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Analysis of the impact of maritime sector development in supporting Indonesian Navy Ship operations

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Abstract

Indonesia is a large archipelagic country. This position triggers various forms of threats to national interests, especially maritime security. Therefore, Indonesia needs to balance it with adequate maritime security capabilities and strengths. One strategy is to build a new Naval Base (Lanal) in a strategic area, Tanjung Benoa. By using system dynamics, we investigate the impact of this development. Simulations are done for the short, medium, and long-term port development. The results show that the variables that affect are port utility and capacity. Hence, the development in this new port can increase Lanal support for Indonesia Navy Ships operations.

Keywords: Maritime sector; navy ship operation; naval bases (lanal); port utility; system dinamic.

1. Introduction

The Indonesian Navy is the main component that can reach the outer boundaries of the seas. Indonesian Navy Bases spread throughout Indonesia. Each Fleet has one Marine Security Group, specifically handling Marine Security operations in the Indonesian territorial sea. Each Fleet's working area is supported by the distribution of several Main Naval Bases and Navy Bases (Lanal). Lanal Denpasar is a type B Navy Base located in Benoa, Bali. This Lanal supports elements of the Navy title, both KRI and pesud elements operating in the Lombok Strait and surrounding

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areas. Lanal Denpasar has several Navy Ships and Patkamla (Marine Security Patrol) to help secure the seas around the port. In terms of securing port facilities, Lanal Denpasar cooperates with the port police and the local Port Security by carrying out land patrols around the port regularly and other components of the community. Lanal Denpasar does not yet have its dock to support Navy Ships/Kapal Perang Republik Indonesia (KRI) operations. Therefore, in carrying out its primary duties and functions, Lanal Denpasar collaborates with several related agencies, Pelindo III Bali Nusra Regional, the Benoa port and other ports operator around the Lombok Strait.

Ports have a strategic role in supporting the transportation system in connecting between regions/countries. In addition, ports are places for intramodal and intermodal transport [1]. Economically, the port functions as one facility that facilitates the distribution of production products. Socially, a port becomes a public facility where interactions between users occur, including interactions that occur due to economic activity. port also provides services for five activities—first, ship services (mooring, piloting, tug, and mooring). Second, handling loading and unloading (container, liquid bulk, dry bulk, general cargo, RORO). Third, embarkation and debarkation of passengers. Fourth, stacking services (general cargo, containers, tanks, silos). Fifth, bunkering (filling supplies such as ship fuel). Sixth, reception, tools, industrial land. Seventh, rental, equipment, industrial land [2].

PT. Pelindo III Bali Nusra Regional as a port service provider at Benoa Harbor in carrying out support for port activities is faced with several limited operational stages of anchoring/pier facilities. In addition, this problem is accompanied by an increase in the number of ships visits each year. The increase in visits occurred on cruise ships, passenger ships, commercial ships, and operating KRIs. This condition makes the dock utility increased. As a result of the impact, the ship queued up, and there was a delay in service time. PT. Pelindo III Bali Nusra Regional has a program to improve Benoa Harbor services. The existing programs include deepening the port channel, increasing the capacity of the passenger terminal, expanding the fishing port, and several programs at particular ports around the Benoa port as stated in KP Number 792 of 2017 concerning the Benoa Port Master Plan. The revitalization program aims to provide optimal service comfort. This program supports maritime economic development in the Province of Bali and increases the carrying capacity in operating KRI services.

Studies related to the operations of the Indonesian Navy have been carried out. Optimizing the involvement of maritime forces as a reserve component to support the duties of the Indonesian Navy in the context of national defense [3]. The role of the Indonesian Navy in Supporting the Realization of Indonesia as a World Maritime Axis in a Defense Management Perspective [4]. Aspect of naval base support and the impact of industrial development, among others (Coastal Fishing Port Development Policy on the Socio-Economic Changes of the surrounding Coastal Communities) [5]. Potential Impact of the Maritime Industry on National Food Security Systems in the Isolated Archipelago [6]. Implementation of Traffic Separation Scheme for Preventing Accidents on the Sunda Strait [7]. A Model of Marine Security Synergy at Chokepoint Lombok Strait With AHP-SWOT Identification Method [8]. These researches have not yet used a holistic approach to view and model the dynamic relationship between the development of the maritime sector and the carrying capacity of Benoa in supporting KRI operations such as a dynamic system. Therefore, this research proposes to study the impact of the development of the maritime sector on the carrying capacity of the Benoa Port in supporting KRI operations by using System Dynamic.

