Comparison of Crude Oil Supply Cost Between Ship Rental and Single Point Mooring

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Abstract. Today, the need for fuel oil and gas are increasing. Fuel oil and gas is the energy needed by the public to support daily activities. To meet the people needs for fuel oil and gas, the company is not only focused on the Indonesian people needs. Production principle carried out is make to stock, so the company makes direct purchase of imported and domestic crude oil and through government entitlement. Currently this fuel oil company has a problem that is quite urgent because the currency value is related to the crude oil procurement. This causes the profit obtained by the company is not optimal. So it needs to be evaluated relates to crude oil procurement policies in the company. As a result, the total costs spent by GP ship rental policy is $ 53.572.938, but by using the SPM (Single Point Mooring) method will save around $114.300.205 for 4 years scale or $28.575.051 in a year.

1. Introduction
Inventory as the products and materials quantity stored. Inventories consist of all products and materials used in the production or distribution process [1]. Inventory is related to capital, storage space usage, maintenance needs, product value decrease, taxes expenditure, insurance needs, theft risk, and loss [2]. Inventories are company assets that can be sold or goods still in the production process or raw material inventories are waiting to be used in the production process [3].

Inventory management is a business process that is responsible for developing and managing inventory levels, which are raw materials inventory, work in process or finished goods, so that right inventory quantity must always available and the company must ensure the cost of excess or shortage stock is always low [4]. Inventory control is very important for a company because it is made specifically to reduce cost or increase profit while meeting customer demands by ensuring that stock balanced items are maintained at quality, quantity, and it can be obtained at the right time and at the right place [5]. Thus, inventory control is very important to achieve the company goals, namely to create a production balance and the ability to distribute these products optimally with minimum costs to achieve maximum profits.

The company is engaged in the energy sector including oil, natural gas and other energy. The need for fuel oil and gas is increasing along with the increasing needs of households and industry. This industry produces 3 groups of products, namely fuel oil (BBM), Non-BBM, and Petrochemical to distribute all over Indonesia.

Receiving raw materials can be through pipelines planted underground and through the shipping system by Musi river and the barging system. Oil receipts still originate from the South Sumatra regions are using pipelines. While the reception of crude oil from outside South Sumatra is done via
MR tankers or barging through the Musi river. The obstacle faced by the acceptance of the waterway is the Musi river depth, which is approximately 6 meters, which does not allow large tankers to enter the dock. Therefore, before entering the Musi river, large tankers will be unloaded and transferred to the smaller sized of GP ships type with a maximum load about 70 MB.

Crude oil procurement using GP ships type takes 2 days to load and unload until it reaches the dock. As the result, the procurement cost of crude oil has increased. In addition, weather factors also gives the great affect the supply crude oil to the dock because the river tidal cause the ship cannot lean on the dock. This research will try to find an alternative supply crude oil so that the procurement cost by renting GP GP ships type can be minimized.

2. Methodology
The objects studied by the Petroleum Industry in the South Sumatra region are mainly the Prabumulih and Jambi Upstream Operations Area. Historical data form on Crude Oil demands received via ship. The study begins by making observations directly to the Marine Region to observe the conditions occur in the Marine. After that, make a description of the problem occurred, namely the high cost of crude oil procurement due to ship rental with a fishbone diagram. Data collection was carried out to analyze the demand for crude oil. Data collected in the form of crude oil demand data, type of crude oil and ship rental cost. The next step is forecasting.

Forecasting is the value estimation at a certain time in the future, while predictions are used for more general estimation [6]. Forecasting use formal statistical methods with time series, cross-sectional or longitudinal data, or as an alternative to less formal assessment methods. Quantitative forecasting methods with time series models are used in this study to predict future data as a function of past data [7]. Models for horizontal data patterns are Single Moving Average, Single Exponential Smoothing and Weighted Moving Average. Moving Average is one of the widely known technical indicators used to predict future data in the time series analysis [8]. In general, Moving Average is used as a refinement instrument in time series analysis. In beginning, moving averages of various dimensions (n = 5, 10, 20, 50 and etc) are plotted against a value to get a picture of the trend. Shorter moving averages (n = 5, 10) have a higher degree of leveling [9]. Crude Oil demand estimation begins by the demand determination for the next 5 months period, the ship type rented, the total cost of ship rental. Furthermore, the costs spent by the company are calculated compared to the Single Point Mooring Method (SPM). Single Point Mooring (SPM) is a type of offshore facility used for loading and unloading oil and gas tankers at sea [10].

