ASRO JOURNAL
http://asrojournal-sttal.ac.id/index.php/ASRO

Volume 14, Number 02, pp.44-54
April-June 2023
ISSN: 2460-7037
E-ISSN: 2722-5763

SMART DEFENSE MODELING OF THE ARCHIPELAGO SEA DEFENSE STRATEGY TO SUPPORT INDONESIAN NAVY DUTIES

Eska Wiratama[1] Yoyok Nurkaya[2] Joko Purnomo[3]

[1,2,3]*Indonesian Naval Technology College, Bumimoro-Morokrembangan, Surabaya 60187, Indonesia*
Eskawiratama54@gmail.com

DOI: https://doi.org/10.37875/asro.v14i02.519

Manuscript received 12th June 2023, Revised 22nd June 2023, Published 30th June 2023

ABSTRACT

To build a strong maritime force, the Indonesian military has an Archipelagic Sea Defense Strategy which is essentially a national defense strategy implemented at sea. Affected by changes occurring in the global strategic landscape which have an impact on the need for military equipment technology in dealing with changing threats, in practice it requires the implementation of a smart defense or smart defense, namely a concept in the context of security and defense that focuses on the use of information and communication technology and innovative solutions to strengthen national defense capabilities. This concept aims to increase effectiveness, efficiency and responsiveness in dealing with complex security threats in the digital era. In this research, we need a strategic structure for the strength of the sea dimension that is able to carry out the defense of the archipelago to deal with every threat, both actual and potential, and will provide scientific studies by creating a dynamic system model of the smart defense system for the archipelago's sea defense strategy to support the duties of the Indonesian Navy. The authors employed the Delphi method to establish the criteria for this study, for smart defense that had an effect on the archipelago's sea defense strategy, then in the next stage used Fuzzy Weighting to determine priorities in the development of smart defense systems and continued with the System Dynamic method to obtain smart defense models and scenarios. The results of the best scenario analysis using a system dynamic approach, scenario 3 is the best choice for Smart Defense modeling of the archipelago's sea defense strategy including cyber threats.

Keywords: *Smart Defense, Delphi, Fuzzy Weighting, Dynamic System.*

1. INTRODUCTION

Force development is directed at meeting the needs of the 2020-2044 National Defense System Development The Indonesian Navy is capable of upholding sovereignty and law in the Indonesian National Jurisdiction area which is guided by the development direction of meeting the 2020-2044 national defense system development needs of the defense of large islands and clusters strategic islands and the surrounding waters within the framework of the Archipelago Sea Defense Strategy and the Indonesian Maritime Defense Strategy.

So in this research, we need a strategic structure for the strength of the sea dimension that is able to carry out the defense of the archipelago to deal with every threat both actual and potential and will provide scientific studies by creating a dynamic system model of the smart defense system of the archipelago's sea defense strategy to support the duties of the Indonesian Navy.

2. LITERATURE REVIEW

2.1 Alfred Thayer Mahan's theory

Alfred Thayer Mahan, a United States Navy High Officer, in his book "The Influence of Sea Power upon History" put forward the theory that sea power is the most important element for the progress and glory of a country, which if the sea powers are empowered, it will improve the welfare and security of a country. Conversely, if these sea powers are neglected, it will result in losses for a country or even undermine the country (Mahan, 1890).

2.2 Smart Defense Concept

War and technology always have a causal relationship, meaning that war greatly influences the technological advances of war equipment and vice versa. The main military equipment system will be more Unmanned Aerial Vehicle (UAV) or unmanned, but with a higher level of autonomy. Military technologies that will develop include: cyber warfare equipment for offensives, more advanced calculation

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

systems, artificial intelligence, etc. (Work & Brimley, 2014).

3. MATERIALS AND METHODS

3.1 Delphi method

Delphi is a group process that involves interaction between researchers and a group of experts on a particular topic, usually through the help of a questionnaire. In the early stages, the informants will answer based on the information, knowledge and experience they have. The informants provided their answers or opinions with a rating scale between 1 (one) to 9 (nine) based on the level of importance of the instrument to be developed as shown in table 1.

