5. Similarity The Assesment Of Naval Base Sustainability Using Dynamic System Thinking Approach

By Okol Sri Suharyo

The Assesment Of Naval Base Sustainability Using Dynamic System Thinking Approach

Siswo Hadi Sumantri, Avando Bastari , Okol Sri Suharyo

Abstract: Naval Base located in the state working area play significant roles as the deployment forces positions as well as the home-bases having 5 (five) R: Rest, Refresh, Refuel, Repair and Replenishment. Some spot determination models have been greatly developed but have some weaknesses such as in the term of location sustainability approach as a system dynamics among the interacted aspects. The change of the system dynamics situation has caused some Bases undergoing the degradation threat. It means that the Bases do not function as the fundamental one. This research is aimed to find out the value of Naval Base Sustainability using Dynamic System Thinking Method from the mutual interacted Technical, Economical and Political aspects as a system. In the technical aspect, it will be viewed from the variables of the base performance (hydro-oceanography, channel depth, logistics supply capability of materials and personnel). In the economic aspect, it is observed from the economic development variables of maritime industries influencing the availability of the base areas, in the political aspect, it is watched from the susceptibility of the base area. The final result of this research is by finding out the Value of Naval Base Sustainability using Dynamic System Thinking Method.

Keywords: Naval Base, Sustainability, System Dynamic Thinking

1. INTRODUCTION

Operations at sea by naval vessels and naval bases as supporters have strategic value for the existence of national sovereignty and maritime security in the territory of Indonesia's national jurisdiction. Security disturbances and sea crime in the form of timber theft and theft of fish by foreign ships and theft of other natural resources requires the presence of Patrol Boats and the existence of Naval Base for safeguarding the entire Indonesian archipelago with an area of sea reaching 3.9 million km2. The abundance of natural resources in the sea is a potential entry of violations and threats (Suharyo et al., 2017). The Naval Chief of Staff in the Navy's 2024 Posture book has launched the development of the Naval Base to support national defense and security operations. Naval Base Development has become an absolute and indispensable necessity, given the threats and crimes from both inside and outside the Republic of Indonesia such as illegal logging, illegal fishing, piracy and piracy and violations of the territory of the Republic of Indonesia by ship-neighboring country ships are increasingly happening. The Republic of Indonesia state fleet command has carried out a base to support daily operations at sea presence. Naval Base Development requires enormous resources. Therefore we need a calculation and strategic consideration to decide the development of a base location. The purpose of this analysis and consideration is to avoid the degradation of Naval Base as a result of changes and system dynamics that develop and change, both due to natural factors and non-natural factors, such as politics and economics (Suharyo et al., 2017). Based on studies conducted on the selection of naval base locations (Suharyo et al., 2017), it can be said that there are several important factors in the Naval Base Development process, which can be influenced by 3 (three) important pillars namely Politics, Technical and Economic. From a political standpoint, it can be seen from the location of the strategic base position in the region with the level of foreign / foreign threat and regional vulnerability, in terms of technical review of the natural and coastal oceanographic conditions at the Naval Base, the ability of port and dock facilities to support warships while in terms of the Economy, the cost of developing the base and the operational costs incurred if a location is chosen as a Naval Military Base. Each location of the Naval Military Base will have characteristics and influences from different political, technical and economic criteria in supporting the territorial integrity of the Republic of Indonesia, so it is necessary to conduct a study and optimization analysis to select the location of naval base development by considering the baseline degradation factors and also factors sustainability of a naval base (Suharjo B. et al, 2019). Naval Base Degradation is a condition in which the Base no longer functions as a base as a Naval Base. Naval Base no longer serves as a re-supply point for warships, no longer serves as a guard for the stability of the country's integration and no longer serves as an antidote to threats from other countries by sea and coast (Suharyo., et al, 2017). Some of the causes of the degradation of the base are the uncontrolled growth of the maritime business which led to the shifting or closing of naval base land (Kazan., et al 2018) for example, the Surabaya Naval Base which was increasingly pressed for by the maritime business in the Surabaya port. Furthermore, the construction of the Merah Putih bridge in Ambon covered the rate of Navy ships heading to Ambon Naval Base. Technical factors such as sedimentation, sea tides, and other hydro-oceanographic conditions also contributed to the increase in the degradation value of the Naval Base. The threat of degradation Naval Base is the basis for researchers about the concept of Naval Base Sustainability or Sustainability. Naval Base Sustainability is a condition where the base can function as a base for a naval base that continues to grow and be used as a sustainable base. The Naval Base will continue to function as a reprocessing point for warships, function as a guard for the stability of the country's integration and serve as a deterrent to threats from other countries by sea and coast (Moyano et al., 2008). Considering the very complex problems faced in assessing the sustainability of Navy

