

## Development Strategy For The Sabang Area With The Logistics Port Concept In The Malaka Strait

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### ABSTRACT

Sabang area is part of the Republic of Indonesia (NKRI) territory, which passed by shipping lines in the Strait of Malacca. Geographic layout of the strategic area, so it is considered a potential to be developed into a maritime area. In the year of 2000, Sabang set to be a free trade area and free port. But until now, this region did not show significant development. In this paper, Sabang area will be assessed the potential and direction of development using the method of TOWS and two step AHP. The direction of development constructed by logistics support concept and simulated using the method of dynamical systems to get the model of the system. The results obtained that Sabang area is potential for development. Simulation of dynamical systems models provides scenarios in anticipation of situations that may happen in the future by increase tank investment and fuel supply so can fulfill fuel needs. In addition, there are a several trickle effects of this system such as the improvement of region economics, the development of docking facilities and service and awareness of regional security.

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## 1. INTRODUCTION

The Malacca Strait which connects the Indian Ocean and the South China Sea and the Pacific Ocean is a choke point for world shipping lanes (Evers & Gerke, 2006). The majority of oil tanker and container shipping companies serving Europe and the Middle East to East Asia and Southeast Asia pass through the Malacca Strait. Seeing Singapore's success in developing port services in the Malacca Strait, the Indonesian government in 1973 made investments in the Batam area through the Batam Authority. However, due to poor management and lack of cooperation between BP Batam and Batam City Government and the unavailability of adequate ports, in January 2016 the Free Trade Zone (FTZ) status

was revoked and replaced with a Special Economic Zone (KEK)(Lestari & Hj. Johar, 2021). In line with Indonesia, in 2000, Malaysia developed the Iskandar Malaysia area with the main facility of the Tanjung Pejuang Container Port (Rizzo & Glasson, 2011). This Malaysian project was considered a success by moving the Maersk Sealand and Evergreen terminals from the Port of Singapore to the Port of Tanjung Pejuang. Malaysia's steps do not stop at this stage, because it is continued with the Port Klang reform which is expected to become Malaysia's second International Hub port (Kleywegt et al., 2023) This situation has affected the changing map of port services in the Malacca Straits as well as increasing Malaysia's source of income from the port services sector. Seeing an example of this success, Indonesia began to develop a trading area in the form of an International Hub port in Kuala Tanjung, North Sumatra under the supervision of the Dutch Port of Rotterdam. It is hoped that this plan will be able to take a portion of the growing volume of container loading and unloading activities in the Malacca Straits.

Figure 1. International Harbor in the Straits of Malacca



Sources: Personal Maps (2023)

In 2005, China brought back the option of building canals on the isthmus of Kra (Kra Isthmus). This proposal is part of China's grand design in controlling the world trade network called One Belt One Route (OBOR)(Kleywegt et al., 2023). The network concept connects China with Southeast Asia, the Middle East, Europe and Africa. The term OBOR which was considered to highlight China's dominance was then changed to the Belt and Road Initiative (BRI) by involving other countries more as supporters of land and sea distribution routes (Victoria, 2018). In the plan, the Kra Canal will be built with a length of 102-kilometers, a width of 400 meters and a depth of 25 meters. Compared to the Malacca Strait cruise line, this new route will shorten the distance by 1,200-kilometers or about 5 days of sailing time. In initial publication, the plan for the canal that separates the northern and southern parts of Thailand was estimated to take 10 years to complete.

Figure 2. World Trade Routes



Sources: Personal Maps (2023)

China takes into account three long-term profit factors in this project, the first of which is shorter shipping distances thereby reducing transportation and operational costs (Zhou & Park, 2020). The second factor is the safety factor of shipping will be guaranteed with direct supervision from the Thai state authorities. The last factor is that the Kra Canal route is a politically free route, unlike the Malacca Strait which is a world choke point so it is prone to blockades. On the other hand, the construction of this canal will have an impact and threat to countries in the Malacca Straits region, because it has the opportunity to divert the main shipping lanes and bring down the economy in the Malacca Straits (Zulkifli et al., 2020).

