SECURITY SIMULATION OF SEA TOLL TRACK BY KRI HEADQUARTER ELEMENTS CORRESPONDING SECTOR OF MARITIME SECURITY OPERATIONS EAST REGION

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ABSTRACT

The concept of Sea Toll which is a Pivot of World Maritime policy programs contributes to National equalization. Where the role of the pioneer ship in the region, especially East Java Province into one of the security programs. Related to maritime security, Lantamal V has the power KRI element to support security operations these pioneer ship lines. By using the Simulation method, model the security designed according to the behavior of an operating system of KRI and sea transport of pioneer ship, so that gives the picture and pattern operate for in the execution of decision making for strategic to head TNI AL in the plan operate for

Keyword: Pivot Maritime, Concept of Sea Toll, Simulation.

1. INTRODUCTION

The determination of maritime sector development priorities initiated by the Government of President Joko Widodo is very reasonable from the point of view of the nation's history. The main target for the development of the maritime sector is to make Indonesia a World Maritime Axis Country, where there are five pillars to make it happen, namely rebuilding maritime culture, managing marine resources, developing infrastructure and maritime connectivity, enhancing maritime diplomacy, and building maritime defense forces.

The concept of the sea highway, which is a strategy for developing infrastructure and maritime connectivity, is expected to realize an efficient and even distribution of goods throughout the country through sea transportation. To implement this strategy, the government has set several achievement targets including; strengthening shipping and port fleets, especially in eastern Indonesia, revitalizing five major ports to become hubs and logistic centers (Belawan, Tanjung Priok, Tanjung Perak, Makassar, and Sorong), modernizing port facilities and information systems, fully strengthening the cabotage principle by strengthening the shipyard industry national ships capable of meeting the growing demand for sea highway national ships.

In connection with the implementation of the sea highway, the conception of maritime defense is compiled to oversee every government policy in order to safeguard the sovereignty of the Unitary State of the Republic of Indonesia (NKRI) over maritime wealth, the safety of shipping, and security of the region and the nation as a whole as well as overcoming any incidents of violation of sovereignty and law at sea which has legal legality both nationally and internationally.

Basically, the operational pattern of securing pioneering ship routes by the Indonesian Navy has a very complex factor where each route will involve more than one defined operation sector in the Lantamal area. This will be very difficult if analyzed using a mathematical model. One of the methods used in various military analyzes that can accommodate the complexity of operating patterns is a simulation model. The simulation model that will be used in this research is the Arena simulation model because basically, this simulation is a simulation of the real world using the concept of probability. Where the concept of safeguarding the sea highway is stochastic, it can be approached using a simulation method. The simulation results obtained can then be used as input in developing a strategy for projecting the strength of the Indonesian Navy against government programs regarding the security of the maritime highway / pioneering route.

2. MATERIALS AND METHODS

Based on the mandate of the Republic of Indonesia Law number 34 of 2004 concerning the TNI, the Navy as an integral part of the TNI, apart from having the main task of enforcing sovereignty (article 7) also has to enforce the law and maintain maritime security from various forms of threats in the waters Indonesian national jurisdiction (art. 9). In order to carry out the mandate of this law, the Indonesian Navy has a perception that the sea must be safe from three aspects of threats which include both dimensions, both sovereignty, and law. The three aspects of the threat are threats of violence, threats of navigation hazards, and threats of law violations.

In this study, the simulation method is used because the simulation method can be used to solve quite complex problems by simplifying it so that it has the possibility to be applied to problems that occur in the operation of securing the Sea Highway. This is since in the implementation of security operations there are often uncertain conditions. For this reason, this study uses a system modeling approach using a simulation method that combines two aspects of decision-makers, namely qualitative aspects and quantitative aspects.