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bases, it is necessary to study and trace deeper data to create a representative model. This model certainly must be able to accommodate the entire scope of the problem in the development of the base, especially the sustainability of the base, so that this model is expected to be able to do a valuation approach to the sustainability of the base. The choice of the location of the Naval Base is not only for the current conditions but also must consider the location Sustainability factors due to changes in system dynamics, so that the dynamic system model needs to be developed in this problem. The dynamic system is a method used to describe, model, and simulate a dynamic system from time to time constantly changing (Forrester, 1997). This study aims to design and build a more complete and comprehensive problem-solving model on the location of a strategic naval base to be developed by analyzing the existence and sustainability of naval base locations based on consideration of various kinds and complexity of important factors that influence them. The development of the site selection optimization model is emphasized on a sustainable location assessment, because optimization is not only for the current condition or when the model is formed but also must be considered in the future the system sustainability from the chosen location. In this study, the author will develop an analysis technique for assessing the sustainability of Naval Base locations with the development of the System Dynamic concept. The concept of this method, in general, has been widely used by researchers and scientists, but the use for integrated assessment of Naval Base from aspects that influence it never been done. The author tries to make the development and modification of the method into an intact model that is systematic and appropriate in the assessment of the location of the sustainability of the Naval Base which is expected to be a renewal in this study.

2. MATERIAL AND METHODS

2.1. Dynamic System Thinking

The system dynamics thinking approach is a combination of theory, method, and philosophy to analyze the behavior of a dynamic system by building a generic model from symptom identification to producing a problem structure for simulation evaluation / policy analysis in making decisions, both for step evaluation strategic steps that have been taken in generating system performance, as well as for evaluation / analysis of alternative steps that need to be taken in achieving the desired goals going forward (Forrester, 1997). The decision can take the form of various aspects, including "allocation, location and distribution", "regulation and deregulation", "stimulation and response" whose essence is system sustainability. According to Stermann (2000), there are six interacting problem-solving steps that form loops in the dynamic system methodology, namely:

a. Problem identification and definition
b. System conceptualization.
c. Model formulation.
d. Model simulation and validation.
e. Policy analysis and improvement
f. Policy implementation

2.2. The Principles of Dynamics System Thinking

System Dynamics Methodology, basically using causal relationships in developing a complex system model, as a basis for recognizing and understanding the dynamic behavior of the system. In other words, the use of system dynamics methodology is emphasized more on the goals of increasing our understanding of how system behavior arises from its structure (Chen et al., 2006). Problems that can be precisely modeled using a dynamic methodology are systems that have dynamic properties (change with time); the phenomenal structure contains at least one feedback structure (Nair and Rodrigues, 2013) According to Stermann (2000) the principles for creating dynamic models with the characteristics described above are as follows:

a. The desired situation and the actual situation must be distinguished in the model.
b. The existence of a stock structure and flow in real life must be represented in the model.
c. Conceptually different streams, the model must be distinguished.
d. The only information that is truly available to actors in the system must be used in modeling the decision.
e. The structure of decision-making rules in the model must be appropriate (suitable) with managerial practices (Tsolakis and Srai, 2017).

