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Marine Control Model in Economic Management of Small Pelagic Capture Fishery in WPPNRI-711

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Abstract

The Fisheries Management Area of Indonesia-711 (WPPNRI-711) is the fishing ground of small pelagic which is vulnerable to illegal fishing activities. The research aimed (1) to estimate the economic values of small pelagic catch fishery and the economic loss caused by illegal fishing, (2) to formulate the model of marine control in order to improve fishermen welfare and GDP. The primary data were collected by interviewing the fishermen, the ocean guard inspector and the expert using questionnaire from July to November 2016. The secondary data were obtained from the Catch Fisheries of Indonesian Statistics Data. The illegal fishing ship data were obtained from the marine resources and fisheries station, Indonesian Navy, and the Marine Security Guard (Bakamla). The data series of 2005 to 2016 were then analyzed using Bio-economic analysis model (Gordon Schaefer) and Surplus Production Model (Fox) to analyze the economic benefits.

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The optimum economic exploitation of small pelagic is 5,040 fishing ships efforts, 13,560.30 tons per year productions, and Rp 225,501.54 million economic rent per year. Meanwhile, the value of fishing 3,284.76 tons and Rp 53,798.26 million due to illegal fishing per year. The exploitation rate carried out in small pelagic catch fishery still must be improved to the optimum rate. The result of Importance and Productivity Analysis (IPA) and SWOT Analysis describes that the marine control model which is effective, efficient and sustainable is indispensable, to combat illegal fishing in WPPNRI-711.

Keywords: marine control model; economic management; small pelagic; WPPNRI-711.

1. Introduction

Indonesia as the world's largest archipelagic country [18,21], has 17,499 islands with an area of 3.25 million km^2 of Indonesian waters comprising a territorial sea area of 0.30 million km^2 and an archipelagic sea area of 2.95 million km^2. The total of Indonesian Economic Zone Exclusive (ZEE) is 2.55 million km^2. The length of coastline recorded as part of Indonesia reaches 81,791 km [16], making Indonesia has tremendous marine potential, both biological resources and other resources under the surface of the sea [10]. Particularly the fisheries sector, which is one of the maritime fields includes activities of fishing, hatchery, cultivation of all kinds of fish and other water biota contained in coastal areas as well as in oceans, and production processing industries from coastal and ocean [11].

This large fishery sector provides a guarantee of contribution to the national GDP so that its management should be able to provide benefits to fishermen in particular and to the public in general. The marine potential of this large fishery sector also invites illegal fishing practices, such as illegal fishing or fishing activities [19] in the Indonesian fishery management area, especially in the waters of WPPNRI-711 which includes the Natuna Sea, the Karimata Strait and the South China Sea (North Natuna) [9], which have small pelagic fishery resources on the surface layer. Here, there are abundant species which have relatively small body despite being mature [15], and the waters in WPPNRI-711 is an area that is vulnerable to illegal fishing activities conducted by foreign fishing vessels and Indonesian fishing boats. Latest data released by the Ministry of Maritime Affairs and Fisheries that the waters in WPPNRI-711 is one of the water zone prone to illegal fishing [2]. The statistics show that the increasing number of cases handling in the Ranai District Court was increasing, from 2015 as many as 37 files completed by PN, by 2016 there were 64 files and until June 2017, the number has reached 39 files that go to court [7]. Therefore, marine control is required to safeguard the marine potential of illegal fishing activities that harm the country for a loss of about three billion to six billion US dollars annually [14]. In Indonesia, marine control still uses multi-agent principles so that there is overlapping despite the existence of the Law of the Republic of Indonesia number 32 of 2014 on Marine [23], where marine control is performed by the single agent with multiple tasks including in the sector fishery.

In addition, illegal fishing activities also reduce national fish production and fisherman income. This marine potential is expected to contribute to national GDP. Based on data from the Indonesian Central Bureau of Statistics [1] it is seen that in 2012, Indonesia's fishery GDP was Rp 184.25 trillion and contributed 2.14 percent to the national GDP. In 2013, its contribution increased to 2.21 percent to the national GDP, and continued to

increase in 2014 with a value of Rp 247.09 trillion or contributed 2.34 percent to the national GDP. While in 2015, the value was Rp 288.92 trillion with a contribution of 2.51 percent, and in 2016, it increased the amount of Rp 317.09 trillion with a contribution of 2.56 percent.

