	1	=	1
U5	0	0	1	0	0	0	1	=	1
U6	0	1	0	0	0	0	1	=	1
Collum SUM	1	1	1	1	1	1			
	=	=	=	=	=	=			
Demand	1	1	1	1	1	1			
Objective (Z Min)	76,75								

The assignment of Denpasar Naval Base elements based on the computational results of the assignment model using the Hungarian method is as follows:

a. Element (U1) is assigned to the Celukan Bawang Naval Post (W1), with a relative cost of 13.00.

b. Element (U2) is assigned to Pengambengan Naval Post (W5), with a relative cost of 14.25.

c. Element (U3) is assigned to Benoa Naval Post (W4), with a relative cost of 13.25.

d. Element (U4) is assigned to Gilimanuk Naval Post (W6), with a relative cost of 9.00.

e. Element (U5) is assigned to Nusa Penida Naval Post (W3), with a relative cost of 14.00.

f. Element (U6) is assigned to Karangasem Naval Post (W2), with a relative cost of 13.25.

4. CONCLUSION.

This research has succeeded in identifying risk categories for the security and safety of the Bali coastal seas using the Relative Comparison Analysis method on the factors that are a source of threats. The calculation of the relative risk assessment of security and safety aspects shows that the Bali Coastal waters have a vulnerability with an overall category of "medium" value. The aggregate relative risk value for security and safety of the Bali coastal sea is 540.4. This shows that if the risk is not managed and controlled properly it can become waters with a high risk. In an effort to manage and control threat risk, it is carried out by optimizing the assignment of Denpasar Naval Base Elements. The assignment model using the Hungarian method succeeded in placing 6 (six) elements ready for operation in 6 (six) areas of operation that had different threat characteristics. Element (U1) is assigned to the Celukan Bawang Naval Post (W1), with a relative cost of 13.00. Element (U2) is assigned to Pengambengan Naval Post (W5), with a relative cost of 14.25. Element (U3) is assigned to Benoa Naval Post (W4), with a relative cost of 13.25. Element (U4) is assigned to Gilimanuk Naval Post (W6), with a relative cost of 9.00. Element (U5) is assigned to Nusa Penida Naval Post (W3), with a relative cost of 14.00. Element (U6) is assigned to Karangasem Naval Post (W2), with a relative cost of 13.25. The total minimum relative cost value of 76.75.

Suggestions for further research can be carried out research to measure the set covering elements of the Denpasar Naval Base channel in carrying out marine security and safety operations in Bali waters. In addition, it is also possible to select the type of element that is suitable for carrying out operations based on regional characteristics in each Naval Post area, and analysis of the impact of maritime security operations on the growth of the tourism industry and the economy in Bali can also be carried out.

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