2.3 The Objectives of Dynamic System Thinking

System Dynamic Model is not only made to provide forecasting or prediction process, but further than that dynamic system is intended to understand the characteristics and behavior of internal and external process mechanisms that occur in a particular system (Sundarakani, 2014). Dynamic systems are very effective to use on systems that require a good level of data management. With the flexibility that is owned, this will help in the process of model formulation, model boundary determination, model validation, policy analysis, and the application of the model. According to Forester (1997), the usefulness of the Dynamic System model is to simulate policy evaluation, both for evaluating strategic steps that have been taken (ex-post) in generating system performance, as well as for future evaluations (ex-ante) namely alternative steps what needs to be taken in achieving the goal. Simulation is the imitation of the behavior of a symptom or process. The simulation aims to understand the symptoms or process, analyze and forecast the behavior of the symptoms or processes. Simulations are carried out through several stages including concept compilation, modeling, simulation, and validation of simulation results. The simulation stages sequentially starting in the first phase of the simulation are drafting concepts (Chang et al., 2008) Symptoms or processes to be imitated need to be understood, among others, by determining the elements that play a role in the phenomenon or process. These elements interact, relate to, and depend on and unite in carrying out activities. From the elements and their relationship, ideas or concepts can be arranged regarding the symptoms or processes that will be simulated (Youssefi et al., 2011)

3. RESULT AND DISCUSSION

3.1. Identification of Variable Interactions

Based on observations and understanding of the Naval Base Sustainability system, all variables that have an influence on the system can be identified, which can be categorized into 3 (three) main aspects of the Sustainability System of Naval Forecasting, namely:

a. Technical Aspects

b. Economic Aspect

c. Political Aspects

Every major aspect of the Navy Base Sustainability system has variables or criteria that are interconnected and interact in the system as shown in Figure 1. Grand Model Diagram Sustainability of Naval Base on the main aspects of the interaction model of Naval Base Sustainability System.

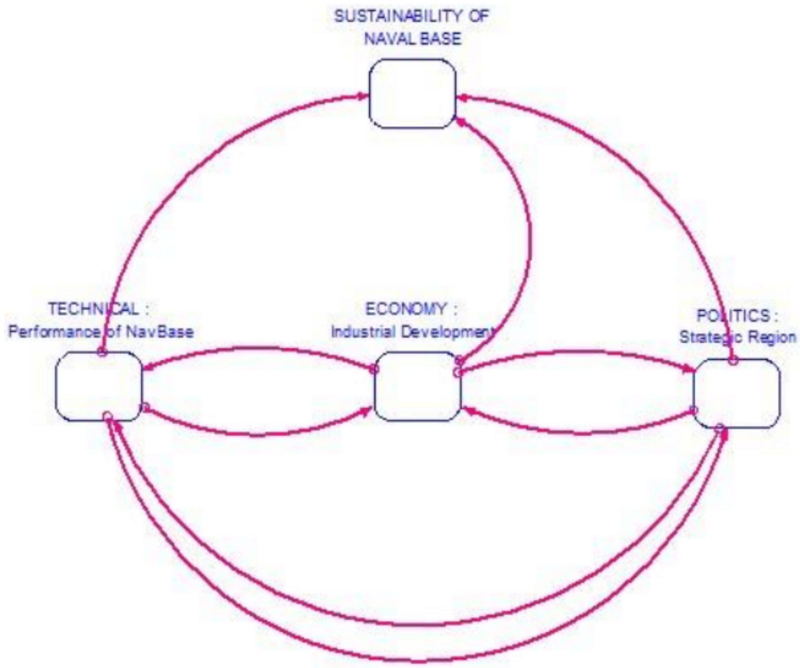

***Figure 1**. Grand Model Diagram Sustainability of Naval Base*

In this study, furthermore specifically identified several variables in the Technical, Economic and Political Aspects. This variable is the result of identification on conceptual understanding of the Navy Base sustainability system. Each variable in aspect has a significant role and has a reciprocal relationship with one another [8]. Based on in-depth interviews and questionnaires with the experts, there are several variables that influence the political, technical and economic aspects. These significant variables are the result of brainstorming with the expert. Each variable in the Technical, Economic and Political aspects has variables that are interconnected and form interactions in the Naval Base Sustainability System. The next step is to create a stock and flow diagram that illustrates the flow of changes in the value of naval base sustainability from the interaction of technical, economic and political aspects, as shown below :