The increase of Indonesian fishery production is inseparable from the management of catch fishery economy and marine control which are effective, efficient and sustainable in order to prosper the life of fishermen and Indonesian people in general.

The marine control model in the management of pelagic small catch fishery economy in WPPNRI-711 is expected to provide sustainable production and synergistic control in supporting the productivity of catch fishery.

Fundamental issues that are explored in the context of economic management and marine control are: (i) What the general description of marine control in the fishing area located in WPPNRI-711 is, (ii) How much the economic estimation value of fishery potential in the region is, (iii) What the economic value of the illegal fishing business in WPPNRI-711 is, and (iv) How the effective, efficient and sustainable marine control model in WPPNRI-711 is.

The objectives of this research were: (i) To describe marine supervisory system in fishery economic management applying in WPPNRI-711, (ii) To estimate economic value of capture fishery potential to improve fisherman's welfare and increase domestic income in WPPNRI-711, (iii) to estimate economic value than the illegal fishing business in the region, and (iv) to formulate models of marine control in the management of fisheries economy in WPPNRI-711.

The benefits of this research are (i) For the state and the people, (a) Increasing the state's income as the basic capital of development for the welfare of the people's life, (b) Being effective, efficient and sustainable state institutions in a marine control agent, c) Providing the existence of security and protection guarantees, especially fishermen in the management of catch fishery economy; (ii) For universities, Adding reference and enriching the scientific information source of marine control model in fishery economic management in WPPNRI-711, (iii) For the writer, Providing knowledge to the authors how to apply the model of fishery economic management using marine control effectively, efficiently and sustainably to improve the income of fishermen.

The hypothesis proposed in this research was that production and effort in the management of pelagic small catch fishery economy can still be increased to the optimum level, and with marine control model, the management of pelagic catch fishery economy becomes better, and marine control in WPPNRI-711 becomes more effective, efficient and sustainable.

The novelty of the research is the application of effective, efficient and sustainable marine control model both technically and economically. This marine control model has never been done before. Effective in the achievement of fishery products in accordance with the objectives as set out, and efficient which is a measure of the economic success of the catch fishery business that is assessed from the applied marine control model.