Simulation is one part of an operation research study (Operation Research) which includes problem definition, model development, model solving, testing the validity of the model, and implementing the final result. Simulation as a problem-solving analysis method has been widely used, starting from the results of research and then being published by members of the TIMS and ORSA (The Institute of Management Science and Operation Research of America). In general, simulation systems are widely used in the military world, both on a broad and narrow scale.

3. ANALYSIS AND DISCUSSION

3.1 System Description

Data collection in this research activity was carried out in the ranks of the Surabaya Navy Main Base (Lantamal V), Tanjung Perak Port Authority (OP), East Java Transportation Service (Dishub), and PT. Pelni Surabaya Branch.

3.2 Conceptualization of the Model

The model conceptualization stage is a series of system modeling activities using simulation. The stages of activity carried out are identifying variables that are thought to have a relationship with the system to be modeled.

3.3 Variable Identification

Decision variables are variables that affect the processes or activities of the system. This variable plays a role in determining the character of the input which will determine the form of the output produced after going through the process in the system.

The variables that affect response time KRI (Table 1) in securing the Sea Highway that pioneer ships pass is as follows:

1) The number of KRI on patrol

The number of KRIs on patrol is related to the sea highway traversed by pioneer ships.

2) The intensity of the anchor clock

The intensity of the anchor hour is related to the effectiveness of the KRI's ability to secure the maritime highway.

3) KRI speed

The speed of the KRI is related to the ship's ability to respond to any problems with the ship carrying out the voyage.

Table 1. Marine Highway Security System Components

Entity	Attribute	Activity	Incident	Status Variable
KRI	Surface radar speed, range (endurance), and range	Patrol, anchor, moor	Arrived at the base, arrived at the operation area	The number of boats patrolling, the number of ships that dock
Ship (Pioneer / Sea Highway)	Surface radar speed, range (endurance), and range	Arriving at the port, distribution of goods	Arrive at the port, cruise line	Number of vessels used
Lanal / Posal, Kamladu	Position (latitude-longitude), berth capacity / dock	Providing anchoring facilities, refilling supplies	The arrival of the elements, the departure of the elements	Base status (full, empty, available to re-stock)

3.4 Conceptual Model

The conceptual model is designed according to activities and behavior in the field. On operational KRI, which consists of two elements, carries out operations alternately every two weeks, where when KRI-1 operates, KRI-2 is waiting (standby) at the Surabaya base.

3.5 Model Simulation

The simulation of the existing model is carried out using the Arena simulation model. The simulation model is built from the conceptual model logic and observational data that has been obtained. Observation data processing is done by using the analyzer input on the Arena. In the data distribution fitting process, the type of data distribution chosen is a distribution that is able to produce low squared errors and is in accordance with the distribution of data for similar processes or properties.

3.6 Model Verification and Validation

The verification of the research model is carried out during the construction of the simulation model continuously and continuously during the process of making the simulation program by looking at the logic of the simulation flow with the simulation output results carried out by the computer.

3.7 Verification

Verification is the process of testing the suitability of the simulation model with the conceptual model that has been created. Practically, verification can be done by making sure the model is running properly and correctly according to the logic of the model arrangement. In this study, verification was carried out by checking for errors in the simulation model (errors) using the features check model in the Arena software. From the verification results, it can be seen that no errors in the simulation model were found. This shows that the simulation model has been verified.

3.8 Validation

Validation is the process of determining whether the simulated conceptual model is truly an accurate representation of the real system being modeled. By running each simulation model, the simulation results are obtained based on the operating hours and anchor hours. Furthermore, the simulation results are obtained to compare the time generated in the existing (actual) conditions.