In general, the prospect of developing the Kra Canal will change the pattern of shipping activities in the Malacca Strait. But with another perception, the plan to build the Kra Canal actually poses a positive challenge to Indonesia because it will increase the volume of ships sailing through both the Malacca Strait and the Kra Canal. Indonesia has geographical potential areas and will be passed by both routes, namely the Sabang waters. First, the Sabang area will be passed by cargo ships and oil tankers when entering the Malacca Straits or leaving the Malacca Straits as shown in the figure below.

Figure 3. Construction of the west gate of the Kra Canal



Sources: Personal Datas (2023)

Figure 4. The Western Gate of The Kra Canal



Sources: Personal Datas (2023)

Second, the Sabang area will become the western gate of the Kra Canal if the construction of the canal is realized as shown in Figure 4. With the development of the world economy and trade, and supported by the development of several international hub ports in the Malacca Strait, in the coming years the traffic in the Malacca Strait will be increasingly crowded.

With all the geographical advantages that exist, the Sabang area has not yet become an advanced maritime area. From the initial mapping of the weaknesses of the Sabang area so that it is unable to maximize its geographic potential, it was found that there are 4 main weaknesses in the Sabang area (Rani et al., 2017). These weaknesses are: 1) unfavorable topographical conditions, 2) the limited area of Pulau Weh, 3) Not yet integrated with ports and other modes of transportation, 4) There are no shipping companies that constantly use Sabang Port as a cargo transit port. Some of these deficiencies are the causes and obstacles in the development of Sabang Port to become an International-Hub port, so it is necessary to formulate a new maritime business model as a driving force for the development of the Sabang area. With all these limitations, the concept of developing the Sabang Area should contain three things, namely 1) Development towards the sea, (Mcilgorm, 2009) 2) Development with business models related to the main needs of ships during shipping, and (Munim, 2019) 3) Development with a single phase service concept. ). The availability of ship logistics is one of the determinants of the smooth sailing, especially those taking long-distance routes (Erkan, 2014). So far, ship logistical support is considered a trivial matter and does not generate big profits. In fact, if managed professionally, logistics support activities are a very profitable business opportunity in the future. The logistics needs of ships during shipping are an opportunity that the Indonesian government can put to good use. The Sabang logistics port has the potential to become the first and main player serving ship logistics in the Malacca Strait.

The Indonesian government has a concept of a National Logistics System. The National Logistics System is one of the infrastructures in building national competitiveness and supporting the

implementation of the Master Plan for the Acceleration and Expansion of Indonesia's Economic Development 2011-2025 (Abbas et al., 2019). The Sea Highway concept is an integration of sea lanes that connect ports in all parts of Indonesia. Improving the function and standard of supporting port services in the sea highway is the focus of this project. The concept of the Trans Sumatra Railroad in order to accelerate the distribution of goods on the island of Sumatra. This project integrates all local railway lines on the island of Sumatra which have been separate, from Banda Aceh to Palembang. It is hoped that the two projects will shorten the distribution time for commodities and goods to all regions of Indonesia, in this case the Sabang region, so as to create even distribution of commodities and support the development of Sabang Port as the main logistics port in the Malacca Strait shipping lane. The development of a dynamic maritime spatial situation in Southeast Asia and the appropriate response from the Government of Indonesia in developing the Sabang region will bring Indonesia to become one of the main players in world shipping and trade.

## 2. METHODS

In this study used a quantitative descriptive method approach. Descriptive method is a method used to describe or analyze a research result but is not used to make broader conclusions. Quantitative research method is the process of finding knowledge that uses data in the form of numbers as a tool to analyze information about what you want to know. The quantitative descriptive approach was chosen because it fits the characteristics of the problem, namely the quantitative assessment of aspects based on observation and observation.

The types of data used in this study are primary and secondary data. Primary data obtained directly from information sources which include the results of interviews and questionnaires. Secondary data is obtained from information sources through information media which includes reference data. These references include a map of the shipping lanes in the Malacca Strait, maritime economic activities in the Malacca Strait, the long-term development plan for the City of Sabang. The main research subjects in this paper are Pelindo III Surabaya, while the City Government of Sabang, shipping and cargo companies that pass through the Malacca Strait and Bappenas are supporting subjects. In this study, the main object of research is the condition of Sabang Port and its surroundings. Meanwhile for supporting objects, among others, the shipping situation in the Malacca Strait, the plan to build the Kra Canal, the Singapore Port service concept, the integration of the Indonesian Sea Highway project..

