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Determining the Location of the Sustainable Fishing Industry with Center of Gravity Method, Case Study: Northeast Coast of Java

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Abstract:- The northern part of East Java which consists along the northern coast line or the city of Tuban to Situbondo and all cities on the island of Madura has a potential of more than 300 thousand tons annually with the city of Lamongan having the largest amount with production of nearly 70 thousand tons [1]. Where this number reaches more than 70% of the total capture fisheries in East Java province and nearly 6% of the total National capture fisheries. With the abundance of capture fisheries, but until now it seems that the distribution of fisheries cannot be channeled properly due to too long the capture fisheries supply chain. Therefore we need a warehouse or inventory that is able to accommodate this great potential, and around this warehouse can later be made into a central area of the development of the capture fisheries industry. The method used is the center of gravity. With the location of the new warehouse, it is expected to minimize the mileage and transportation costs from upstream to downstream of the capture fisheries distribution in the north coast of East Java.

Keywords:- distance, warehouse, center of gravity, cost.

I. INTRODUCTION

One of Indonesia's renewable natural resources and the country's pre-eminent foreign exchange is fisheries resources. The definition of fisheries according to the Law of the Republic of Indonesia Number 31 Year 2004 explains that fisheries are human activities related to the management and utilization of aquatic biological resources. In the Act- the shrimp explained that aquatic biological resources are not strictly restricted and generally include fish, amphibians, and various invertebrates inhabitants of the waters and adjacent areas, and the environment. For activities that are included in fisheries starting from preproduction, production, processing to marketing, which is carried out in a fisheries business system.

According to Bappenas [2], the sustainable potential of fishery resources or maximum sustainable yield (MSY) in Indonesian marine waters is 6.5 million tons per year, with the amount of permissible catch of 5.2 million tons / year (80% MSY). Maritime and fisheries statistics data (2014) shows that the volume of capture fisheries production in the period of 2009-2014 experienced a growth of 3.97 percent, with the growth in the volume of capture fisheries production at sea by 3.75 percent and general capture fisheries at 7.39 percent. According to FAO [3], Indonesia is the second largest producer of capture fisheries in the world that supplies 6.8% of the world's fish needs. Based on data released by the Central Statistics Agency [4] in the CTF (2018) the economic performance of the fisheries sector is always higher than the agriculture sector.

One of Indonesia's renewable natural resources and the country's pre-eminent foreign exchange is fisheries resources. The definition of fisheries according to the Law of the Republic of Indonesia Number 31 Year 2004 [5] explains that fisheries are human activities related to the management and utilization of aquatic biological resources. In the Act the shrimp explained that aquatic biological resources are not strictly restricted and generally include fish, amphibians, and various invertebrates inhabitants of the waters and adjacent areas, and the environment. For activities that are included in fisheries starting from preproduction, production, processing to marketing, which is carried out in a fisheries business system.

One area in Indonesia that has an important role is East Java Province with a large fishery resource. The potential of fishery resources in East Java Province which was successfully captured by fishermen in 2016 reached 411,000 tons. Whereas in 2017, the number reached 417,000 tons and 2018 reached 430,000 tons [6]. These facts show that the prospect of the fisheries sector is considered very bright and has become one of the strategic economic activities. To that end, the government issued a strategy to increase the added value of fisheries production in the form of fisheries industrialization. This is in line with Poernomo and Heruwati [7] which states that fishery industrialization is seen as an appropriate form of managing fisheries on a business basis. As the implementation of this strategy the government issued a Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number PER 27 / MEN / 2012 concerning General Guidelines for the Industrialization of Maritime Affairs and Fisheries. Industrialization is an integration of fisheries production systems from upstream to downstream with the aim of quality production scales with value added, productivity and sustainable competitiveness [8].

To accelerate the industrialization of fisheries, in 2013 the government also issued a blue economy paradigm that was applied at several points in the eastern and western regions of Indonesia. Blue economy was made into the 2013-2025 Medium- Term Development Plan (RPJMN) for the fisheries and marine sector. In order to utilize the marine and fisheries sector in East Java Province, the government has declared East Java as a national fishing industry. East Java as a national fishery industry is intended as an effort to make the East Java region as a region producing fishery processed products in Indonesia in a sustainable manner whose management is integrated within the framework of the "National Fish Logistics System" SLIN. SLIN is regulated in the Minister of Maritime Affairs and Fisheries Regulation No. 5 of 2014. The issuance of the Minister of Maritime Affairs and Fisheries Regulation No. 5 of 2014 concerning the National Fish Logistics System (SLIN), is an effort by the government to regulate and organize the logistics of fishery products to meet the needs and consumption of food in a sustainable manner.In the National Fish Logistics System (SLIN) is closely related to the function of a warehouse or distribution center. It is expected that the distribution center will reduce the lead time in the distribution of capture fishery products because capture fisheries production is vulnerable to damage. The research in this paper aims to examine the possible distribution center locations for capture fisheries production on the north eastern coast of Java.