Table 1. Delphi Rating Scale

Mark	Information
1-2	Very unimportant
3-4	Not important
5-6	Quite important
7-8	Important
9	Very important

3.2 Fuzzy Weighting Method

The data processing uses the Fuzzy weighting algorithm up to level 8 (eight) as follows (Liang & Wang, 1994):

a. Generate the outcomes of evaluating the qualitative aspect variable level through the process of weighting.

b. Generate the results of weighting the evaluation of qualitative criteria variables at various levels.

c. Calculate the central value of the fuzzy number () by summing up the values corresponding to each level of the linguistic scale and dividing the total by the number of aspects or criteria included in the linguistic assessment level. The mathematical notation is as follows:a_t

$$a_t = \frac{\sum_{i=1}^{k} \sum_j Tij}{\sum_{i}^{k=1} n_{ij}} \text{.....(2.1)}$$

a_t=the mean value of the fuzzy number for the assessment level

T = rating level is very low, low, medium, high and very high

N = the number of criteria aspects from the Linguistic T scale for the 1st aspect of the i criteria

T_{ij}= numerical value of the T linguistic scale for the 1st aspect of the jth criterion.

d. Establish the lower limit value (ct) and upper limit value (bt) of fuzzy numbers, wherein the lower limit value (ct = b(i - 1)) coincides with the middle value of the level directly below it.

e. To ascertain the cumulative weight of each qualitative criterion, a linguistic assessment method with a triangular fuzzy number definition is employed in this study. The aggregation process involves determining the collective value of the lower limit (c), middle value (a), and upper limit (b) for each criterion. This process can be represented as follows:

$$c_t = \frac{\sum_j^n = 1\, c_{tj}}{n} a_t = \frac{\sum_j^n = 1\, a_{tj}}{n} b_t = \frac{\sum_j^n = 1\, b_{tj}}{n}$$

Ctj = the minimum value of the t-th qualitative criterion as assessed by the j-th decision maker

a_{tj} = the mean value of the t-th qualitative criterion by the j-th decision maker

b_{tj} = upper limit value of the t-th qualitative criteria by the j-th decision maker

n = number of raters (decision makers) The aggregate value is N = (where Nt.=aggregation weight value for the t-th qualitative criterion.c_j, a_j, b_j).

3.3 Dynamic System

In studying and analyzing the system, we need a method where each component becomes the focus of analysis. One of the superior methods in analyzing systems is system dynamics. In simple terms, the system is defined as a set of components that interact with each other to achieve a certain goal.

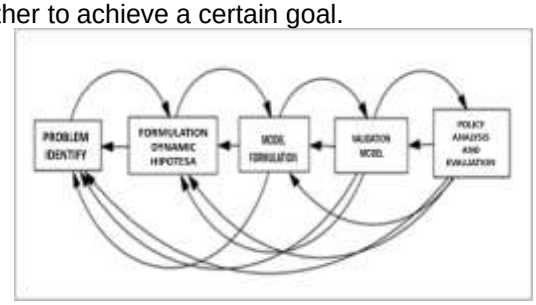

Figure 1. Stages in the system dynamic modeling process (Source: Sterman, 2000)

4. RESULTS AND DISCUSSION.

In this section, data analysis and research results are carried out. The data obtained is in the form of data consisting of primary and secondary data obtained by conducting direct interviews with experts from relevant agencies and also with ship journals in the field. Efforts in data collection are aimed at obtaining valid data so that it can be used according to research objectives Modeling (Developing).

4.1 Identifying Variable Main Aspects of Smart Defense Nusantara Sea Defense Strategy

The initial stage in the series of developing a smart defense model for the archipelago's sea

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

defense strategy (SPLN) is to identify and collect data on the main aspect variables that influence smart defense. The data was obtained from previous research references and the results of in-depth interviews with experts. Then the next process is to identify the main variables for the smart defense of the archipelago's sea defense strategy, the researcher proposes several aspects that influence the smart defense of the archipelago's sea defense strategy to the experts based on theories in books, previous research and phenomena that occur regarding smart defense strategy maritime defense of the archipelago These aspects are as follows:

Table 2. Preliminary identification of smart defense variables for the archipelago's maritime defense strategy

NO	VARIABLE	DESCRIPTION	REFERENCE
1.	OPERATIONAL STRATEGY	The Operations Strategy uses the forces that have been prepared by the Military Strategy. So that the definition of Operations Strategy becomes the art and science of planning, coordinating and controlling military combat.	K. Koesnadi, 2018.
2.	Indonesian Navy POSTURE	In an effort to organize national defense at sea, the Indonesian Navy carries out tasks which are the embodiment of three roles that are universal, namely the military role, the constable role and the role of diplomacy.	D. Sanders, 2017.
3.	TECHNOLOGY	The future battlefield environment is increasingly network-based. War Center Network Network Centric Means from detecting the enemy to attacking, which consists of cycles. For this reason, information and communication technology must be the basis, and it will be more effective if it is accompanied by a cyber battlefield environment that can simulate a real battlefield.	Kyo-il Chung, 2014.
4.	THREAT PERCEPTION	Threats that might be faced by the Indonesian Navy in enforcing the law and maintaining the security of the maritime area.	A. Dipua, 2021.
5.	POLITICAL	Politics comes from the Greek "polis". Politics includes all policies/actions in state/government affairs including the determination of the forms, tasks and scope of state affairs.	Kusmanto, 2014.
6.	SOCIAL AND CULTURE	In general, ISB (Social Science and Cultural Sciences) belongs to a group of knowledge, namely studying basic knowledge and a general understanding of the concepts of human (social) and cultural relations that are developed to study human, social and cultural issues.	C. Basrun, 2016.
7.	NATURAL RESOURCES	Natural Resources (SDA) are the elements of the natural environment, both physical and biological, that are needed by humans to meet their needs and improve their welfare.	A. Winasis, 2016.