Research design (Alavi, Nguyen, Fei, & Sayareh, 2018) Research method or research design is a technique or procedure by which the author obtains the data needed from research data sources to collect and analyze data. Selection of research design includes data collection techniques, data collection instruments, and data analysis techniques. Data collection techniques used in this study were interviews,

observations and documents. Research instruments are tools that are selected and used by researchers in their activities to collect data so that these activities become easy and systematic. As a tool for using data collection methods, researchers use interview guidelines, questionnaire guidelines, observation guidelines. The stages of data analysis in this research are: data examination, data classification, data verification, data analysis, and data conclusion.

In research on the analysis of the development strategy of Sabang Port to anticipate plans for the construction of the Kra Canal in order to increase Indonesia's role in the economy of this region, research procedures were carried out starting from proposals, data collection, data processing, simulations and ending with conclusions.

The research phase begins with a literature review related to the analysis of the Sabang port development strategy in order to anticipate changes in maritime spatial planning in Southeast Asia. The literature studied included journals and scientific writings on the conditions of the Port of Sabang, maritime activities in the Malacca Strait, port operational studies, China's development of the OBOR and BRI lines, plans to build the Kra Canal, and maritime economic development. The field study phase was carried out in parallel with the literature review. Field studies were carried out to see the real condition of the research object, in this case the current conditions of the Port of Sabang and the conditions of the maritime spatial layout around the Sabang area and the Malacca Straits. The problem identification stage is carried out by assessing the weaknesses, strengths, threats and potential of Sabang Port in maritime economic activities in the Malacca Strait. Next is assessing the potential of Sabang Port to be developed into a logistics port. The problem formulation stage is to look for problem topics related to the development of the Port of Sabang in collaboration with the current situation in the Southeast Asian region, especially regarding maritime spatial planning. The variable identification stage decides what variables are used in the research. Determination of variables is based on the marketing mix concept combined with the results of the TOWS-AHP analysis that has been carried out. It takes the formulation of the right model to facilitate the process of collecting research data so that the data collected is in accordance with needs. In the data collection stage, primary and secondary data are collected relating to the development of the Port of Sabang, shipping line activities, port logistics standards. Data for the development of the Port of Sabang were obtained secondary from the literature on the condition of the Port of Sabang and the development plan for the City of Sabang. Data on shipping line activity was obtained from data on ship traffic in the Malacca Strait and data on China-Europe trade destinations by sea. Logistics port standard data obtained from primary data from sources at PT Pelindo III Surabaya as a basis for modeling.

Data analysis begins with mapping the current condition of Sabang Port using TOWS analysis. All existing external and internal condition variables are arranged in the form of criteria into each

TOWS factor. Furthermore, from each TOWS factor, criteria were determined which were considered influential using the first AHP. Criteria that are considered influential are then grouped based on external and internal factors. In the external and internal factors, a second AHP was carried out to determine the dominant criteria in external and internal factors. After knowing the dominant criteria in these factors, a potential value was determined for the development of Sabang Port. If considered potential, then proceed with system dynamic modeling.

At the modeling stage, a causal analysis is carried out using a Causal Loop Diagram (CLD). in CLD it can be seen the causal relationship and the influence of the relationship of a variable on other variables, whether positive or negative. The criteria used in the preparation of this model are based on the operational analysis of the logistics port concept. In the dynamic simulation stage, the CLD conversion is carried out into a Stock and Flow Diagram by entering the function formula of each variable in the model. In this process, unit checking is carried out so that there are no variables that experience unit errors. Then a simulation is carried out by running the model and giving values to the variables according to the data. The next stage is model validation, namely determining whether the model is in accordance with real conditions or not. There are 2 validations used, namely structural validation and performance/output validation. The model is declared structurally valid if the basic structure and pattern of the model can describe the real behavior of the system, represent it fairly accurately, and the data collected or assumptions made regarding the system work. This validation is done by checking the relationship between the variables in the model and the units used in the model. Meanwhile, for performance/output validation, ex-ante evaluation is used, namely validation is carried out by comparing the predicted results of the dynamic system model with changes that occur in the real world. The results obtained from the dynamic system model are analyzed to be compared with the real conditions in the field at this time. A good model gives results that are close to the behavior and relationship patterns of variables in the system in the field.