II. LITERATURE REVIEW

A. Warehouse / Distribution Centre Strategy

20 - 30 percent of an organization's logistics costs are caused by warehousing. As such, it also forms a significant part of total costs and greatly influences an organization's finances. Because warehousing provides many amazing benefits, however, it is also very important to pay attention to optimal inventory levels. determine the level of service needed in accordance with the strategy, the organization must be able to understand the current situation as accurately as possible. In addition, organizations must have an objective image of the role of distribution centers in the supply chain. Thus, warehousing must carry out its duties effectively in the supply chain. When the role is clear, it is possible to make reasonable conclusions about the future and the changes needed at the service level.

Warehousing has become increasingly important time to set warehouse goals in accordance with broad company strategies. Traditionally, warehousing goals have focused on being productive, fast, cheap and accurate, but now it is time to complement these goals with value-oriented goals. He emphasized the focus among three types of operational performance objectives: efficiency, asset utilization, and customer response. Figure 1 represents this triangle of warehousing purposes.

Fig. 1. Dependence between warehousing goals and business goal.

B. Gravity Location Model

The Gravity Location Model method is part of the supply chain management strategy that is used to determine the location of a facility (for example a warehouse or factory) that serves as a link between supply sources and several locations such as markets. This model is highly developed to support multi-national companies in the development of shipping goods, it is because of its superiority in the analysis of the distribution costs that can be reduced. The Gravity Location Model is based on selecting a point of a distribution center that provides the shortest total distance to the entire center of the production zone that must be supplied. Thus the choice of location will be more focused on hauling distances which require the lowest transportation costs. This model uses several assumptions, namely :

- Transportation costs are assumed to increase in proportion to the volume transferred.
- Both supply sources and production locations can be located on a map with clear X and Y coordinates. Calculation of location coordinates using the following formula :

$$x' = \frac{\sum_{n=1}^{k} \frac{D_n C_n x_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n C_n}{d_n}} \qquad y' = \frac{\sum_{n=1}^{k} \frac{D_n C_n y_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n C_n}{d_n}} \qquad (1)$$

Xn, Yn: coordinate the location of the market or point of supply
Cn: the cost of sending one unit to one km from or to the location and facilities to be found
Dn : Amount to be sent from or to location n to the facility
dn: distance to or from facility n to facility

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C. Political Policy Implication

Furthermore, analyzing the capture fisheries supply chain based on local political policies or the local community. Political policy can also be like the establishment of a fisherman institution that can meet the needs of fishermen in terms of capital access and is able to overcome the fishermen's constraints in terms of capital access that is responsive to fishermen. Institutions as rules of play within a social group and are strongly influenced by economic, social and political factors.

Institutions can be in the form of formal rules or in the form of informal codes of ethics that are mutually agreed upon. Thus, it is expected that the established fishermen's institutions can improve the performance of the capture fisheries industry supply chain because the financial institutions that will be built adopt the prevailing social cultural values of the community.

III. DISCUSSION

Gravity location model is used as a basic way to determine the location of supporting facilities, while the steps required are determining the location as a basis for reference points as input distance. In this case the first reference point chosen is PPDI PPN Brondong. This selection was made because PPDI Brondong is fish auction center as the largest fish auction site on the north coast of East Java and based on the results of inter-port connectivity studies found that the PPDI Brondong has a central role as the start of the capture fisheries supply channel, especially on the North East Coast. The Map of PPDI Brondong PPN can be seen in the following figure 2 below :

Fig. 2. PPDI PPN Brondong as the First Point of Reference in Determining the Location of Supporting Facilities.

After the reference point is determined, a straight line is drawn towards the destination of distribution, the result of distance drawing is defined as the "dn" notation. While the assumption of the objectives of the distribution of capture fishery products from PPDI PPN Brondong can be seen in the following table 1 below :

TABLE I. PPDI PPN BRONDONG AS THE FIRST POINT OF REFERENCE IN DETERMINING THE LOCATION OF SUPPORTING FACILITIES

Purpose of Distribution of Capture Fisheries Products in East Coast of East Java		
No	**Company / Place**	**Business fields**
0	TPI PPN Brondong	**Centre of Reference Point**
1	Pasar Ikan Pabean Cantikan	**Long Distance Market**
2	Pasar Wonoayu	**Local Market**
3	PT Bumi Menara Internusa	**Frozen Fish and Shrimp**
4	PT Fishindo Isma Raya	**Frozen Fish**
5	PT Madsumadaya Seafood	**Shrimp, Seafood & Frozen Fish**
6	PT Inti Luhur Puja Abadi	**Frozen Fish**
7	PT Aneka Tuna Indonesia	**Fish Canning**
8	PT Varia Niga Nusantara	**Frozen Fish**
9	PT Rex Canning	**Fish Canning**
10	PT Lousiana Far East	**Seafood Value Added**
11	PT Phillips Seafood	**Seafood and Frozen Fish**
12	**PT Hatni**	**Frozen Fish**