(Source: Research data processing based on expert depth interviews, 2023)

After the identification of the main aspect variables and their criteria has been carried out, the next step is to look for the weight of the influence of the importance level of the aspects and variables that constitute qualitative data obtained from the results of interviews with experts/source persons along with questionnaires from each of these Experts.

4.2 Delphi Method Calculations

Based on the design of the Delphi method, opinions were drawn from 7 respondents who were experts related to determining the Smart Defense Strategy for the Archipelago's Marine Defense. From the answers to the opinion withdrawal, the answers from the sources were obtained as follows:

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

Table 3. Expert Opinion Results

NO	EXPERT	CRITERIA						
		K1	K2	K3	K4	K5	K6	K7
1	**E1**	8	8	9	9	6	5	5
2	**E2**	9	9	9	8	6	4	3
3	**E3**	7	7	9	9	3	1	1
4	**E4**	9	7	8	7	4	2	1
5	**E5**	9	9	9	8	5	4	4
6	**E6**	9	9	9	8	7	6	7
7	**E7**	8	7	7	6	5	4	6
SCORE		59	56	60	55	36	26	27
MARK		12.70	12.70	14,29	14,29	9.52	7,94	7,94
min		7	7	7	6	3	1	1
MAX		9	9	9	9	7	6	7
AVERAGE		8,43	8.00	8.57	7.86	5,14	3.71	3.86
STD DEV.		0.79	1.00	0.79	1.07	1.35	1.70	2.34
EVALUATION		**CON**	**CON**	**CON**	**CON**	**DIV**	**DIV**	**DIV**

From the results of processing the Delphi method above, there was a change in position from the previous criteria, namely at the beginning of data collection there were 7 (seven) criteria that became factors of the smart defense of the archipelago's maritime defense strategy, but after undergoing the data processing using the Delphi method into 4 criteria (average value or average > 7.00). The criteria for processing the Delphi method consist of Technology (K3), Operations Strategy (K1), TNI AL Posture (K2) and Threat Perception (K4) which will be used as the final data for further weighting processing using the next method.

4.3 Fuzzy Weighting Method Calculation

Data processing and finding weight values influence the level of importance of aspects and criteria in this thesis using a method called the Fuzzy Weighting method (Suharyo, 2017), where the processing has levels up to 8 (eight) processing levels.

The data processing uses the Fuzzy weighting algorithm as follows: (Suharyo, 2017)

a. Make the results of the weighting assessment of the qualitative aspect variable level.
b. Make the results of the weighting of the assessment of the level of qualitative criteria variables.
c. Determine the value of fuzzy numbers.
d. Determine the value of the upper limit and lower limit of fuzzy numbers.
e. Calculates the aggregate weight of each criterion.
f. Calculating the defuzzy value from the results of the assessment of each qualitative criterion.
g. Calculating the final weight value / level of importance of each aspect variable and criteria.

Table 4. Assessment Aggregate Simulation on Technology Aspects

NO	CRITERIA	E1	E2	E3	E4	E5	E6	E7
1	Integrated Systems	9	9	9	9	9	8	9
2	Monitoring	9	9	9	9	9	9	9
3	Big Data (IoT, AI & Machine Learning)	9	9	9	9	10	8	9
4	cyber	9	9	9	9	9	8	9
5	Autonomous	7	9	8	9	9	8	9

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

Table 5. Assessment Aggregate Simulation on Operational Strategy Aspects

NO	CRITERIA	E1	E2	E3	E4	E5	E6	E7
1	Command & control / maritime operation center	9	9	9	9	9	9	9
2	Coastal watch system (radar, ESM electronic support measure, long range camera)	7	7	8	8	8	8	9
3	Mobile surveillance (air, surface, subsurface unmanned vehicle)	8	9	9	9	9	6	9
4	Coastal defense (fixed & mobile missile system, sonar and sonobuoy)	7	5	6	7	6	6	6
5	Integrated air defense	8	9	9	9	9	7	6
6	Anti Submarine Warfare (ASW) defense	8	7	9	8	8	8	7
7	Sea Control	8	7	9	8	7	9	8
8	Human Resources Development	8	7	7	8	8	9	9
9	Risk Management	7	7	7	5	7	9	8
10	Logistics	8	9	8	8	7	8	8