At the scenario stage, the system model that has been determined is a dynamic system simulation scenario for the development of Sabang Port. There are 2 situations that are assumed to occur in the future, namely 1) construction and operation of the Kra Canal and 2) development of Port Klang Port. It is predicted that the construction of the Kra Canal will be completed in accordance with the original construction plan in 2025. The construction of the Port Klang Port will be further enhanced if the increase in loading and unloading traffic in the Malacca Strait continues. Then evaluate how the changes that occur and anticipate the variable adjustments in the system model so as to provide the best results for every possible event.

The final stage is to conclude the best scenario to anticipate future possibilities. It is hoped that the best strategy and scenario will be able to increase Indonesia's role in world and Southeast Asian shipping and trade activities.

### 3. FINDINGS AND DISCUSSION

### 3.1 Description of the Research Object

Sabang is the northernmost administrative region in Indonesia and is directly bordered by Malaysia, Thailand and India. The city of Sabang is surrounded by the Malacca Straits in the north, the Indian Ocean in the south, the Malacca Straits in the east and the Indian Ocean in the west. Pulau Weh has an area of 156.3 km<sup>2</sup> with geographical contours dominated by hills and mountains which cover 87% of Pulau Weh. The Sabang region is included in the Aceh-Andaman earthquake chain which poses a major threat to the potential for underwater earthquakes. In 2015, the population of Sabang was 33,215 people with a population growth rate of 1.45%. Most of the population in Sabang work as employees/employees/laborers and are self-employed.

The waters in Sabang Bay have a very adequate depth for a PanaMax type ship. During the 2004 Aceh earthquake and tsunami, the Sabang area was saved from the brunt of the tsunami due to the existence of a sea trough to the west of Pulau Weh so that the tsunami waves were exhausted when they reached the coast. There are 2 piers at Sabang Port, namely CT-1 wharf with a capacity of 30 thousand Dead Weight Tons (DWT) and CT-3 wharf with a capacity of 100 thousand Dead Weight Tons (DWT).

The Port of Sabang is located on Pulau Weh which is part of the Province of Nanggroe Aceh Darussalam. In 1881 the Port of Sabang was known as the Kolen Station natural harbor which was managed by the colonial government. In 1887, port facilities and supporting facilities were built by Firma Delange and Sabang Haven. In 1895 the Port of Sabang was known as a free port (vrij haven) under the management of Maatschaappij Zeehaven en Kolen Station which changed to Sabang Maatschaappij. During World War II, Sabang was occupied by Japanese troops, and became the target of attacks and bombs by Allied aircraft, causing it to suffer physical damage.

The Port of Sabang has a strategic location value with a close proximity to the main Asian-European shipping lanes that will pass through the Malacca Strait. The Malacca Strait area, which is a route for 30% of world shipping, is a great opportunity to be developed as a logistics port. The increasing volume of world trade and the reduced convenience of the Malacca Strait route due to the increasing number of ships passing have increased the strategic economic value of the Sabang area as a logistics buffer area. The prospect of opening an alternative shipping route with the construction of the Kra Canal in Thailand is also an opportunity that can change the map of port competition in the Andaman Sea and the Malacca Strait.