This research pursue answer to the following questions: (1) What variables are influential in analyzing the impact of maritime sector development? (2) What is the impact of the Port development scenario on the Carrying Capacity of Denpasar Lanal in supporting KRI operations? (3) What is the impact of changes to the carrying capacity of Lanal in cooperation to maintain the stability and security of the Benoa port?

2. Literature review

2.1. Port infrastructure

Transportation has many objectives include organizing and coordinating the movement of passengers and goods. Transport systems can be interpreted as a form of linkage to move the passengers and products from one place to another [9]. Transportation system can impact the economic growth rate [10]. There are many researches mentioned that transportation investment can improve the accessibility of transportation, increase traffic volume and economic growth. On the other hand, there are negative relation between transportation and economic development in China during the period 1978-1993 [11]. Finally, it concluded that the relationship between transportation and economic growth may not naturally linear. In order to get the better transportation in the region, there are several standard indicator performances that have been set by the institution. The standard transportation performance should be

determined for assessing evaluating and improving the transportation modes. There is an assessment in the passenger and freight transportation [12]. Moreover, it explained many kinds of transportation with different performance. It explained the highway performance indicators including traffic vehicle, cost, condition, access, safety, and congestion. Moreover, the transportation performance is measured by using the survey method. Several indicators for port performance are: waiting time, postpone time, approaching time, berthing time, and turn round time [13]. Several studies have been carried out to evaluate the port performance in many kinds of countries. There are critical factors that determines the competitiveness of container port in Mainland China, Hong Kong and other Asian countries using AHP method [14]. This research is rarely done in the previous study because it analyzes in different perspective which is shipping liners, forwarders and shippers. The determination of attribute of port competitiveness that can influence the port operational performance [15]. As a result, decisive attribute is port services, hinterlands condition, availability, convenience, logistic cost, regional center and connectivity. The study regarding the containers using simulation was done in determining the container needs and availability using Agent Based Simulation [16] and the economic impact of the availability using system dynamics [17]

2.2. Role of Denpasar's Lanal (Benoa Port)

As an integral part of the Tentara Nasional Indonesia (TNI), the Navy carries out roles of the military, police, and role of diplomacy. These roles are based on state political policies and decisions as stipulated in Law Number 34 of 2004 concerning the TNI [18]. The 1982 United Nations (UN) Convention concerning International Maritime Law which Indonesia ratified with Law Number 17 of 1985, as well as national laws and regulations legally authorized officers/officers of the Navy, Warship and Government Ships as investigators of any forms of crime and lawlessness in and or through the sea area of national jurisdiction, high seas and on ships of Indonesian nationality. In connection with efforts to improve maritime security in the Lombok Strait, the Navy as a related party in it has a very strategic role. Law enforcement at sea is one of the main tasks of the Navy, and the KRI element is the spearhead of maritime security enforcement. In its primary task, the Indonesian Navy Base serves as a support unit for KRI, which operates and executes limited security operations by elements of KAL and Patkamla, who are under it. So that the effectiveness of the implementation of KRI's primary duties cannot be separated from the ability of Lanal's Supporting Capacity to support it [8]. Strategies for Empowerment of Maritime Components by the Indonesian Navy Base around the Lombok Strait supporting TNI-AL Marine Security operations. The development of the TNI AL's posture is linked to the dynamics of National Marine Security. The author identifies a threat to national maritime security and a strategy for developing the TNI AL's Posture to respond to the challenges of the dynamics of National Marine Security.

The research conducted was limited to improving the sub-system in the maritime sector concerning the economic sector from previous research studies. This aim is associated with several factors, including maritime infrastructure, maritime service industry, maritime security, and community marine area governance, and the influence of technology. There has been no analysis of the impact of maritime sector development in the development of port facilities to support the operational elements of the KRI at Benoa port. Therefore, this research will investigate the analysis of maritime sector development on the carrying capacity of Lanal Denpasar in supporting KRI operations using a dynamic systems model approach.