Table 6. Assessment Aggregate Simulation on Aspects of TNI AL Posture

NO	CRITERIA	E1	E2	E3	E4	E5	E6	E7
1	Weapons	9	9	9	8	9	9	9
2	Security, Defense, Intelmar, Diplomacy, Dawinhanla, Support	8	7	7	8	8	9	8
3	Operation Degree (Harvest / Deployment / routine ops & Enforcement Degree / Employment / 3 trouble spot standby unit)	9	7	7	8	8	8	9

Table 7. Simulation Aggregate Rating on Threat Perception Aspect

NO	CRITERIA	E1	E2	E3	E4	E5	E6	E7
1	Air (Aircraft, Drones, Missiles)	8	9	9	8	7	9	7
2	Warships (Surface & Sub Surface)	8	7	7	7	8	9	8
3	Maritime Cyber Security	9	9	9	9	9	9	7

c. To derive the central value of the fuzzy number (at), the calculation involves adding up the values corresponding to each level of the linguistic scale and then dividing the sum by the total number of aspects or criteria considered within the linguistic assessment level. This can be expressed mathematically as follows:

$$a_t = \frac{\sum_{i=1}^{k} \sum_j T_{ij}}{\sum_{i=1}^{k} n_{ij}}$$

a_t = the mean value of the fuzzy number for the assessment level
T = rating level is very low, low, medium, high and very high.
N = number of aspects of the linguistic scale criteria T for the 1st aspect of the i-criterion
Tij = numerical value of the T linguistic scale for the 1st aspect of the jth criterion

Table 8. Aggregate simulation of mid, lower and upper limit values for expert 1 to expert 4.

NO	LEVELS LINGUISTIC	E1			E2			E3			E4		
		ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt
1	VERY LOW												
2	LOW	0.00	3.00	6.00	1.00	4.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
3	CURRENTLY	4.00	6.00	7,79	4.00	5.00	7,40	1.00	6.00	7,77	1.00	5.00	7.89
4	TALL	6.00	7,79	9.00	5.00	7,40	9.00	6.00	7,77	9.00	5.00	7.89	9.00
5	VERY HIGH	7,79	9.00	10.00	7,40	9.00	10.00	7,77	9.00	10.00	7.89	9.00	10.00

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

Table 9. Aggregate simulation of mid, lower and upper limit values for expert 5 to expert 7.

NO	LEVELS LINGUISTIC	E5			E6			E7		
		ct	at	bt	ct	at	bt	ct	at	bt
1	VERY LOW	-	-	-	-	-	-	-	-	-
2	LOW	1.00	3,33	5.91	0.00	0.00	0.00	0.00	0.00	0.00
3	CURRENTLY	3,33	5.91	7,79	3.00	5.69	7,63	3.00	6.00	7,21
4	TALL	5.91	7,79	9.00	5.69	7,63	9.00	6.00	7,21	9.00
5	VERY HIGH	7,79	9.00	10.00	7,63	9.00	10.00	7,21	9.00	10.00

f. The next step is to find the criterion defuzzification value, where the defuzzification method used is the centroid method. The formula for defuzzification criteria is as follows:

Defuzzifikasi N_t

$$= \frac{\left[\left[\int_{c_t}^{a_t} \frac{(x-c_t)}{(a_t-c_t)} x dx + \int_{a_t}^{b_t} \frac{(x-b_t)}{(a_t-b_t)} x dx\right]\right]}{\left[\left[\int_{c_t}^{a_t} \frac{(x-c_t)}{(a_t-c_t)} dx + \int_{a_t}^{b_t} \frac{(x-b_t)}{(a_t-b_t)} dx\right]\right]}$$

with : t = criteria 1,2,3.....n

Table 10. Main Aspect Defuzzy Value (simulation)

No	Key Aspects	Defuzzy Value
1	TECHNOLOGICAL ASPECT	8,099
2	ASPECT OF OPERATIONAL STRATEGY	6,866
3	POSTURE ASPECTS OF THE INDONESIAN NAVY	7,623
4	THREAT PERCEPTION ASPECT	6,985
		29,574

Table 11. Technology Aspect Criteria Defuzzy Value (simulation)