### 3.2 Data processing

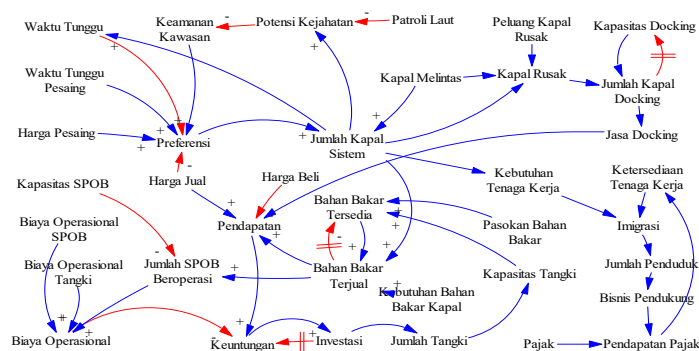
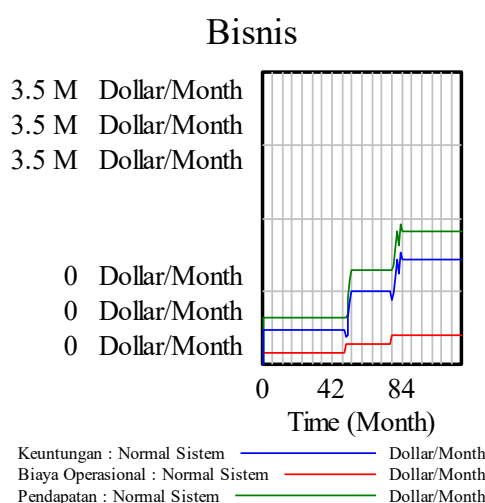


Figure 5. Causal Loop Diagram

From the Causal Loop Diagram in Figure 4, it can be seen that the fuel sold (Fuel Sold) is the main variable in system operations. The amount of fuel sold (Fuel Sold) is affected by the availability of oil (Available Fuel) and a combination of the number of vessels entering the system (Number of Vessels) and the fuel requirements of incoming vessels (Ship Fuel Requirements). The second influential variable is SPOB operations (Operating Costs) which are influenced by SPOB Rental Fees (SPOB Rental Fees) and a combination of the number of SPOBs operated (Total SPOB Operations) and costs for SPOB operations (SPOB Operational Costs). The third variable that has an influence is the preference of ships to enter the system (Preferences). Preference is influenced by waiting time, price and regional safety. The comparison between the waiting time in the system and the waiting time at the competitor's port and the selling price in the system with the selling price at the competitor's port influences the preference determination. The regional security variable is influenced by whether or not there is a marine patrol (Sea Patrol).

Figure 6. Graph of Income, Operations and Profits



Sources: Personal Datas (2023)

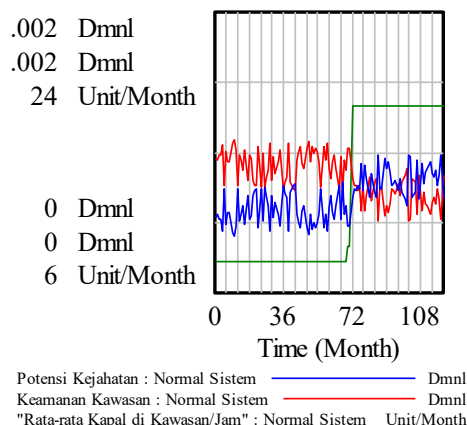
Revenue from the sale of fuel systems continued to increase to US\$ 1,600,000, operating expenses reached a maximum value of US\$ 347,000 and profits starting in the 53rd month were around US\$ 1,250,000. The value of 25% of the profit per month is allocated as an investment fund for the construction of new fuel tanks.

The effect of the system is that the increasing number of vessels entering the system will create a need for support personnel. There was an increase in regional income on average up to US\$ 10,300/month. This increase can be allocated to the organization of community training so that they have the skills needed to fill the opportunities needed for support staff in this business process. The second effect is the docking investment opportunity at Sabang Port. This investment is in response to

the increasing number of vessels entering the system. Investment with a capacity of 1 ship occurred in the second year the system was running, increasing to 2 ships in the 87th month.

Figure 7. Threats and Potential for Marine Crimes

### Kejahatan Laut Akibat Kanal Kra



Sources: Personal Datas (2023).

Operation of the Kra Canal will increase the number of ships in Sabang waters as a result of queues entering the Kra Canal (Tseng & Pilcher, 2022). This increase in the number of ships has resulted in an increase in the potential for crime (blue graph) due to an increase in the economy in the region. The increase in the potential for crime requires related parties, in this case the Indonesian Navy, to provide a good response in maintaining regional security.