Table 2. Simulation Output and Actual KRI Hours of Operation 1

KRI Hours of Operation 1		
Output To-	Simulation	Actual
1	381,30252	613
2	342.2012844	861.6
3	372.4638841	266
4	386,8353526	311
5	353.9053317	313
6	351,3531076	324
7	339,9204144	314
8	351.0305497	617.45
9	347,0686629	265
10	353.6842513	701.3
11	360.0595343	676
Average	358,1658994	478,3954545
St.dev	15,52977541	216,7774048
Variance	241.1739243	46992,44323

Table 3. Simulation and Actual Output of KRI Anchor Clock 1

KRI Anchor Clock 1		
Output To-	**Simulation**	**Actual**
1	285.7022749	48
2	236,3388498	354
3	248,6469572	138
4	264.7025881	289
5	222.3393087	291
6	235.3118509	296
7	232.9331359	292
8	249.679053	318
9	232.7994919	192
10	240.4438896	366
11	228,6562229	489
Average	243.4139657	279,3636364
St.dev	18,21294024	118.4595059
Variance	331,7111923	14032.65455

Whereas in the KRI 2 simulation calculation, the results of the average operating hours (Table 4.12) were 352.89 hours and the average leg hours (Table 4.13) were 237.61 hours.

Table 4. Simulation Output and Actual KRI Operating Hours 2

KRI Operation Hours 2		
Output Ke-	**Simulation**	**Actual**
1	370,8841717	672
2	344.9010168	664
3	340.7619477	284
4	348.4328101	309
5	358.8827911	305.75
Average	352.7725475	446.95
St.dev	12.14922665	202.038703
Variance	147.6037082	40819,6375

Table 5. Simulation and Actual Output of KRI Anchor Clock 2

Anchor KRI clock 2		
Output Ke-	**Simulation**	**Actual**
1	255.1772111	65
2	241,5971357	243
3	227.3226352	238
4	227.9267827	256.5
5	236.0683899	259.5
Average	237.6184309	212.4
St.dev	11.47252083	82.88802688
Variance	131.6187342	6870,425

From these data, the minimum number of replication simulation models that must be performed can be calculated. The data used to calculate the minimum number of replications is, for example, taken samples of operating hours dataKRI 2. The first step in calculating the model simulation minimum replication is calculating the degree of freedom (df) of the input data. The following is the calculation of the degree of freedom (df) data on KRI 2 operating hours.

$$\mathrm{df} = \frac{\left[\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}\right]^2}{\left[\frac{\left[\frac{s_1{}^2}{n_1}\right]^2}{n_1 - 1} + \frac{\left[\frac{s_2{}^2}{n_2}\right]^2}{n_2 - 1}\right]} = 19{,}137$$

Next count half-width (hw) which describes the distribution of data as follows.

$$\mathrm{hw} = t_{df,\alpha/2}\sqrt{\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}}$$

$$\mathrm{hw} = (2{,}093)(90{,}518) = 189{,}457$$

After finding the value half-width, the minimal number of replication simulations can be calculated as follows.

$$n = \left[\frac{Z\alpha/_2 \times s_2}{\mathrm{hw}}\right]^2$$

$$n = 1{,}663 \approx 2$$

From the above calculations, it can be seen that the minimum replication in the model simulation that should be done is two times. Furthermore, model validation is to test the significance of the difference in the average simulation output with the observational data. The method used in this test is the Welch Confidence Interval method. The model is said to be valid when the confidence interval formed accommodates a value of 0. Validation is carried out for each simulation output data that has been carried out, which includes data on operating hours and anchor hours of KRI 1 and KRI 2 as well as total hours of each voyage of pioneer ships. The following are the steps and calculations of the Welch Confidence Interval method for the validation of each simulation model.

a. Validation of Operating Hours Data Output KRI 1

Hypothesis:

H0 : $\mu_1 - \mu_2 = 0$

HA : $\mu_1 - \mu_2 \neq 0$

Calculation Welch confidence interval for the level of significant: $\alpha = 0{,}05$

$$P[(\overline{x_1} - \overline{x_2}) - \mathrm{hw} \leq \mu_1 - \mu_2 \leq (\overline{x_1} - \overline{x_2}) + \mathrm{hw}] = 1 - \alpha$$

$$\mathrm{hw} = t_{df,\alpha/2}\sqrt{\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}}$$

$$\mathrm{df} = \frac{\left[\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}\right]^2}{\left[\frac{\left[\frac{s_1{}^2}{n_1}\right]^2}{n_1 - 1} + \frac{\left[\frac{s_2{}^2}{n_2}\right]^2}{n_2 - 1}\right]}$$