NO	CRITERIA	DEFUZZY VALUE
1	Integrated Systems	8,290
2	Monitoring	7,671
3	Big Data (IoT, AI & Machine Learning)	6,575
4	cyber	7,194
5	Autonomous (Ride & Weapon)	6,252
		35,982

Table 12. Defuzzy Value Criteria Operational Strategy Aspect (simulation)

NO	CRITERIA	DEFUZZY VALUE
1	Command & control / maritime operation center (Puskodal)	6,115
2	Coastal watch system (radar, ESM electronic support measure, long range camera)	4,060
3	Mobile surveillance (air, surface, subsurface unmanned vehicle)	6,020
4	Coastal defense (fixed & mobile missile system, sonar and sonobuoy)	6,194
5	Integrated air defense (arhanud marines, KRI class PKR)	5.185
6	Anti Submarine Warfare (ASW) defense	6,909
7	Sea task force / sea control at ALKI I, II and III	6,161
8	Human Resources Development	7,290
9	Risk Management	7,671
10	Logistics	6,877
		62,482

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

Table 13. Defuzzy Value of TNI AL Posture Aspect Criteria (simulation)

NO	CRITERIA	DEFUZZY VALUE
1	Weapons	7,671
2	Security	6,575
3	Defense	7,194
4	Intelmar	6,252
5	Diplomacy	6,194
6	Dawinhanla	5.185
7	Support	6,909
8	Harvesting/Deployment/routine ops degrees	6,233
9	Degree of Enforcement/Employment/ sat.alert 3 trouble spot	7,433
		59,647

Table 14. Defuzzy Value of Threat Perception Aspect Criteria (simulation)

NO	CRITERIA	DEFUZZY VALUE
1	Air (Aircraft, Drones, Missiles)	5,662
2	Warships (Surface & Sub Surface)	6,652
3	Maritime CyberSecurity	7,194
		19,508

g. The next step is processing the defuzzification value into the final weight value for each criterion, by dividing the weight value for each defuzzification criterion by the total number of weight values for all defuzzification criteria.

$NB\ t = N\ t / \Sigma Nt(1\text{-}n)$

$NB\ t$ =The final weight value of each criterion
Nt =Defuzzification criterion weight value
$\Sigma\ Nt(1\text{-}n)$ =Total weight value of all defuzzification criteria

Table 15. Key Aspect Weighting Value (simulation)

NO	MAIN ASPECT	FINAL WEIGHT
1	TECHNOLOGICAL ASPECT	0.27
2	ASPECT OF OPERATIONAL STRATEGY	0.23
3	POSTURE ASPECTS OF THE INDONESIAN NAVY	0.26
4	THREAT PERCEPTION ASPECT	0.24

Table 16. Technology Aspect Criteria Weighting Value (simulation)

NO	CRITERIA	FINAL WEIGHT
1	Integrated Systems	0.230
2	Monitoring	0.213
3	Big Data (IoT, AI & Machine Learning)	0.183
4	cyber	0.200
5	Autonomous (Ride & Weapon)	0.174

Table 17. Weighting Value Aspect Criteria Operational Strategy (simulation)

NO	CRITERIA	FINAL WEIGHT
1	Command & control / maritime operation center (Puskodal)	0.0979
2	Coastal watch system (radar, ESM electronic support measure, long range camera)	0.0650

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

NO	CRITERIA	FINAL WEIGHT
3	Mobile surveillance (air, surface, subsurface unmanned vehicle)	0.0963
4	Coastal defense (fixed & mobile missile system, sonar and sonobuoy)	0.0991
5	Integrated air defense (arhanud marines, KRI class PKR)	0.0830
6	Anti Submarine Warfare (ASW) defense	0.1106
7	Sea task force / sea control at ALKI I, II and III	0.0986
8	Human Resources Development	0.1167
9	Risk Management	0.1228
10	Logistics	0.1101

Table 18. Indonesian Navy Posture Aspect Criteria Weighting Value (simulation)

NO	CRITERIA	FINAL WEIGHT
1	WEAPON (KRI, Air Force, Marines, Base, Special Forces, Personnel)	0.129
2	Security	0.110
3	Defense	0.121
4	Intelmar	0.105
5	Diplomacy	0.1039
6	Dawinhanla	0.0869
7	Support	0.1158
8	Harvesting/Deployment/routine ops degrees	0.104
9	Degree of Enforcement/Employment/ sat.alert 3 trouble spot	0.125

The value of the weight of influence (final weight of the simulation) the level of importance of all aspects and criteria for the Smart Defense of the Nusantara Sea Defense Strategy:

1. 0.27 =Technology Aspect Value
2. 0.23 = Value of Operational Strategy Aspects
3. 0.26 = Value of TNI AL Posture Aspect
4. 0.24 = ValueThreat Perception Aspect

4.4 Modelern System dynamic method

Meach of the main aspects as described above has sub-variables and criteria (these variables are explained in the following discussion) so that if a Causal Loop Diagram is compiled it will form a closed system depicted in Figure 3, it can be seenthe sub-variables of each variable interact influence one another, interact to form a dynamic relationship pattern:

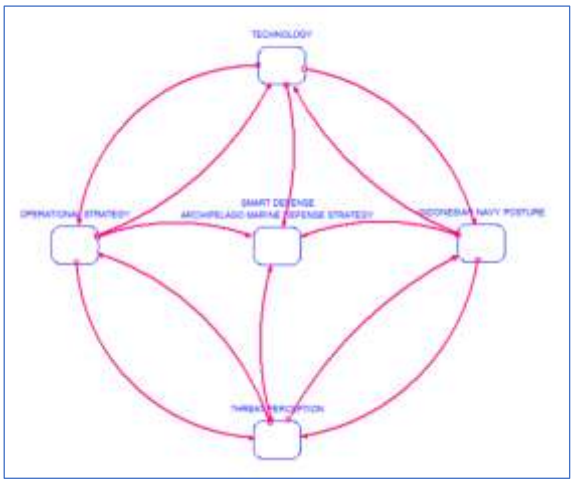

Figure 3. Causal loop diagram of all aspects of smart defense.

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

After obtaining information from experts and other references from various sources as well as previous studies, the next step is to develop a formulation. This model formulation is structured to see the value of the relationship between variables and their sub-variables that interact and influence one another in the system.

4.5 Model Simulation Analysis on the Smart Defense of the Archipelago Marine Defense Strategy

After analyzing the model simulation for each aspect of the Smart Defense Strategy for the Archipelago Sea Defense Strategy which consists of Technology Aspects, Operations Strategy Aspects, Indonesia navy Posture Aspects and hreat Perception Aspects, then obtaining values from these four aspects variables, the next step is to analyze the formulation of the Smart Defense Strategy model. Archipelago Marine Defense as shown in Figure 4,Based on the model formulation, the overall results of the variables of the four aspects that have obtained their values are then also integrated with the constant values of the four aspects obtained from the weighting results of the influence of the importance level of the four aspects using the Fuzzy Weighting method which have obtained values from the previous discussion, namely the constant value of the Technology Aspect is worth 0.27, the constant value of the Operations Strategy Aspect is worth 0.23, the constant value of the Indonesian Navy's Posture is worth 0.26 and the constant value of the Threat Perception Aspect is worth 0.24 which has been measured based on the sub-variables of the four aspects.

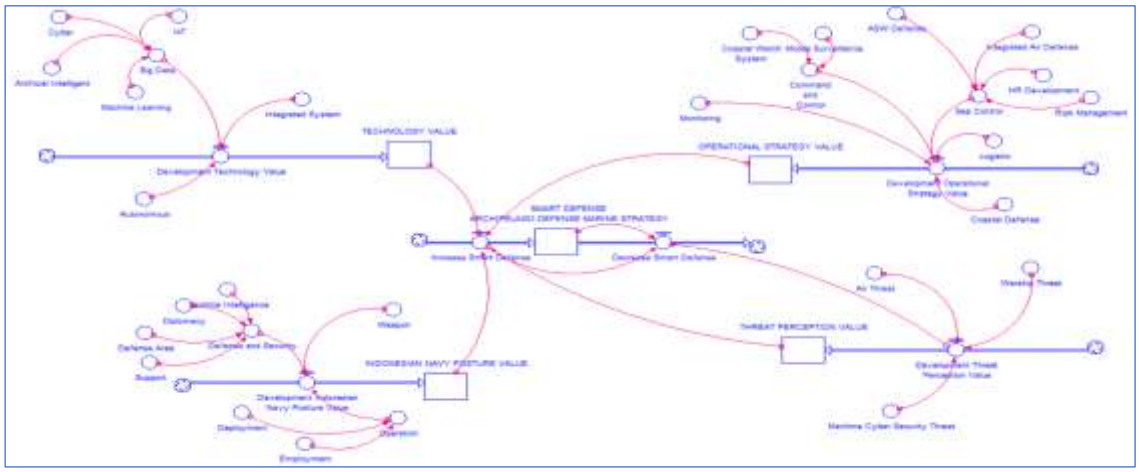

Figure 4. Formulation Smart Defense Model for the Archipelago Sea Defense Strategy