3. Research method

The method used in this research is a system dynamic simulation according to the following stages [19].

3.1. Data collection and processing

The source of the data is obtained from interviews with several experts and practitioners to find the variables and literature study from operational journal archives. The data sources related to this research include: Journal of KRI visits at Benoa port, Cargo ship visit data at Benoa port. Data on Visits of Pelni Vessels at Benoa Harbor, Data on Cruise Ship Visits at Benoa Harbor and Data on Ship Visits at Benoa Harbor.

3.2. Identification of variables and conceptualization of the model

The variables of the entire system related to implementation of the Traffic Separation Scheme (TSS) in the Lombok Strait are as follows:

a. Capacity of the pier: Fishing Ports, Public Ports, Gas and Bulk Ports, Passenger Terminals.
b. Port activity: loading and unloading activities.
c. The Flow Traffic: Flow Exit and Flow Entry activities.
d. Queue: number of ships in the anchor area.

After identifying the primary variables, then develop the relationship between the main variables, followed by the conceptualization stage of the model by making a causal loop diagram (CLD). The simulation model formulation is carried out based on the conceptualization of the initial model that has been made.

3.3. Model validation

The validation process using the white box validation and black box validation methods. Perform external and internal validation. External Validation involves several experts from each related agency with the problems modeled in the research. Internal Validation is done by testing the model's behavior, testing data validation, and testing extreme conditions.

3.4. Policy scenario

The application of policy scenarios aim is analyzing the effect of port development on the operational carrying capacity of the port from the model proposed. The scenario changes the port capacity according to the port development plan, the implementation time, and the development of the model so that outputs will be different from the initial conditions (existing). The simulation results of model development are then compared with the existing output and identify whether it has resulted in significant changes.

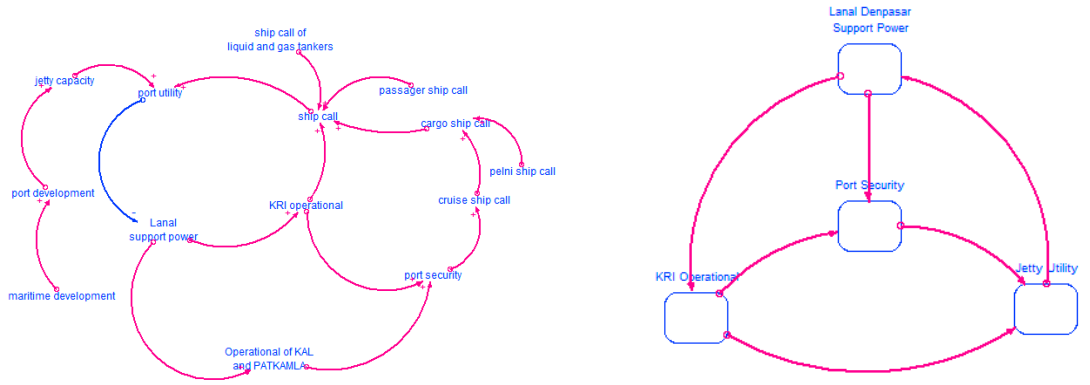
3.5. Analysis and conclusion

The analysis and interpretation follow the research objectives, namely the analysis of the impact of port development scenarios on the carrying capacity of anchoring facilities during a specific period. The final stage of this research is the compilation of conclusions from the entire study.

4. Result and implication

4.1. Research object identification

In this study, the impact of the development of the maritime sector in the Benoa Port Area will be examined based on the Benoa Port Master Plan from the point of view of defense and security interests, in this case concerning Lanal Denpasar Supporting Capacity in supporting KRI elements carrying out Operations in the Lanal Denpasar area. Hierarchically, based on the Decree of the Minister of Transportation KP 432 of 2017 concerning the National Port Master Plan, Benoa Port is the only public port in Bali Province. Currently, the operational performance of Benoa Port is increasing in line with the better port connectivity and infrastructure development program. The results of the terminal development show the port utility to measure the berthing capacity of ships that can be served at the Benoa port. Furthermore, based on existing data, the frequency of arrival and departure of ships is uncertain, which affects the process of dwelling time and channel traffic. Therefore, Benoa Main Port Authority established strategic plan to support policies and programs to improve the maritime sector in the port development plan, which is divided into three stages, Short-Term Stage (2017-2022), Medium-Term Stage (2017-2027) and Long-Term Stage (2017-2037).