The former situation will occur in the future, assuming the Kra Canal will start operating in the 6th year after the system is up and running. The operation of the Kra Canal will change the shipping route map with the diversion of oil tankers heading for East Asia (China and Japan). This occurred as a result of considerations of shipping operational cost efficiency and shorter travel times. This route change will affect fuel consumption patterns, where the need for refueling will decrease due to shorter shipping route distances. The model predicts the ship's fuel consumption will drop by 50%. In addition, the queue of ships to use the Kra Canal route will create congestion in Sabang waters (Brahma, 2020). This density will increase the potential for crime at sea, which will reduce the security value of the Sabang area. To anticipate this condition, a scenario is carried out to increase the percentage of investment value in the first 4 years to 50% of profits. This step succeeded in increasing the average sales to 11,200 tons/month, this value was higher than the initial sales value of 10,200 tons/month. The second scenario is an increase in the percentage of investment value in the first year to 75% of profits. This step succeeded in increasing the average sales to 10,600 tons/month, this value was higher than the initial sales value of 10,200 tons/month.

The second situation that will occur in the future is Port Klang Port being developed by Malaysia as a new international hub port after the Port of Tanjung Pejuang. This situation will lead to

an increase in the number of service options (servers) in competing ports. Increasing the number of service options (servers) will reduce the waiting time at competitors' ports to 2 times faster as a result of the increase in servers. This situation also increases the number of vessels passing through the Malacca Strait due to the increasing number of service options. The increase that occurs is assumed to be 0.02%. To improve this condition, a scenario is carried out to increase the percentage of investment value in the first year to 30% of profits. This step succeeded in increasing the average sales to 10,600 tonnes/month. The second scenario is an increase in the percentage of investment value in the first year to 50% of profits. This step succeeded in increasing the average sales to 12,500 tons/month.

The concept of developing the Sabang area using a dynamic system model is carried out with a span of 120 months, giving the result that activities in the system are able to maintain the continuity of the logistics port development model. From the simulation of the dynamic system of the logistics port concept in the Malacca Strait, there are 4 main variables, namely the number of vessels passing, preferences, availability and profits.

The number of ships passing through the Malacca Strait and its growth is the main background for dynamic system modeling in this study. The increasing number of ships in line with the increase in world trade volume is a very potential opportunity to be used as a new business market. The average number of ships crossing the Malacca Strait is 200 ships/day or 6,000 ships/month. This amount is assumed to experience growth of 2%/year or 0.16%/month. The preference value is the percentage of the shipping company's tendency to refuel in the system. This value is a combination of waiting time, price and area safety variables in Sabang waters. The preference value will be directly proportional to the number of vessels entering the system. In this system, the average preference value is 0.0042 resulting in an average number of ships entering the system reaching 38 ships/month within a span of 10 years with an average fuel requirement of 31,700 tonnes/month.

Availability in this system is a combination of tank capacity and Pertamina's support capabilities. The initial investment was in the form of 1 fuel storage tank with a capacity of 5,600 Tons valued at US\$ 4,000,000, rental of 1 SPOB (Self Propeller Oil Barge) vessel with a capacity of 1,000 Tons, 1 SPOB (Self Propeller Oil Barge) vessel with a capacity of 500 Tons. Pertamina's support capability begins with the support of 6,000 tons/month, with the option of adding as the system's operational journey. Within 5 years, there was an increase in availability from 5,600 Tons according to the initial capacity to 12,000 Tons in the 53rd month, and reaching 16,000 Tons in the 80th month until the end of the 10th year. This increase in availability was the result of investment in the form of building fuel storage tanks to 3 tanks and increasing Pertamina's support to 16,000 tons.

Profit is the difference between revenue and operational costs. Total revenue in the first year was US\$ 6,720,000 and total investment and operational costs were US\$ 5,660,000. The profit earned in the first year of operating the system is US\$ 5,050,000 or equivalent to Rp. 75.8 billion. The rate of return on investment is 7.4%/month and in the 15th month the return on investment reaches 100%.