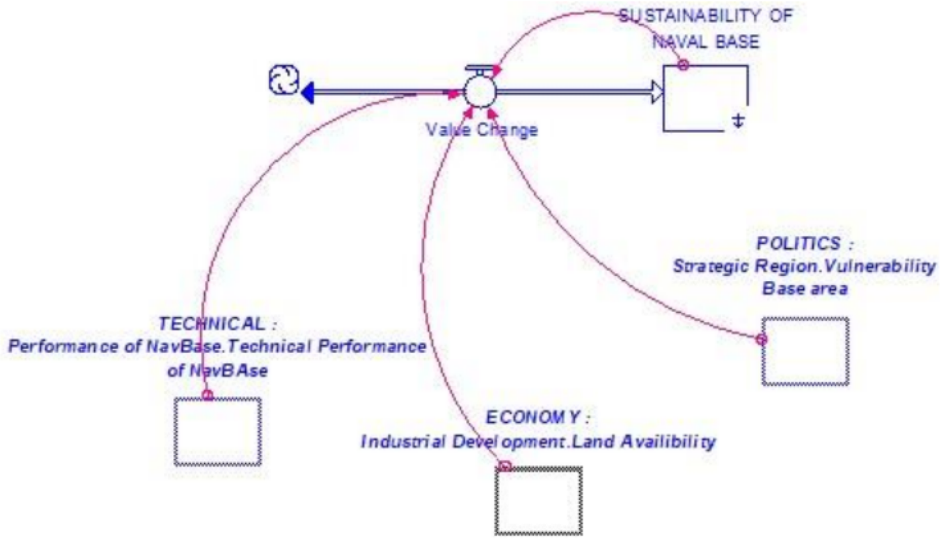

Figure 2. *Stock Flow Diagram Sustainability of Naval Base*

Furthermore, based on stock and flow diagrams, a modeling formulation is then arranged with the system thinking approach, as follows:

THE FORMULATION
SUSTAINABILITY OF NAVAL BASE:

SUSTAINABILITY_OF_NAVAL_BASE(t) =
SUSTAINABILITY_OF_NAVAL_BASE(t - dt) +
(Value_Change) * dt
Technical_Performance__of_NavBAse(t) =
Technical_Performance__of_NavBAse(t - dt) +
(Change_of_Value) * dt
INIT Technical_Performance__of_NavBAse = 4
INFLOWS:
Change_of_Value =
(Geo_Technical__of_Navbase+Technical_Facility_of_Navbase)/2- Technical_Performance__of_NavBAse

Land_Availibility(t) = Land_Availibility(t - dt) +
(Change_Value) * dt
INIT Land_Availibility = 5
INFLOWS:
Change_Value = (Land_Capacity/Land_Use)-
Land_Availibility
Land_Use(t) = Land_Use(t - dt) + (Land_Use_Change) * dt
INIT Land_Use = 6
INFLOWS:
Land_Use_Change =
(Land_Use*Change_faction_land_area)

INIT SUSTAINABILITY_OF_NAVAL_BASE = 4

INFLOWS:
Value_Change =
((POLITICS_:__Strategic_Region.Vulnerability_Base_area+
ECONOMY_:___Industrial_Development.Land_Availability+
TECHNICAL_:__Performance_of_NavBase.Technical_Performance__of_NavBAse)/3)-
SUSTAINABILITY_OF_NAVAL_BASE

Sea_Crime(t) = Sea_Crime(t - dt) +
(Sea_Crime__Changes) * dt
INIT Sea_Crime = 4
INFLOWS:
Sea_Crime__Changes =
(Sea_Crime+Illegal_Fishing+Illegal_Logging+Foreign_vessel__violations)*Fraction_crime_in_the_sea
Vulnerability_Base_area(t) = Vulnerability_Base_area(t - dt)
+ (Vulnerability_Base_area_changes) * dt
INIT Vulnerability_Base_area = 3.5
INFLOWS:
Vulnerability_Base_area_changes =
((Sea_Crime+Land_Crime+Regional_Index_Strategic_economy)/3)-Vulnerability_Base_area+1

3.2. Naval Base Sustainability Index.

Each variable in the Naval Base Sustainability System is assessed and scored (ranked) on the system dynamic model, namely: (1) Very Low, (2) Low, (3) Medium, (4) High and (5) Very High by using measured parameters. Naval Base Sustainability Index can be shown as follows:

