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Optimization of Product Oil Shipment System for Archipelegic Region

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ABSTRACT

Demand of products oil continues to increase by increasing the mobilization in various areas in Indonesia. The government should rethink considering the uneven spread of demand and supply of products oil that can not be mixed in the cargo hold. Currently product oil deliveries to Nusa Tenggara Barat carried by tanker vessels. The issue is whether the vessel's size not yet optimum. The purpose of this study is to optimize the distribution of product oil from Transit Terminal Product Oil to Unloading Ports. The most influenced variable are the size of the main vessel and the effect on the primary measure is the amount of goods transported. The main dimensions of tanker are LPP= 105 m; B= 18,01 m; H= 8.23 m T= 6.78 m ;DWT= 7,992 DWT ;Payload = 8,933 KL and Tankers's unit cost is Rp. 203,587.70 per Kiloliter
Key Words: Optimum, Product Oil, Tanker Ship

INTRODUCTION

Along with the development and technology in Indonesia, Fuel is one of the basic needs that are not separated from the industrial sector. So that transportation needs continue to increase every year. The higher mobility causing increased flow of transportation (Harvey, 2002). For the oil shipping company must be able to plan the allocation needs, inventory, and distribution of fuel throughout Indonesia optimally. President Director of the biggest state oil company in Indonesia claimed that the distribution pattern of products oil in Indonesia is the most difficult one in the world because it consists of a vast ocean, and archipelgic region so that the distribution pattern is quite complicated (Carlson, 2019).

Hong Ti Min Ha, et al [1] deal with a routing and scheduling problem of vessels that carry oil product (Srinivas & Deb, 1994). One of the ways used to facilitate the country's current fuel distribution patterns throughout Indonesia is to do the zoning region shipments to and from a particular region. Surabaya oversees the Regional V Fuel Terminal Unit consisting of East Java, Bali, Nusa Tenggara Barat (NTB) and East Nusa Tenggara (NTT).

For Nusa Tenggara Barat are Ampenan Depot in the service stations in the western region of NTB. Ampenan own fuel depot to get new supplies of fuel Manggis Transit Terminal and Fuel Terminal Surabaya. For the distribution of fuel in Nusa Tenggara Barat it self is quite difficult because of the geography of Nusa Tenggara Barat has a separate island separated and spread of demand in each of the island with the numbers fluctuate, but should still be covered in order to prevent a surge in the price of products oil in Nusa Tenggara Barat. In this case, the necessary data capture demand in each of the depots of fuel and fuel quota for each Depot Ampenan, Badas, and Bima so do the calculations for the use of conveyances or modes appropriate and efficient to serve the distribution of product oil in Nusa Tenggara Barat.

RESEARCH METHOD

Problem Identification

After determining the problems that arise namely logistics planning study following oil product vessels and ports. Then the following will be the problem thatt needs to be identified. In this chapter, described some of the problems related to the identification process in this research is the determination of products oil logistics planning in Nusa Tenggara Barat contained in Figure 1 bellow.

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Figure 1 Products Oil Shipping Route to Nusa Tenggara Barat

As for some identification as bellows :

1. Fixed Cost Identification :
   Identification aims to find the fees charged each year from ships and port investments. These costs contain costs such as the price of the construction of ships (Wallinga, 2018), docks and port facilities that have the economic life of each tool. There is also the cost of insurance, maintenance and taxes.
2. Variable Cost Identification :
   Variable cost is meant here is the costs resulting from the passage of the delivery system in an amount not fixed as the fuel cost is calculated based on the number of ships vessel trip, need fresh water, and food (Ting &Tzeng, 2003). Additionally the calculated variable cost is the cost of port operations which only comes out when it serves the process of loading and unloading (Tolofari, 1987).

Analyzing Phase

In the analysis phase is carried calculation of the oil product distribution and supply chain management that passed. Distribution is the process of moving goods from the production site to every place or region in need (Lasserre, 2004). Distribution will include the planning, implementation and monitoring the flow of materials to obtain the final product from the production site to make a profit. Most companies stated that the purpose of the distribution is to bring the goods in the right quantity, at the right time, and at the lowest possible cost

Supply chain management (supply chain management) is the integration of activities of the procurement of materials and services, conversion into semi-finished goods and finished products, as well as delivery to the customer (Christopher & Towill, 2000). The goal is to build a supply chain that focuses on maximizing value for customers. The key for effective supply chain management is to make the suppliers as "partners" in the company's strategy to meet the ever-changing market.