4.6 Preparation of Policy Scenarios

The policy scenario is taken based on conditions that allow it to be controlled by Stakeholders/policy makers in this case the Indonesian Navy. Then every parameter change if it is increased or decreased from the basic scenario parameter values, if it is proven that these changes result in real and significant changes to the main parameters, then these parameters will be considered as key parameters (Sterman, 2000).

a. Scenario 1 Technology Aspect with scenario: Integrated system improvement. Where the condition of the integrated system is assumed to be increased by 30%, the following is a graph of the scenario of the relationship between the integrated system and big data variables:

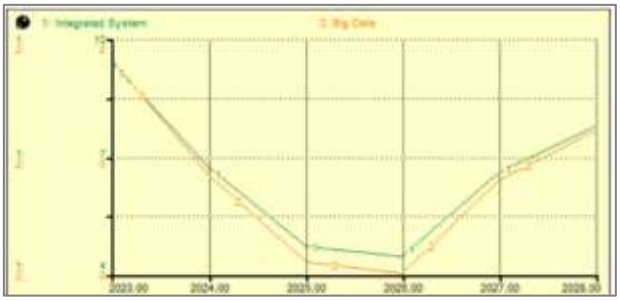

Figure 5. Test Scenario 1 30% increase in the integrated system variable

From the picture above, green line is integrated system, orange line is big data the simulation results show that at the beginning of 2023 to 2026 there is a decline in the integrated system variable and is followed by the same trend pattern of decline in big data variables, it is in this condition that policy scenarios are planned before it's too late. On

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

the basis of this vigilance, an increase in the integrated system of 30% will only have an impact after 3 years, namely in 2026 and in line with big data variables until 2028 there will be a significant increase, after the policy scenario is implemented.

b. Scenario 2 Aspects of Operations Strategy: increasing logistical variables is a scenario taken to getknow how influence,

Figure 6. Test Scenario 2 with a 30% increase in logistic variables

From Figure 6 above, blue line is logistic, orange line is smart defense value, pink is command control and the green line is sea control. The logistics variable has increased by 30%. From the scenario engineering results for the developed model, it can be concluded that a significant increase in the logistics budget will have implications for increasing aspects of the operations strategy and the value of smart defense in the archipelago's maritime defense strategy.

c. Scenario 3 Aspects of TNI AL Posture: increasing variables WEAPON is 30% to be able to find out how it affects the security variable

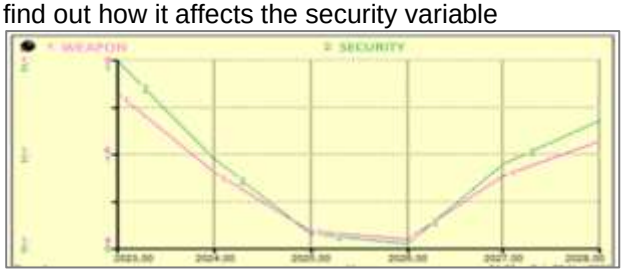

Figure 7. Scenario 3 test assumes a 30% increase in the weapon variable.

On the basis of vigilance against the decrease in weapon pink line and green line is security variables in the aspect of TNI AL posture, a 30% increase in weapons consisting of warships, aircraft, marines, bases, marine special forces and personnel can protect the interests of the Indonesian nation at sea and guarantee security for marine users.

d. Scenario 4 Aspects of Threat perception: increase the Maritime Cyber Security variable by 30% knowing the effect on the Smart Defense Value.

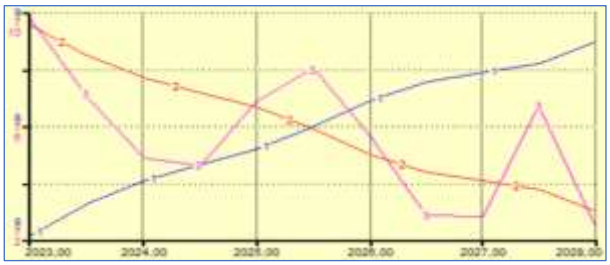

Figure 8. Test Scenario 4 assuming a 30% increase in Maritime Cyber Security Threat.

Observing Figure 7 above, blue line is threat perception value, red line is smart defense value and pink line is maritime cyber security threat, where it is assumed that the condition of the maritime cyber security threat variable has increased by 30%. According to the time movement of the simulation, it appears that there is a close relationship between threat perception and the smart defense of the archipelago's sea defense strategy, namely a negative relationship, when the threat perception increases, the value of the smart defense strategy for the archipelago's sea defense strategy will decrease, and vice versa.