The next thing is to determine the demand for each point. Determination of demand is targeted at the total production of PPN Brondong for one year, namely in 2018. The total production of PPN Brondong during 2018 was 64,033,000 kg. As for the distribution of local and national markets amounting to 54,471,755 kg. The division of demand was simulated that 54,471,755 kg of capture fisheries were divided into 8 domains. These 8 domains include the customs market representing the national market, the wonoayu market representing local demand, and PT Bumi Menara Internusa, PT Fishindo Isma Raya, PT Madsumadaya Seafood, PT Inti Luhur Puja Abadi, PT Aneka Tuna Indonesia and PT Varia Niga Nusantara are interpretations companies engaged in capture fisheries registered with the Ministry of Industry located around the PPN Brondong that are simulated as the first point of reference and production center. The company's target is the north eastern coast of Java, specifically in Lamongan Regency, Tuban Regency, Gresik Regency, Pasuruan Regency and Surabaya City. From these results it was found that each domain received a catch fishery allowance of 6,808,969.38 kg.

Meanwhile, to export the export market, it was represented by 4 international companies namely PT Rex Canning, PT Lousiana Far East, PT Phillips Seafood and PT Hatni. The company's target is the north eastern coast of

Java specifically in Lamongan Regency, Tuban Regency, Gresik Regency, Pasuruan Regency and Surabaya City. As for the distribution of demand for each company, that is 9,561,245 kg divided into 4 companies so that it was found that 2,390,311.25 kg for each company. After determining the location of the capture fisheries production distribution destination, the next is to determine the number of requests at each point. The number of requests at each point can be seen in table 2 below.

TABLE II. NUMBER OF PRODUCTION REQUESTS FOR EACH DISTRIBUTION PURPOSE

No	Company Name / Place	Demand (Dn) (kg)
1	Pasar Ikan Pabean Cantikan	6.808.969,38
2	Pasar Wonoayu	6.808.969,38
3	PT Bumi Menara Internusa	6.808.969,38
4	PT Fishindo Isma Raya	6.808.969,38
5	PT Madsumadaya Seafood	6.808.969,38
6	PT Inti Luhur Puja Abadi	6.808.969,38
7	PT Aneka Tuna Indonesia	6.808.969,38
8	PT Varia Niga Nusantara	6.808.969,38
9	PT Rex Canning	2.390.311,25
10	PT Lousiana Far East	2.390.311,25
11	PT Phillips Seafood	2.390.311,25
12	PT Hatni	2.390.311,25

After determining the first reference point and the number of requests at each point of destination that is notated with (Dn), then calculating the distribution cost per kg / km and notated with (Cn).

Furthermore, after knowing the components needed, namely market location or supply point (Xn.Yn), the cost of sending one unit for one km from or to the location and facilities to be found (Cn), the amount to be sent from or to location n to the facility (Dn). Next is to determine the distance from the center of the first reference point, in this case in PPDI Brondong, to the distribution destination.

After the data is collected, the next step is to do the first iteration. The first iteration is done to find the coordinates of the new supporting facilities according to the center of gravity formula. From the 14th iteration, the location is obtained as a proposal for the location as a development distribution center, the area obtained is in the wilayut village, Sukodono sub-district, Sidoarjo Regency. The location of the results of the 14th iteration can be seen in the following figure.

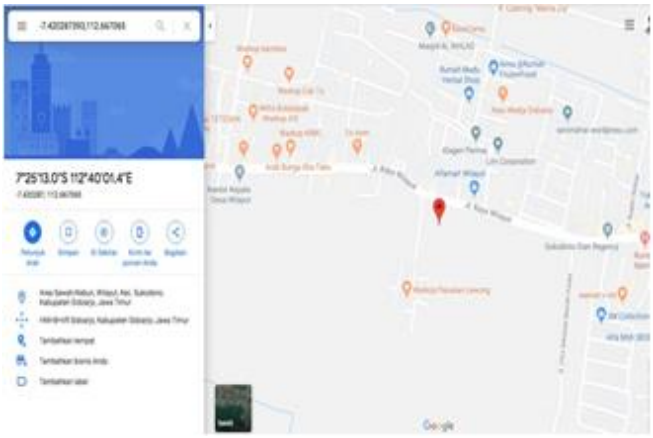

Fig. 3. The location of the 14th iteration

The results of the center of gravity are coordinates which specifically refer to a place where the results of this study are in the Wilayut Village, Sukodono District, Sidoarjo Regency.

IV. CONCLUSION

After iterating up to 14 times, the result point of the center of gravity is at the point between all requests starting from Tuban Regency to Pasuruan Regency in the Wilayut Village area, Sukodono District, Sidoarjo Regency. However, this point does not necessarily immediately appoint a place as a location to be built supporting facilities but needs to be analyzed in terms of supporting factors where the supply chain takes place. Broadly speaking, the factors that support are:

1. Ease of Access
2. Far from residential areas
3. Energy availability

From these three factors, it is necessary to analyse further whether the results of the center of gravity have met the three criteria, so it is necessary to compare alternative locations that meet these criteria but are close to the area of the results of the center of gravity.

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