Currently, optimization problems need support in solving software so as to produce the optimal solution with faster calculation times. To solve a problem is usually done by converting the problem into a mathematical model in advance to facilitate its completion. The successful implementation of optimization techniques, it takes at least three conditions, namely the ability to create models, mathematical of the problems faced, knowledge of optimization techniques, and knowledge of computer programs. Januari 2016, ESDM [3].

At this stage, related analysis determining the size of the vessel, port facilities, the costs incurred along with the resulting unit cost. In this phase 2 analysis of the ship tankers and container ships to transport the three types of oil products (premium, kerosene, diesel fuel).

Here are the steps to exit the vessel size and costs spent as well as the products being transported by each vessel:

1. Determine the 3-point fuel depot in West Nusa Tenggara as the demand side and one Transit Terminal as the supply side.
2. Determining the primary measure of the boats and the amount of each traffic carried by the operating pattern with the multiport calculating sailing time (sea time) and a port (port time) to obtain the maximum frequency and can be obtained production ship for one year.
3. The calculation of shipping costs (voyage cost) ship from these patterns of total port multiport each route pattern generating total mileage. Shipping costs (voyage cost) is a component of the variable cost (variable cost).
4. The calculation of investment costs vessel

(ship investment) which is the cost incurred for the construction of the boats and vessel operating expenses are used for the delivery of oil products in all four ports (fixed cost).

5. The calculation of investment costs port (port investment) which is the cost incurred for the construction of the port and its facilities used for the delivery of oil products in all four ports (fixed cost).
6. Comparison of the total cost and unit cost (unit cost) of each of the size of vessels. Determination of the number and type of cargo transported by ship and the minimum cost can be seen from every charge per unit (unit cost) of these patterns multiport.

Mathematical Model

With the development of formulations, the following is a mathematical model that is created and must be implemented in software microsoft excel with decision variables (decision variables). The equation used to determine the total cost is as follows:

Formulations for calculating the cost of ships and bulk port for tankers modes are as follows:

$$TC = FC + VC + PC$$

For the calculation of the cost of the unit is using the formulation as follows:

Obective Function :

Min unit cost $= \dfrac{m \,.\, FC + n \,.\, VC}{n \,.\, Py}$

Wich : $FC = S_C + P_C$

$$S_C = \frac{(P_{ST}(LPP \,.B \,.D_A \,.C_{ST})}{UE}$$

$$P_C = D_C + Pi_C + Em_C + ReM_C + Tax$$

$$D_C = (L_D + B_D)\,.d_C$$

$$L_D = ((m.\,L_{OA}) + ((m\text{-}1).15) + (2\,.\,25))$$

$$L_{OA} = LPP\,.\,110\%$$

$$V_C = S_{OC} + S_{VC} + P_{OC}$$

$$S_{OC} = n\,(S_{EMC} + TD + FW_C)$$

$$S_{VC} = ME_C + AE_C$$

$$ME_C = n\,(MCR\,.\,SFOC\,.\,t_S\,.\,P_{MFO})$$

$$AE_C = n\,(MCR\,.\,SFOC\,.\,(t_S + t_P)\,.\,_{PMDO}$$

$$PO_C = n\,(ABM_C)$$

Decision Variable:

LPP *(Length of Perpendicular)*

Constraint:

$LPP > 0 \,;\, LPP \in 1,2,3...$

$X_{ij} \geq Dh_j\,.\,(t_S + t_P)$

$Ts \leq LWS$

The following is a mathematical model used for the calculation of tanker's cargo holds:

Objective Function 2:

$$Min\,TD = \sum_{j=1}^{3}(\sum_{i=1}^{10}.\,|X\,iYij - Dj\,|)\,.\,Dc$$

Decision Variable:

$Xi \rightarrow i = (1,2,3...10)$

$Yij \begin{cases}1\\0\end{cases} \rightarrow j = (1,2,3)$

Constraint:

$\sum_{j=1}^{3}.\; Yij\,. = 1 \rightarrow i = (1,2,3 \ldots 10)$.