There are several trickle effects that arise as a result of the running system. The first is that there has been an increase in regional income starting in the 12th month up to US\$ 10,300/month. This increase can be allocated to the organization of community training so that they have the skills needed to fill the opportunities needed for support staff in this business process. The second is the growing investment in docking facilities at Sabang Port. This investment arose in response to the stable number of ships entering the system. Investment with a capacity of 1 ship occurred in the second year the system was running, able to increase to 2 ships in the 87th month. The third effect is the increased potential for crime following the opening of the Kra Canal in the 72nd month. This is due to the increasing density and queues of ships that will access the Kra Canal route. It is necessary to increase the number of patrols to an ideal number of 6 units so as to reduce the potential for crime and increase the security value of the area. The guaranteed security of the Sabang area will maintain the continuity of all business processes and economic activities in the Sabang area.

There are 2 situations that may occur in the future in the waters of the Malacca Strait, namely the operation of the Kra Canal and an increase in the capacity of Port Klang Port. The first situation is the operation of the Kra Canal which will reduce ship fuel consumption as a result of shorter sailing distances. this situation will reduce the ship's fuel requirement in the system by 50%. This condition resulted in sales of fuel in the system experiencing an average decrease of 600 tons/month. A relatively large value when viewed from the potential decrease in income as a result of this incident. From this situation, the first scenario is to increase the percentage of investment value in the first 4 years to 50% of profits. This step succeeded in increasing the average sales to 11,200 tons/month. The second scenario is an increase in the percentage of investment value in the first year to 75% of profits. This step succeeded in increasing the average sales to 10,600 tonnes/month. Both scenario values are greater than the average initial sales of 10,200 tonnes/month. The best scenario chosen is to increase investment to 50% profit for 4 years which will increase sales by 1,000 tons/month.

The optimization steps carried out in the model will be supported by external factors in the form of an increase in the number of patrol boats in response to the increase in the number of ships in Sabang waters. Operation of the Kra Canal will create a queue of ships that will enter the Kra Canal which will increase ships in Sabang waters. Increasing the number of ships will increase the potential for crime which will affect regional security. The Indonesian Navy as one of the implementers of

safeguarding Indonesia's maritime area will increase the number of patrol boats to maintain the security of Indonesia's maritime area.

The second situation is an increase in the capacity of the Port Klang Port which will increase the number of ships crossing the Malacca Strait while simultaneously reducing the waiting time at competitor ports as a result of the increasing number of competitor ports that can serve refueling. The first assumption is that an increase in service time at competitors' ports will reduce waiting times at competitors' ports to be 2 times faster. The second assumption is that there is an average increase in passing ships by 0.02%. The first scenario is an increase in the percentage of investment value in the first year to 30% of profits. This step succeeded in increasing the average sales to 10,600 tonnes/month. The second scenario is an increase in the percentage of investment value in the first year to 50% of profits. This step succeeded in increasing the average sales to 12,500 tons/month. Both scenario values are greater than the average initial sales of 10,200 tonnes/month. The best scenario chosen is to increase investment to 50% profit for 1 year which will increase sales by 2,300 tons/month.

#### 4. CONCLUSION

The conclusions of the study are:

a. Sabang Port and its surrounding waters based on TOWS and AHP analysis provide very good potential to be developed into a logistics port. The cycle of using ship fuel is a cycle that will continue to increase, so as to ensure the continuity of logistics port operational activities.

b. The development of Sabang Port as a logistics port with a dynamic system model is arranged with variables according to shipping and maritime business activities. Model checking is done by checking the causal relationship between variables, followed by model validation in the form of units check, check model, validation with extreme values and field validation with simulation confirmation to informants at Pelindo 3. Performance/output validation uses ex-ante evaluation so that the dynamic system model compared to changes and developments in the real world.

c. There is a trickle effect of business processes in a dynamic system that is compiled. There were 1) an increase in Sabang regional revenue from system support businesses, 2) ship docking activities, and 3) changes in the level of potential crime and regional security.

d. The first possible future event is the construction and operation of the Kra Canal in the system's 6th year. The best scenario is to increase the percentage of investment during the first 4 years to 50% of profits which will result in an increase in average fuel sales from 10,200 tons/month to 11,200 tons/month. Operation of the Kra Canal will increase the potential for crime as a result of the increase in ships in the Sabang area. This condition will be the responsibility of the Indonesian Navy

in maintaining the stability and security of the maritime area. Increasing regional security will have a positive effect on the maritime business in the region.

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