Table 3. Naval Base Sustainability Index

Index of Sustainability Naval Base	Index Conversion	Strategic Meaning
Very Low	1.00 – 2.99	Alert
Low	3.00 – 4.99	Warning
Medium	5.00 – 6.99	Moderate
High	7.00 – 8.99	Sustainable
Very High	9.00 – 10.00	Establish

The Naval base sustainability index is obtained from the results of the questionnaire to the Navy experts and in-depth interviews with the Commander of the Naval Base unit. The naval base sustainability index serves to show the sustainability value of the naval base, based on the conversion index and strategic meaning, namely: Alert, Warning, Moderate, Sustainable and Establish. The MeaningAlert. Naval Base Sustainability is said to be an Alert if the dynamic condition of the Navy Base that contains the resilience and sustainability of the Navy Base in dealing with and overcoming all challenges, threats, obstacles and disturbances, both coming from outside or from within is in a very weak condition according to its function. In this condition the slightest threat can jeopardize the integrity, identity and sustainability of the Navy Base. This condition is called Very Low Sustainability. Warning. Naval Base Sustainability is said to be a Warning if the defense and sustainability of the Navy Base is in a weak condition. The meaning is that in the short term the Naval Base can still survive a variety of challenges, threats, obstacles and disturbances, both from outside and within according to their basic functions. However, if there is no immediate significant improvement to the weak dynamic conditions, then in the long run these threats and disturbances will shake Pangkalan's sustainability. This condition is also called Low Sustainability. Moderate. Naval Base Sustainability is said to be Moderate if the resilience and sustainability of the nation is in sufficient condition to face challenges, threats, obstacles and disturbances both from outside and from within. Every pillar and aspect of the Navy Base is also quite adequate in responding to the various demands for changes that arise. But there are some internal weaknesses that need to be fixed immediately so that threats and disruptions do not weaken the sustainability of the Navy Base. This condition is the Medium Sustainability stage.

Sustainable. Naval Base Sustainability is said to be Sustainable if the Naval Base's resilience and sustainability is in good condition. In this condition, all challenges, threats, obstacles and disturbances both from outside and inside can be overcome. Every pillar and aspect of the AL Base is in a good position in responding to the various demands for changes that arise. However, we must be aware of the ongoing disruption and threats from both outside and inside, which will weaken the sustainability and integrity of the Naval Base. This condition is better than moderate conditions, in this condition the Naval Base is in a condition of High Sustainability. Establish. Naval Base Sustainability is said to be Establish if the Naval Base's resilience and sustainability is in excellent and prime condition. In this condition, all challenges, threats, obstacles and disturbances both from outside and from within that threaten the sustainability of the Base in accordance with its basic functions can be overcome properly. These threats and disruptions will not shake the Bases Sustainability, they can even be turned into opportunities. In this condition the Navy Base is in a Very High Sustainability condition.

3.3. The Assesment of Naval Base Sustainability

Based on the model development, Sustainability Naval Base is then measured, which is a measurement of Sustainability from every aspect (technical, economic and political). The results are then aggregated into Naval Base Sustainability as a whole/totality. Based on this dimension Sustainability Naval Base is the resultant and the overall aggregation of Sustainability of each aspect that has been measured based on sub-sub aspects of technical, economic and political. The following picture is the Naval Base Sustainability Value as a result of running from modeling.