By using data input In table 4.10, the Welch Confidence Interval value using a significance level of 0.05 is as follows.

$$\mathrm{df} = \frac{\left[\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}\right]^2}{\left[\frac{\left[\frac{s_1{}^2}{n_1}\right]^2}{n_1 - 1} + \frac{\left[\frac{s_2{}^2}{n_2}\right]^2}{n_2 - 1}\right]}$$

$$\mathrm{df} = 19{,}195$$

$$\mathrm{hw} = t_{df,\alpha/2}\sqrt{\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}}$$

$$\mathrm{hw} = (2{,}093)(65{,}528) = 137{,}152$$

Welch confidence interval 95% confidence level:

$$(\overline{x_1} - \overline{x_2}) - hw \leq \mu_1 - \mu_2 \leq (\overline{x_1} - \overline{x_2}) + hw$$
$$(478{,}395 - 358{,}166) - 137{,}15 \leq \mu_1 - \mu_2 \leq (478{,}395 - 358{,}166) + 137{,}15$$
$$-16{,}923 \leq \mu_1 - \mu_2 \leq 257{,}382$$

Decision:

Because the value of 0 is at the 95% Welch Confidence Interval, then H0 cannot be rejected.

Conclusion:

The difference in the average number of customers from the simulation model output and the observational data is not significant, so the simulation model can be said to be valid.

b. Anchor Clock Data Output Validation KRI 1

Hypothesis:

H0 : $\mu_1 - \mu_2 = 0$

HA : $\mu_1 - \mu_2 \neq 0$

Welch confidence interval calculation for the level of significant: $\alpha = 0{,}05$

$$P[(\overline{x_1} - \overline{x_2}) - hw \leq \mu_1 - \mu_2 \leq (\overline{x_1} - \overline{x_2}) + hw] = 1 - \alpha$$

$$hw = t_{df,\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

$$df = \frac{\left[\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right]^2}{\left[\frac{\left[\frac{s_1^2}{n_1}\right]^2}{n_1 - 1} + \frac{\left[\frac{s_2^2}{n_2}\right]^2}{n_2 - 1}\right]}$$

By using data input In table 4.10, the Welch Confidence Interval value using a significance level of 0.05 is as follows.

$$df = \frac{\left[\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right]^2}{\left[\frac{\left[\frac{s_1^2}{n_1}\right]^2}{n_1 - 1} + \frac{\left[\frac{s_2^2}{n_2}\right]^2}{n_2 - 1}\right]}$$
$$df = 19{,}195$$

$$hw = t_{df,\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$
$$hw = (2{,}093)(65{,}528) = 137{,}152$$

Welch confidence interval 95% confidence level:

$$(\overline{x_1} - \overline{x_2}) - hw \leq \mu_1 - \mu_2 \leq (\overline{x_1} - \overline{x_2}) + hw$$
$$(478{,}395 - 358{,}166) - 137{,}15 \leq \mu_1 - \mu_2 \leq (478{,}395 - 358{,}166) + 137{,}15$$
$$-16{,}923 \leq \mu_1 - \mu_2 \leq 257{,}382$$

Decision:

Because the value of 0 is in the Welch 95% confidence interval, then H0 cannot be rejected.

Conclusion:

The difference in the average number of customers from the simulation model output and the observational data is not significant, so the simulation model can be said to be valid.

From the validation that has been done, it is found that the simulation model can produce output that resembles the output of activities in the field. This shows that the simulation model designed has represented the real system behaviorKRI operations and pioneer ship shipping.