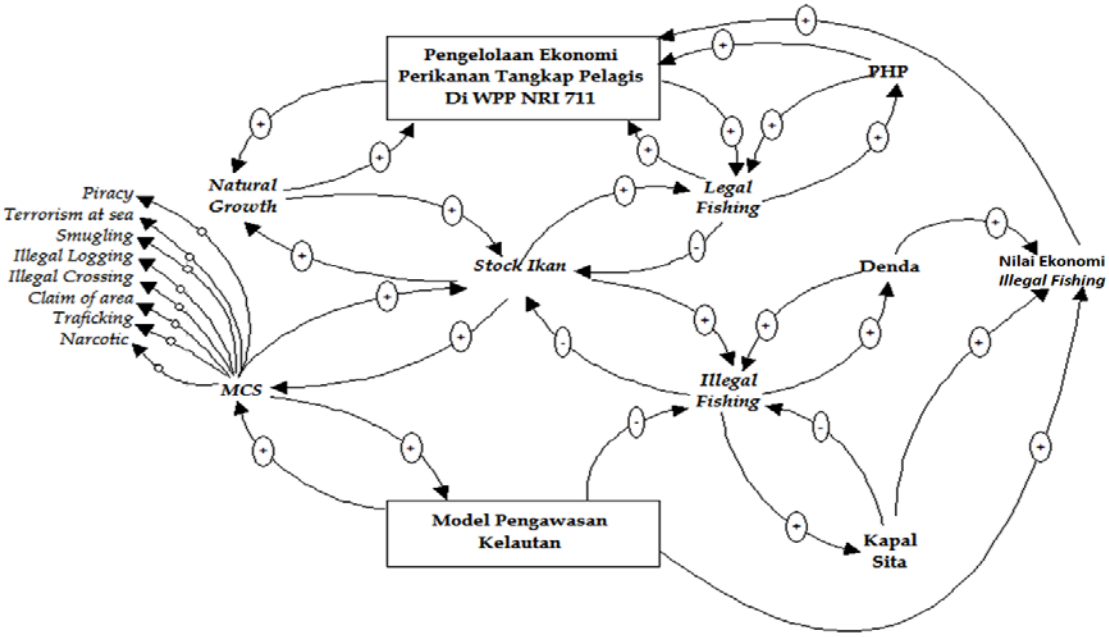

Figure 1: Causal loop diagram

2. Research Methods

The method used in this study was a case study method. The research was conducted to study the application case of marine control model in fisheries economic management. According to Maxfield in Nazir [13], the research focuses on the status of research subjects which are related to a specific phase or characteristic of overall personality. Research subjects can be individuals, groups, institutions, and society. Researchers wanted to study intensively the background and environmental interaction of marine control, catch fishery and illegal fishing subject.

Contextually, this study focused on marine control in the economic management of small pelagic catch fisheries in WPPNRI-711 by using constructed estimation models as follows:

- Bio-economic Analysis of Small Pelagic Catch Fisheries with Gordon Schaefer model [6,20] and for economic benefit analysis using Fox's surplus production model [4.5]
- The bio-economic analysis is then run in the MAPLE-12 algorithm [12] and produces a yield-effort curve for dynamic management. The curve of the calculation results can be used as a reference to determine the condition of small pelagic catch fisheries at this time, whether in the condition can still be improved to achieve optimally and compare the point which produces optimal economic rents
- Importance and Productivity Analysis (IPA) [8] or analysis of the importance and productivity of marine control agents, for the level of interest using 4 scales consisting of: (i) very important by giving scale of 4, (ii) important by giving scale of 3, (iii) less importance by giving scale of 2, and (iv) not important by giving scale of 1, and for productivity also used 4 scales namely: (i) scale of 4 if the supervisor productivity assessment has good ability, (ii) scale of 3 if control model already exists but still needs little improvement (iii) scale of 2 if the control model already exists but still not adequate,

and (iv) scale of 1 if no control or very inadequate control model

- The matrix method of Strengths, Weaknesses, Opportunities, and Threats (SWOT) [17] compares the external factors of opportunity, important situations that are favorable in an environment; and threats, important situations that are not favorable in an environment; with internal factors of strength and weakness which are limitation or lack of resources. This matrix can clearly illustrate how external opportunities and threats can be tailored to their strengths and weaknesses. This matrix can generate four possible alternative strategy cells, namely S-O strategy, W-O strategy, W-T strategy and S-T strategy.