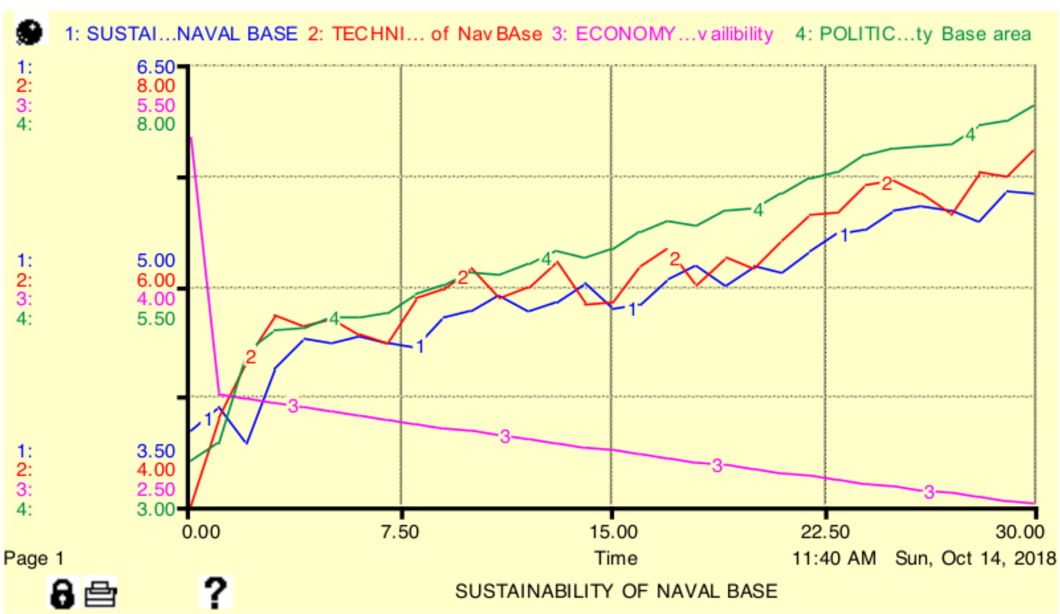

Figure 3. *Assessment of Sustainability Naval Base (Based on 3 Aspects Interaction)*

Figure 3 shows an assessment of the Sustainability Naval Base Grand model carried out by carrying out simulations on the main models that have been compiled. From the graph, it can be analyzed that the value of Sustainability Naval Base is strongly influenced by the conditions of the technical, economic and political aspects that occur at the location of the naval base. The relationship between the variables is the relationship of the system dynamics between all variables for the 30-years dimension.

Table 2. The Value of Assesment of Naval Base Sustainability

Time / Year	Sustainability Naval Base	Technical Aspect Value	Economical Aspect Value	Political Aspect Value
0	4,00	4,00	5,00	3,50
5	4,60	5,69	3,14	5,12
10	4,82	6,15	3,00	5,64
15	4,84	5,84	2,87	5,91
20	5,13	6,15	2,74	6,38
25	5,51	6,94	2,62	7,05
30	5,63	7,23	2,51	7,53

Based on Table 2 and the analysis of the calculation results presented in all of the images, the results are obtained in the form of the value of all base aspects and the value of the base sustainability which is the value of integration between aspects for the 30-year time dimension, which includes the following:

a. Technical aspects of Naval Base: 7.23 (Sustainable)

b. Value of economic aspects of Naval Base: 2.51 (Alert)

c. Value of the Naval Base political aspect: 7.53 (Sustainable)

d. Naval Base's sustainability value which is the integration value of all aspects, Naval Base Sustainability Value: 5.63 (Moderate)

4. CONCLUSION

In this study, a sustainability model for naval bases was completed. This model serves to make an approach in measuring the sustainability of a naval base. The sustainability of a naval base is an absolute matter that must be considered in the selection of naval bases because elections are not only for now but are also used for the future. In this study, obtained a measurement value of naval base sustainability that is influenced by 3 (three) main aspects that interact with each other, namely: Technical, Economic and Political Aspects. Technical aspects represent naval base performance conditions in terms of technical and logistical support to warships. Economic aspects represent the conditions of maritime industry development that can influence and shift the availability of naval base land. Furthermore, the political aspect represents the strategic value of the base region which is influenced by the number of crime in the sea and territorial development of the naval maritime area. Naval base sustainability is a dynamic condition of a base that represents the sustainability of the base in accordance with its functions in supporting the defense and security of the Republic of Indonesia's national sea territory.

5. FUTURE WORK

The output in this study is limited to the preparation of the Naval Base Sustainability Value so that this research can be continued and can be further developed based on the existing models that have been developed. The development of the next model is a model that can be used to design policy scenarios, in order to get an effective anticipation policy for various possibilities that can occur in the sustainability of naval bases in the future. The scenario that will be carried out is based on conditions that allow it to be controlled by stakeholders/policymakers of the Navy. In addition, the scenario is also determined based on parameters that have a high effect on system performance by using key variables in the model. This scenario serves to increase the sustainability value of the naval base. This will be developed again in the next research.

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