3.9 Scenario Combination Analysis

When simulated by combining the two scenarios above, the analysis results show that using 1 KRI, in the operation of guarding the route of the pioneer ship, was unable to cover it with a fast response time when it had to follow the existing patrol route. So the involvement of 2 KRIs in the system will further increase the response time when an event scenario arises.

Table 6. Scenario Combination Simulation Output (10% Probability)

Voyage To-	Time with = 10 Knots$\overline{V}$ (Hour)	Time with = 16 Knots$\overline{V}$ (Hour)
1	4.124902722	5.8980701
2	4,635618035	14.30589461
3	4.317376403	9.397629515
4	17.40058166	3.244932625
5	9,992608288	3.453901122
6	4.19221061	2.934547427
7	7.144422388	6.994825801
8	4.447863086	7.972632789
9	8.263596806	2.585622477
10	9,965790986	13.85611379
11	4.362728598	10.25658074
12	15.66271586	6.610877445
13	17.70943505	12.18040717
14	18.38847979	3.11350416
15	9.784519964	2.530008362
16	4.216680604	3.149320899

17	19.67721967	2.702749542
18	17.88236826	4.257300947
19	15.53478463	3.033608865
20	9.830116833	3.299922178
21	7.077193209	4.286653433
22	15.32095984	12.63114413
23	17.09430124	5.601962063
24	9.336603438	10.62566103
25	8.066430794	15.74177574
26	7.095501578	6.453144635
27	17.32014224	2.617637159
28	4.309370796	10.48763761
29	4.33372695	7.827615971
30	4.504582569	14.71078384
31	15.78893017	4.246315925
32	14.98233945	9.320870776
33	4.499029856	12.25676787
Average	10.22009492	7.229891538
Min	4.124902722	2.530008362
Max	19.67721967	15.74177574

After the simulation is carried out by combining 2 event scenarios, the KRI response output shows the fastest time is 2 hours 53 minutes using a speed of 16 knots. Meanwhile, when using a speed of 10 knots, the KRI response to the incident was 4 hours 15 minutes. Based on the current KRI speed data, it is only able to reach 10 knots, this will slightly hinder the response of the incident.

On the other hand, KRI's response to the 2 incident scenarios has the longest response time, which is about 20 hours 7 minutes with a KRI speed of 10 knots and 16 hours 14 minutes at a speed of 16 knots. It shows that the simulated KRI random position is far from the incident. Thus, a study is needed to improve the operating pattern of securing pioneer shipping routes (R16).

4. CONCLUSION

After doing existing research and based on the results of experiments and analyzes that have been carried out in the previous chapter. So the following are the conclusions that can be drawn in this study:

a. Operations to safeguard the maritime highway, in this case, the pioneer ship shipping route, are activities that have not yet become a concern in the preparation of the TNI AL operational plan. With the results of this study, the concept of security operations can be simulated by combining the two systems, namely the KRI operation and the pioneering shipping process.

b. The result of combining the two systems in a simulation model shows the relationship between time. So that the KRI operation time is a standby in an effort to safeguard the shipping route of the pioneer ship. So that several scenarios of events emerge that can calculate the KRI response time in the act of securing pioneer ships.

c. Determination of event scenarios based on the level of vulnerability in the shipping lanes passed by the pioneer ships by considering historical data of accidents and sea areas with high waves during bad weather. The scenario of the event is obtained from the navigation data and BMKG about water areas that need to be aware of and have a risk level for bad weather so that it needs attention to respond to any events that occur.

d. The output of the simulation program can be concluded that from the two alternative scenarios the existing event demands that the KRI response time be faster when faced with this incident. This achievement will be realized by changing the KRI operating system which adapts to the shipping routes of pioneer ships.

e. With simulations, analysis can be carried out to make real efforts in the field to improve operations and change the patrol route formation to make it more effective. And improving the performance of KRI through repairing or procuring new KRI elements that can increase the tactical response of the security.

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