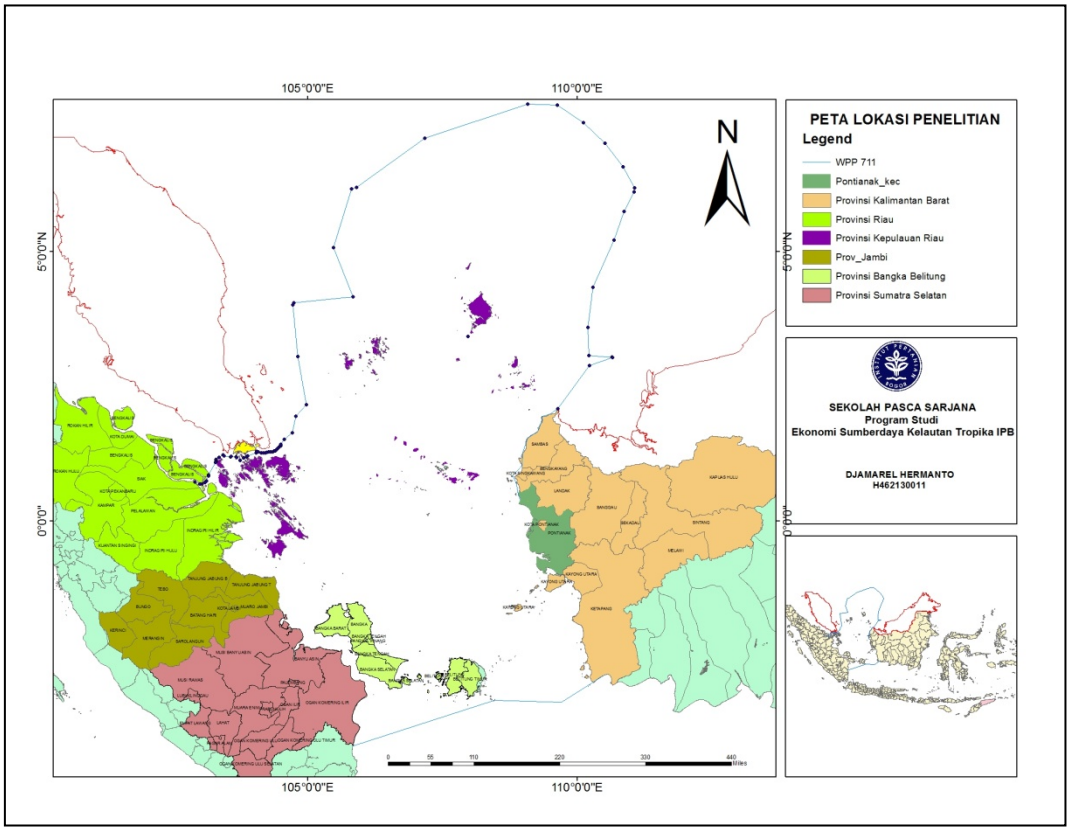

Figure 2: Map of research location of WPPNRI-711

3. Results and discussion

3.1. Fishing Catch condition in WPPNRI 711

The condition of small pelagic catch fishery in WPPNRI-711 seen from production and effort can be increased to reach the optimum level. To compare the sustainable production and actual production of the small pelagic fishery, the production function of Fox surplus was used, and for the purposes of analysis, it was used small pelagic fish production data and the number of fishing vessels for the period of 2005-2016 according to the processed statistical data in WPPNRI-711 [3].

Calculations based on the Fox algorithm, yield q = 0.000023518, r = 0.28499, and K = 195,860.52 were derived

from the calculation of sustainable production of small pelagic capture fisheries. The real fluctuations between the actual model and production, which in the beginning of the actual production period were under sustainable production and then reversed after 2009. This indicates that indeed in the early periods where the level of effort was still relatively low, actual production still showed a level beneath sustainable production, but in line with the sharp increase of effort in early 2009, actual production increased sharply so that it was above its sustainable production. This phenomenon is in accordance with the condition of small pelagic catch fishery in WPPNRI-711 which showed the tendency of decrease of production per unit effort in the years after 2010.

The addition of effort will initially increase production and at the while reducing the stock of fish (biomass) in a linear, while the increase in production is not linear. If the effort is increased continuously then production will reach the maximum point and then decrease. The obtained capture production was at a maximum level (MSY) of 13,954.61 tons per year at the time of effort of 6,059 units and stocks (biomass) of 97,930.26 tons.

3.2. Estimation of Small Pelagic Catch Fisheries

To estimate the extent to which the economic management of small pelagic fisheries in WPPNRI-711 viewed from the bio-economic side, the Schaefer balance estimation is combined with the economic parameters of the average price of pelagic fish per ton (p) = Rp 23.35 million and the operating cost per unit of effort (c) = Rp 18.08 million. The calculation results were obtained optimal value of economic balance (MSY) and open access balance. To see the optimum level of effort input and production under different fishery conditions is needed open access, MEY, and MSY. The table below shows the comparison of inputs and outputs of economic management conditions and actual conditions of small pelagic catch fisheries in WPPNRI-711.

Table 1: Results of static optimization analysis of small pelagic catch fisheries

Condition	Production (ton)	*Effort* (ship unit)	Economic Rent (million Rp)
MEY	13,560.30	5,040	225,501.54
MSY	13,954.61	6,059	216,294.34
Open Access	7,805.70	10,081	-
Actual	12,506.81	4,683	207,398.58

Based on the results of the analysis above that the level of production, effort, and economic rent actual condition is smaller than the condition of MEY and MSY. In MEY condition the effort level is smaller than MSY condition, but the economic rent is bigger. Thus the actual condition of the effort can still be increased as much as 1,250 units-liner (actual MEY-difference) to obtain economic rent of Rp 225,501.54 million.

The amount of economic value of illegal fishing in WPPNRI-711 is the production difference of 3,284.76 tons and the economic rent of 53,798.26 million rupiahs in the actual condition between legal and illegal fishing, which obtained legal fishing production of 9,222.04 tons and economic rent of 153,600.32 million rupiahs.