Data Sets of Supply - Demand Side

In this study, there are three (3) ports that are used as the demand side is the fuel depots in the city of Ampenan Ampenan, fuel depots in the city Badas Badas and fuel depots in the city of Bima Bima. There is also a fuel Transit Terminal at Karangasem, Bali as the supply side.

It is also known how the matrix distance from the supply side to the demand side in the table 1 below. Adaalah following table illustrates the distance that the distance between the port of origin and destination of the port of origin (origin) is Manggis in Bali and the port of destination (destination) is Ampenan, Badas, and Bima. If a route is used are the multiport the distance traveled is 492 nautical miles for every roundtrip.

Table 1. Distance Table of Ports

O/D	Manggis	Ampenan	Badas	Bima
Manggis		30 nm	123 nm	214 nm
Ampenan	30 nm		115 nm	194 nm
Badas	123 nm	115 nm		101 nm
Bima	214 nm	194 nm	101 nm	

Source : Terminal Transit BBM Manggis 2016

Tabel 2. Demand of Products Oil in Nusa Tenggara Barat

Depot	Product			Total (KL)
	Premium (KL)	Solar (KL)	Kerosene (KL)	
Ampenan	187.864,270	216.013,227	3.908,844	407.786,341
Badas	19.373,655	46.574,217	19.923,183	85.871,055
Bima	21.178,571	32.593,688	10.419,686	64.191,945
Total (KL)	228.416,50	295.181,13	34.251,71	557.849,341

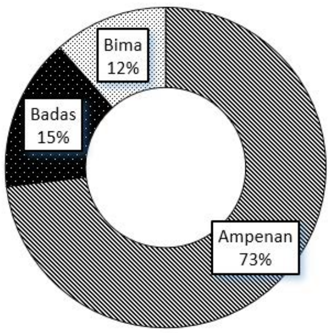

Figure 2. Proportion of Products oil Demand in Ampenan-Badas-Bima

Oil product needs in Ampenan, Badas, and Bima is determined based on the consumption of each area served by each fuel depots in the area. With the acquisition of data per year which is owned TBBM Manggis it can be determined the model to arrange the delivery of fuel to Ampenan, Badas, and Bima. Here is the fuel needs in Ampenan, Badas, and Bima where the third area is supplied by Products Oil Transit Terminal Manggis, Bali.

Here is the data demand of the three fuel depots in Ampenan, Badas, and Bima in the form of pie charts where Ampenan has the biggest oil product demand 407,786.34 KL, KL Badas 85871.05 and 64871.95 KL. If modified as percent Ampenan have demand 73%, 15% and Bima Badas 12% according to the news, quoted by the compass in 2015. The high demand for oil in Ampenan caused by high mobility in the western part of Nusa Tenggara Barat such as the tourism sector and the high its population in the western part of Nusa Tenggara Barat, especially in Mataram.

The diagram above illustrates that the greatest demand of product oil in each depot Ampenan, Badas, and Bima. A very large proportion taken by Ampenan Depot in West Nusa Tenggara western part where there are Kota Mataram and many attractions and causing the area is more advanced than other regions in Nusa Tenggara Barat.

RESULTS

Total Cost Calculation

In calculating the total cost can be done by summing the fixed costs of the ships and ports with variable costs (variable costs) of the ship and the port. In this study, these costs are fixed costs is the usual construction of the vessel obtained from the calculation of heavy steel, machinery, and equipment is calculated to obtain the ship that ship prices and then divided according to the economic life of the vessel to obtain a fixed fee per ship annually (Ross, 2004). Additionally fixed costs to be incurred is the cost of port investment in the amount appropriate to the size of the vessel selected. While the variable costs consist of the costs of shipping (voyage costs). and operational costs port (port operating cost). Because the cost of components can be there for their cargo to be shipped (is variable) (Carlson, 2019).