(a) (b)

Fig. 1. (a) Causal Loop; (b) Stock and Flow Diagram.

4.2. Research result

4.2.1. Causal loop and model

In Fig. 1(a) there are four loops in this research, namely: (i) Loop 1. A negative loop consisting of the relationship between the variables of Lanal Supporting Capacity, KRI Operations, Ship Visits, and Port Utilities. (ii) Loop 2. A positive loop consisting of the relationship between KRI Operational variables, Port Security, Cruise Ship Visits, and Ship Visits. (iii) Loop 3. A negative loop consisting of Lanal Supporting Capacity, KRI Operations, Port Security, Passenger Ship Visits, Ship Visits, and Wharf Utilities. (iv) Loop 4. A negative loop consisting of the relationship between the Lanal Supporting Capacity, KAL and PATKAMLA Operations, Port Security, Passenger Ship Visits, Ship Visits, and Port Utilities.

Fig. 1(b) is the stock and flow diagram. In this stage, the conceptual model will be modeled with Stella software. Variable in causal loop will group in four sub-modules, namely: Lanal Denpasar Support Power sub modules, KRI operation sub module, Jetty utility sub module, and Port Security sub module.

4.2.2. Verification dan validation

Verification is done using STELLA simulation software, by checking the unit variable equation formulation of the model. Based on the verification results, it is found that the model units are error free. Validation is carried out to ensure that the overall model meets the objectives of modeling. Validation is done by using the Structure Validation Test, Boundary Adequacy Test, Model Parameter Test, Extreme Condition Test, and Behavior Model Test. The structure validation test conducted by discus with analyst expert operations, naval base officials and port systems experts. Then, boundary adequacy test is done when testing all variables in the system. All of the variable is testing in one module and all of modules. If the variable has no effect from the main variable, then it should not be included in the system. The other test is model parameter test. The goal of this test is verified the causal loop and the result model. The input variable will be compared with conceptual model (causal loop). This test will be valid if the behavior variable model has the similar result with the conceptual model (causal loop). The goal of extreme condition test is measuring the ability of the model. In this test, all variable will change with the large and small value. The model will be valid if the output model has the same result with the actual logic. Then the last test is behavior model test. In this test, all output data variable will be compared with actual data.