From the results of the next analysis, it is obtained dynamic optimal conditions with the suggested discount rate of 10% for the economic management of small pelagic catch fisheries that can be managed optimally and sustainably. The lower the discount rate is the lower the production input quantity so that naturally the amount of fish growth becomes more and sustainable, and this condition will also generate high economic rent.

Table 2: Results of dynamic optimization analysis of small pelagic catch fishery

Economic management of small pelagic fisheries	Actual	Dinamic Optimization				
		i=6	i=10	i=12	i=15	i=18
Biomass(x) (ton)	-	114,387.16	93,201.97	89,729.15	84,965.49	65.132.83
Production *(h)*(ton)	12,506.81	13,560.54	13,922.08	13,856.75	13,710.04	12.054.18
Effort (unit)	4,683	5,041	6,351	6,566	6,861	6.946
Economy Rent (billion Rp)	207.40	-	2,206.41	1,807.87	1,403.32	1,129.81

3.3. Effective, Efficient and Sustainable Marine Control Model

From the results of the previous analysis, it was found that the level of pelagic small fishery catch condition in WPPNRI-711 can still be increased production and effort to reach optimal condition, besides it is necessary to prevent illegal fishing with marine control on small pelagic catch fishery in WPPNRI-711.

The collection of data and information in this study has succeeded in briefly identifying 24 countries in the world that apply marine control. These countries are Malaysia, Philippines, Thailand, Maldives, India, Bangladesh, Myanmar, Cambodia, Srilangka, Vietnam, Australia, Canada, Argentina, USA, Japan, Namibia, South Africa, Northwest Africa countries, Mozambique and the South African Countries, the UK and Norway. The comparative assessment of maritime oversight capabilities of each country is conducted on the basis of the following assessments:

- If there is no system, or there is one system but does not have capability in the implementation of marine control, it is rated 1
- If there is a partial, but the system is not capable of performing it, it is rated 2
- If there is a system that has a good level of ability but still requires addition, it is given a value of 3
- If there is a system that has a really good level of capability, though it still requires a slight addition, it is rated 4

In this study, the marine control component is divided into 2 groups, namely:

- The operational base of marine control
- Implementation of marine control

The strategy adopted by Indonesia is to increase operational productivity to obtain international certification. In particular, in spite of the need for full authority in a single agent, it also requires strong inter-institutional control mechanisms, so other related institutions must play an active role in supporting them. The key factor of marine control model was identified based on expert judgment, and it was obtained 18 key factors with 144 component factors which were then analyzed the level of importance and productivity.

The results of the analysis show that almost all of the key marine control factors have an above average level of importance except for legislation and licensing. However, in terms of productivity, licensing factors have better productivity that is above average compared to other factors, it shows that the implementation of the license is still procedural. From the institutional model analysis, it is found that marine control model needs to be implemented in an integrated manner with good governance and supported by governmental policies as well as the quality of human resources that support productivity improvement of marine control implementation.

Based on the result of external factor analysis, it can be seen that there is a strong political will from the central and regional government towards the implementation of marine control. This is also supported by the international commitment due to the huge potential of marine and fishery resources of Indonesia. Internal strength (1.4174) should be able to take advantage of opportunities (1.3652), but cannot cope with external threats (1.6477). Internal weakness (1.7079), causing the organization cannot cope with external threats (1.6475). This condition reflects the weaknesses of the implementation of marine control, for it is needed marine control development strategy that is supported by strong policy and commitment from the government. However, the number of marines and non-functional agencies with a score of 0.1715 can be a major threat to marine control, which often leads to difficult conflicts due to unclear authority between institutions and between central and local governments. Other influential factors are related to economic factors such as inflation, fuel price hikes, taxes and various levies and licensing systems that have not gone well.

Table 3: Expert opinion results for scenario selection

Scenario	Percentage
Very optimistic	13.33%
Rather optimistic	20.00%
Optimistic terms of development of government policy	26.67%
Optimistic with terms of development of legislation	23.33%
Optimistic with terms of productivity increase	10.00%
Pessimistic	6.67%
Total	100%

From the expert's opinion, it can be found the result that the most realistic and recommended scenario to be operationalized in the next 10 years is optimistic scenario with the condition of government policy toward marine control. The marine control model needs to be implemented in an integrated manner with good

governance and supported by government policies with legislation and quality of human resources that support productivity improvement of marine control implementation.