Optimization Results

In this final project, the optimization model using these patterns multiport by tanker as one option and container ships as a second option so that comparable unit cost cheaper owned by tanker or container.

Tanker Ship

Size tankers selected has been calculated to obtain optimum primary measure according solver table is :

- LPP = 105 m
- B = 18,01 m
- H = 8,23 m
- T = 6,78 m
- DWT = 7.992 DWT
- Payload= 8.933 KL

Table 3. Combination Results of Type and Volume of Product Oil

No	Kapasitas Tiap Cargo Hold		Kombinasi Cargo		
			Criteria	Volume	Jenis Cargo
1	CARGO HOLD 1 P	893,27 KL	>=	893,27 KL	2
2	CARGO HOLD 1 S	893,27 KL	>=	519,64 KL	3
3	CARGO HOLD 2 P	893,27 KL	>=	758,64 KL	1
4	CARGO HOLD 2 S	893,27 KL	>=	806,41 KL	1
5	CARGO HOLD 3 P	893,27 KL	>=	893,27 KL	2
6	CARGO HOLD 3 S	893,27 KL	>=	893,27 KL	2
7	CARGO HOLD 4 P	893,27 KL	>=	832,21 KL	1
8	CARGO HOLD 4 S	893,27 KL	>=	777,14 KL	1
9	CARGO HOLD 5 P	893,27 KL	>=	805,03 KL	2
10	CARGO HOLD 5 S	893,27 KL	>=	893,27 KL	2

Table 4. Total Cost of Tanker Shipping System

Cost	Value	
Depresiation Cost	Rp 13.080.792.699	/year
ME Fuel Cost	Rp 7.812.329.145	/year
AE Fuel Cost	Rp 25.704.480.742	/year
Port Investation Cost	Rp 34.647.518.230	/year
Port Operational Cost	Rp 33.887.684.689	/year
Total Cost	Rp115.132.805.506	/year

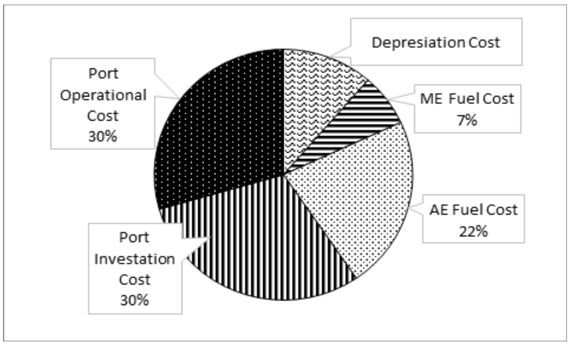

Figure 3. Cost Proportion of Tanker Shipping System

Data obtained by the above primary measure solver by calculating the minimum unit cost beralan along with calculations for load space ship which is calculated by combinatorial optimization solver microsoft excel.

Table 3 is a table of the results of the combination of the type of product and the volume of oil to be transported in the cargo hold 7,992 DWT tanker.

On Table 4, here are the results of the analysis of the costs incurred in the performance delivery system using tanker ship

Depend on the total cost in Table 4 obtained unit cost for delivery of product oil tankers using the mode of Rp. 203,587.70 per kilo liter.

CONCLUSION

Based on research that has been resolved in this Final then obtained some conclusions as follows:

1. The distribution system of oil product is currently carried by tanker to tanker small type I and II small tanker with DWT range of 1,000 to 6,500 DWT. The vessels used in the following route multiport irregular (no pattern of ship operations).
2. Model ocean transportation for delivery of product oil route from Terminal Transit multiport fuel Manggis, Bali to Ampenan Depot, Badas, and Bima in West Nusa Tenggara produce shipments with unit cost is to use the most cost:
   - The vessels used to make deliveries was 7,992 DWT tanker.
   - The number of vessels used as one unit to meet demand in the third goal.
   - Time: 4:47 day for one roundtrip.
   - The cost is Rp. 46,154,248,036 for the cost of procurement and operation of ships and Rp. 68,497,190,478 for the procurement and port operations.
   - The total cost incurred is Rp 114,633,438,514 per year and generate unit cost of Product Rp 203,587.70 per kilo liter of oil.

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