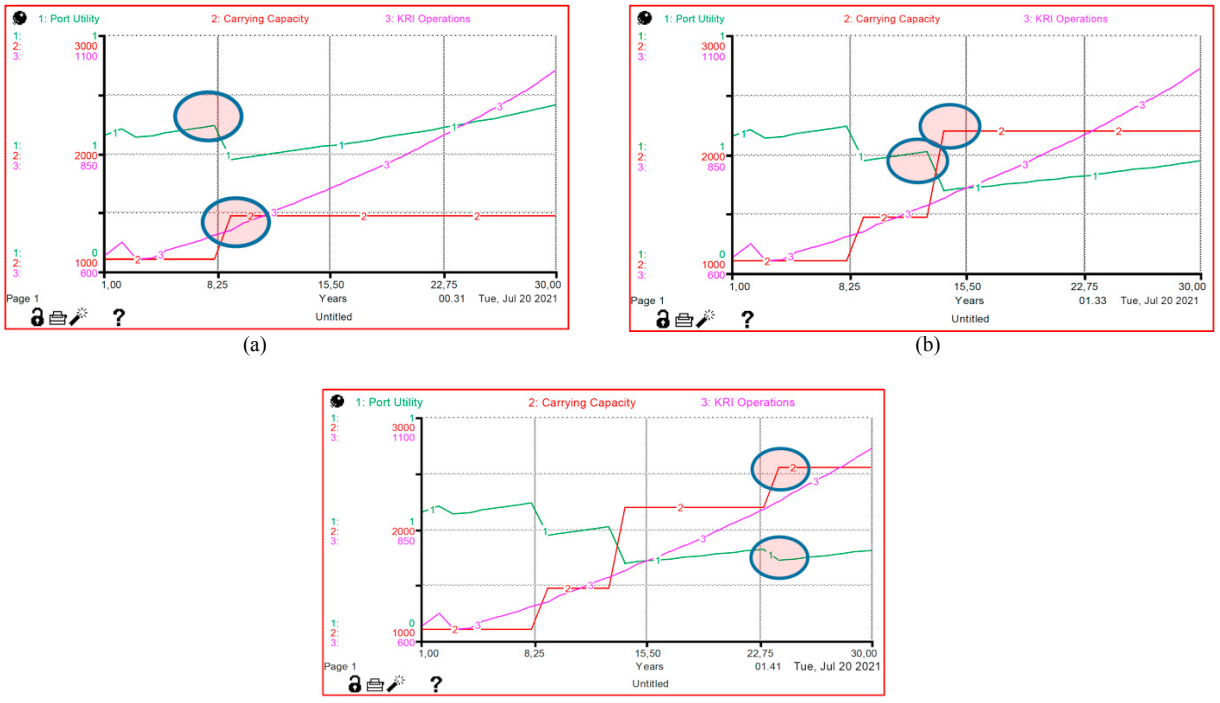


Fig. 2. Simulation Result for the Port Utility for (a) Short-Term; (b) Medium-Term; (c) Long-Term.

4.2.3. Model simulation

a. Short-Term Scenarios (2017-2022)

Constructing a 110 m long pier, 1.8 ha land facilities, construction of a 210 containers pier and extension of the cruise jetty for 60 m north of the East Pier, the multipurpose pier that used by KRI elements. This scenario results in the addition of 1 multipurpose mooring pier.

b. Medium-Term Scenarios (2017-2027)

Build a cruise pier with a length of 234 m to the north of the East Pier and 210 m extension of the South Pier. Thus, there will be an additional 1 Cruise mooring at the East Pier, one passenger boat mooring at South Pier, and an additional two mooring units in the liquid and gas bulk zone in this medium-term plan 1 unit as a substitute for ex.

c. Long-Term Scenarios (2017-2037)

Adding one jetty in the bulk liquid and gas zone and an extension of the South Pier to the west along 211 m.

4.2.4. Policy scenario analysis

The simulation scenario is based on the Decree of the Minister of Transportation KP 792 in 2017 concerning the Master Plan (i.e., Rencana Induk Pelabuhan) for Benoa Port, Bali Province. The Master Plan of Benoa Harbor 2017 will complete the construction of phases I, II, and III started in 2017 and expected to be completed in 2037. The calculation of the terminal capacity increases and meets the demand for port use in the Benoa Port. Therefore, the scenarios are divided into three parts. Assuming the port operates continuously for 365 days a year, the factors that affect the use of port facilities can be measured. There are no events that result in the cessation of port operations.

a. Short-Term Scenarios (2017-2022)

The result of the short-term development plan is an increase in the number of docks by 365 units/year. In the 9th year, there was an increase in the capacity of (1) the dock totaling 365 units/year, resulting in a change in the dock

from 1,095 units/year to 1,460 units/year. This result affects decreasing port utility, which in the previous year reached 62%, down to 47% (2) as illustrated in Fig. 2(a). Every year, the increase in ship visits makes the dock water back to above 50% in the 13th year (2026). This result increase Lanal's Supporting Capacity from 64% to 66% in the following year, followed by an increase in KRI Operations from 35 elements/year to 36 elements/year. In port security, there is no significant change, only an increase of 0.01 points in the 10th year.

b. Medium-Term Scenarios (2017-2027)

In the Medium-Term scenario, there is an additional dock capacity of 730 units/year. There is a change in berth capacity from the previous 1,460 units/year to 2,190 units/year. From the simulation results, it can be seen that there is a decrease in dock utility in the 14th year of simulation or 2027, which is 34%, as depicted in Fig. 2(b). The decrease in dock utilities resulted in an increase in Lanal's Carrying Capacity from 0.69 to 0.71. This result led to an increase in the number of supported KRIs, as 37 elements/year. In the aspect of port security, there has been no significant change from previous years.

c. Long-Term Scenarios (2017-2037)

There is an additional dock capacity of 365 units/year in the Long-Term scenario with a final capacity of 2,555 units/year. The simulation results show that dock utility has decreased from 41% to 37%, as depicted in Fig. 2(c). The decline in wharf utility resulted in a rise in the index. They were carrying Capacity Lanal from an index of 67% to 68%. In the aspect of marine safety, it has increased by 0.2 points.