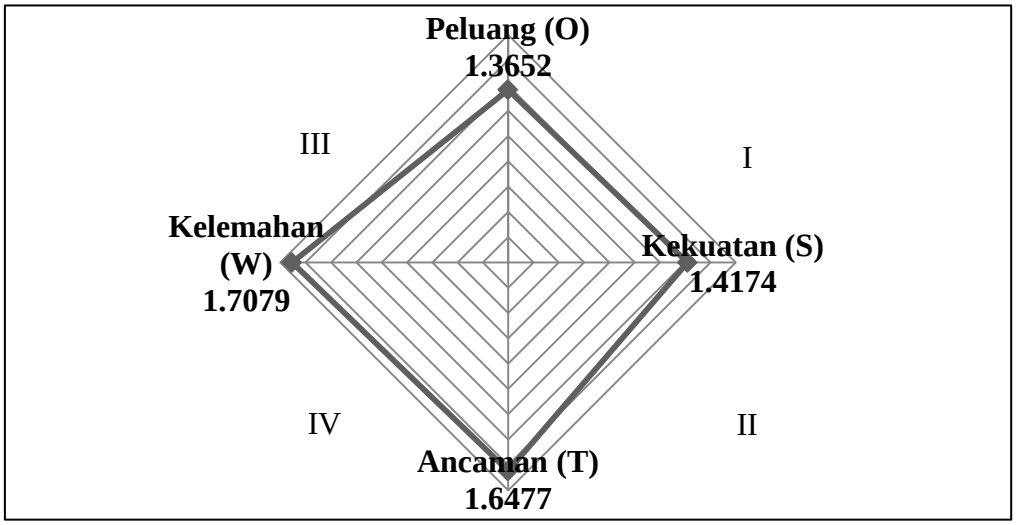

Figure 3: SWOT diagram

The implementing elements of multi-agent marine control such as Directorate General of PSDKP, Satpolair, the fleet of patrol vessels of Directorate General of Sea Transportation, patrol fleet of Directorate General of Customs and Excise, the patent ship of Ditjen Imigrasi need to be merged into single marine control agent. The Navy was not involved in the smelter, in accordance with the basic tasks and functions of the Navy stipulated in article 9 of Law 34 of 2004 on the Indonesian National Army [22], as the enforcement of state sovereignty at sea. In addition, marine control on the part of the military will make it difficult for some countries to provide aid since the law prohibits giving assistance to the military of other countries. Single-agent marine control model as mandated by Law number 32 the year 2014 concerning on Marine, needs to be supported and followed up by other marine agencies with the delivery of infrastructure and facilities required in the implementation of supervision including preparing its human resources as a supervisor in integrated marine control, who has no overlapping of activities.

4. Conclusions and recommendations

Based on the condition of economic management of small pelagic fishery in WPPNRI- 711, the production and effort can still be increased to reach optimum level based on Fox Bio-economic analysis, so it can increase fisherman income and regional GDP in the region. By applying a single agent of marine control model, it can improve community welfare as well as an effective, efficient and sustainable monitoring. The marine control model is built on existing condition analysis and the stakeholder needs three main interrelated components namely monitoring, control and surveillance. Comparative analysis based on the operational basis and implementation of marine control showed the quadrant position of two which meant that the operational basis and its implementation were not relatively good enough. For the level of marine control, almost all marine control factors had a level of importance above the median except legislation and licensing, while the productivity level of all marine control factors implementation was still considered to be lacking, except the

licensing factor was still relatively good but still more procedural. Optimistic policy scenarios with government policy development requirements are priority scenarios that may be implemented. In this scenario, it is necessary to develop a single agent's marine control with government support. The existence of good governance which is complemented by various supporting regulations, international support in the form of cooperation and international recognition, and integrated and synergistic control with professional human resources in the field. Thus the implications of government policy need to establish marine control agency and full support of all institutional institutions with single-agent marine control model, which must be implemented as mandated by Law No. 32 of 2014 on Marine to obtain effective, efficient and sustainable marine control. Therefore, it is suggested in the short term, to improve the implementation of marine control should be enhanced the ability of the operational basis and enhanced the productivity of its implementation. Development of marine control needs integration among all stakeholders, both from military elements and non-military elements. The active participation of the ministry of finance in the operationalization of the marine control model will result in a "resource rent" that can enhance Indonesia's maritime development.

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