5. CONCLUSIONS

From the simulation and analysis that has been carried out in the previous chapter, the following conclusions can be drawn:

a. Variables in the main aspects that play an important role are as follows:
   1) On Technology Aspect key variable integrated system.
   2) On Aspects of the Operations Strategy key variable is Logistics.
   3) On The aspect of TNI AL posture, the key variable is WEAPON.
   4) On the Aspect of Threat Perception, the key variable is Maritime Cyber Security.

b. Fuzzy Weighting is used to determine priorities in the development of Smart Defense for the Archipelago Marine Defense Strategy, the final weighting results for the main aspects are obtained as follows:
   1) Technology Aspect: 0.27
   2) Aspects of Operations Strategy: 0.23
   3) Indonesian Navy Posture Aspect:0.26
   4) Threat Perception Aspect: 0.24

These values are used in the integration of the dynamic system model to produce the final value of the Nusantara Sea Defense Strategy Smart Defense.

c. The results of the formulation and simulation of the policy scenarios developed by the results of the best scenario analysis are scenario 3.

Overall, the suggestion from the evaluation of policy scenarios is to increase the integrated system integrated, logistics, command and control, strengthening the TNI AL posture, especially the

Volume 14, Number 02, pp.44-54
ISSN: 2460-7037
E-ISSN: 2722-5763

SSAT and then on maritime cyber security which includes cyber threats. By making these efforts, it is expected to significantly increase the Smart Defense value of the Nusantara Sea Defense Strategy in Supporting the Tasks of the Indonesian Navy.

ACKNOWLEDGEMENTS

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.

REFERENCES

Agustian, I. (2019). Sustainability Naval Base With Three Main Aspects With System Dynamic Approach. International journal ASRO-STTAL, 11-23.

Ahmadi. (2017). Applied of Impressed Current Cathodic Protection Design for Fuel Pipeline Network at Naval Base. Iranian Journal of Materials Science & Engineering Vol 14, 41-52.

Astika, IM (2018). Measurement of Indonesian Naval Base Development in a Border Area: A Case Study. International Journal of Applied Engineering Research Vol 13(3), 1560-1566.

Carravilla, MA, & Oliveira, JF (2013). Better Decisions for a Scarce and Uncertain World. Agris online Papers in Economics and Informatics, V(2), 37-46

Chen T. (2021). An Auto-Weighting FWI Fuzzy Collaborative Intelligence Approach Elseiver Journal Procedia Manufacturing 55 (2021) page 102-109

Francesca Ricciardi (2020). System dynamics modeling as a circular process: The smart commons approach to impact management Elseiver Journal Technological Forecasting & Social Change 151 (2020) 119799 page 1-10

Georgiev Venelin (2012). Is the Smart Defense Concept an Innovation Journal OMICS Publishing Group Defense Management vol.2 Issue 4 page2-4/2012

Ion G. (2012). Smart Defense A Concept Aligned to The Current Physiognomy of The Military Phenomenon Journal of Defense Resources Management vol.3, issue 1 (4)

Kyo-il Chung (2014). Development of Information Technology for Smart Defense. The Korean Society of Mechanical Engineers vol.38 no 3 pp 323-328,2014

Mustari B. (2018). Archipelago Sea Defense Strategy in Realizing Indonesia Journal of Universal War Strategy Study Program, Defense University August 2018, vol.4 no.2 page 17-3

Mahan, AT (1890). The Influence of Sea Power Upon History . Boston: University of Toronto.

Sterman. (2000). Business Dynamics System. Cambridge: Irwin-McGraw-Hill.

Suharyo, OS (2017). Establishing the Location of Naval Base Using Fuzzy MCDM and Covering Technique International Journal of Operations and Quantitative Management IJOQM Vol 23(1).

Sushil. (1993). System Dynamics; A Practical Approach for Managerial Problems. USA: Wiley Eastern Limited.

Susilo, AK (2018). Analysis of National Maritime Security Strategy as an Effect of Regional Development using SWOT, Fuzzy Multi Criteria Decision Making (FMCDM) and Borda. IJOQM Volume 25, Number 3, September 2019, pp. 153-174.

Walters, DC Kotze, (2021). Validation of a rapid wetland ecosystem services assessment technique using the Delphi method Elseiver Journal Ecologic Indicators 125 (2021) 107551 page 1-10.

Widen, JJ (2012). Theorist of Maritime Strategy: Sir Julian Corbett and his Contribution to Military and Naval Thought. Ashgate Publishing Ltd. Vermont

Wirjodirdjo, B. (2022). Systems Dynamics: A systems thinking methodology. PT ITS Techno Science.