4.3. Research implication

Table 1 shows the average point of every scenario in every sub-model. Among all of the Sub-Model show that the development of the port will make improvement of the variables. A decrease in port utility results in an increase in the index of Naval Base Carrying Capacity and followed by the increase in number of KRI operations. Meanwhile, in the port safety the change is up to 0.01 point. Service priorities at public ports were adjusted to the provisions of port services where there was a hierarchy of ship service priorities. Following the focus of Benoa port services on cruise ships, cruise ships get the main service priority. The dependence of Lanal Denpasar on the Benoa Harbor dock facilities has resulted in frequent delays in service to KRI. It is caused by considerations of services for other ships, especially cruise ships. In addition to this, it was found that an increase in ship visits at Benoa Harbor helped increase dock utilities which directly affected the decrease in the carrying capacity of Denpasar Lanal.

Geostrategic and geopolitical developments have created opportunities and threats in global life. The competition for military capabilities between countries triggered concerns in facing future challenges. In response to this, the Indonesian Government seeks to build a defense force formulated in the concept of Minimum Essential Force (MEF). To realize this concept, the Indonesian Navy prepares a force development plan to achieve capability-based planning. Including its phasing following the MEF development program that the Government has launched. The deployment of the Navy's fleet in the form of KRI Operations includes the deployment of a striking force, a patrolling force and a supporting force, and other weapon systems.

Table 1. Simulation result average for every scenario.

No	Sub-Model	Existing	Short-Term	Medium-Term	Long-Term
1	Naval Base Carrying Capacity (%)	0,635	0,654	0,67	0,672
2	Port Utility (%)	0,589	0,58	0,467	0,453
3	KRI Operations (number)	s36	37	38	38
4	Port Safety (%)	0,686	0,687	0,688	0,689

As implementation, Lanal Denpasar must maintain its Supporting Capacity as a form of carrying out its primary duties and functions in supporting KRI Operations. Lanal Denpasar was dependent on the condition of the Benoa port. Lanal Denpasar’s Carrying Capacity Index in supporting KRI Operations has decreased along with the increase in port utility. To achieve the expected Lanal Carrying Capacity Index conditions, Navy institution can consider the independence of the anchoring facilities by building port facilities which Lanal Denpasar operates. This is in line with the Indonesian Navy's MEF Development concept in improving facilities and infrastructure that support the operation

of defences equipment and its personnel in realizing more effective deployment of operational elements. This result aligns with the study of Amelia [17] that analyse container capacity problem in port of East Java.

5. Conclusion and further research

The simulation model with a system dynamic described the relationship between the development of the maritime sector and the carrying capacity of Lanal Denpasar in a comprehensive manner. The variable that influences analyzing the impact of maritime sector development on the carrying capacity of Lanal Denpasar in supporting KRI operations is the port utility. The addition of dock capacity influences the Port utility. The construction of the Benoa port can increase the carrying capacity of Lanal Denpasar in supporting KRI operations. Lanal Denpasar plays an active role in maintaining the stability of Benoa port security by including Lanal personnel to secure the port on both land and sea aspects. Increasing Lanal's Supporting Capacity in supporting KRI operations also has an impact on improving port security. This capacity should also maintain facing government policies listed in the Minister of Energy and Mineral Resources Regulation No. 41 of 2018, where bio solar should replace diesel fuel. The services of Pertamina in the Bali region, especially in Benoa does not serve the need for biodiesel-type fuel. Hence gradually, the Navy needs to adjust the technology of the elements of the KRI to adjust the fuel needs following government policies. Further research can examine the impact of applying this biodiesel fuel, affecting the carrying capacity for KRI operation in Benoa port (Denpasar's Lanal). Another comprehensive study can examine the impact of the development of the maritime sector in Tanjung Benoa on maritime security in the Lombok Strait.

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