3. Result and Discussion
The problem of the high total cost of crude oil procurement occurs in the Petroleum Industry in Indonesia is described of the fishbone diagram. Fishbone diagram or also called Ishikawa diagram or cause-effect diagram) is a technical graph to show some causes of certain events or phenomena. Specifically, fish bone diagrams (shaped like fish skeletons) are commonly tools used for a purpose and effects analysis to identify causes complex interactions for a particular problem or event. Fishbone diagrams can be a comprehensive theoretical framework for representing and analyzing sources of innovation [11].

Based on the fishbone diagram, the cause of the high total cost of crude oil procurement due to ship rentals happen because:
1. Man, the need for additional labor served as inspector and security in order to maintain the quality of crude oil in the mother ship which is will increase the labor costs.
2. Material, transport ships used sometimes arrive earlier than the specified date and even later than the specified date which causes an increase in inventory costs.
3. Method, ship used to transport oil are rented ships and cause increase rental costs for transportation.
4. Environment, there are competitors who require companies to maintain performance to meet consumer needs. From the diagram it was found that the high total cost spent for crude oil procurement due to ship rental.

Crude Oil demand by type from January to August 2019 can be seen in Table 1.

**Table 1.** Actual Data of Crude Oil (January-August 2019)

| Period     | Arjuna (MB) | Banyu Urip (MB) | Grissik (MB) | Geragai Crude (MB) |
|------------|-------------|-----------------|--------------|--------------------|
| January    | 280         | 600             | 180          | 205.5              |
| February   | 200         | 600             | 180          | 210                |
| March      | 210         | 600             | 165          | 0                  |
| April      | 0           | 600             | 100          | 0                  |
| May        | 0           | 600             | 0            | 0                  |
| June       | 0           | 400             | 140          | 100                |
| July       | 200         | 600             | 230          | 155                |
| August     | 180         | 600             | 0.00         | 250                |
| **Total**  | **1070**    | **4600**        | **995**      | **920.5**          |

Based on the table above, it can be seen that the crude types are often ordered of Banyu Urip, Arjuna, Grissik and Geragai Crude.

3.1. Forecasting of Crude Oil

The selection of the best method is used to determine the forecasting results that can be used to calculate the total costs spent in the next period. The following is a table shows the comparison of error values with Mean Absolute Deviation, Mean Square Error, Mean Absolute Percentage Error from the Single Moving Average method, Single Exponential Smoothing, Weighted Moving Average.

**Table 2.** Selection of Crude Oil Forecasting Methods

| The Best Method               | MAD      | MSE           | MAPE      |
|-------------------------------|----------|---------------|-----------|
| Single Moving Average (n=3)   | 308.5    | 139861.09     | 31.71%    |
| Single Exponential Smoothing (α=0.3) | 249.3   | 99236.55      | 25.85%    |
| Weighted Moving Average       | 254.93   | 75719.2       | 26.8%     |

Based on the calculation results of errors with the Mean Absolute Deviation (MAD), Measure Square Error (MSE), and Mean Absolute Percentage Error (MAPE) methods in Table 2, shows the single moving average method with α = 0.3 has the smallest error rate. So this method is used to predict crude oil demand in the next 5 periods. The disaggregate demand for Crude Oil can be seen in the following table:

**Table 3.** The Disaggregate Demand of Crude Oil

| Period       | Forecasting Result | Arjuna (MB) | Banyu Urip (MB) | Grissik (MB) | Geragai Crude (MB) |
|--------------|---------------------|-------------|-----------------|--------------|--------------------|
| September 2019 | 1143.52             | 161.24      | 693.43          | 149.91       | 138.59             |
| October 2019  | 800.47              | 112.87      | 485.40          | 104.94       | 97.02              |
| November 2019 | 560.33              | 79.00       | 339.78          | 73.46        | 67.92              |
Based on the table above shows that the demand for crude oil requires the rental of MR and GP ship for the oil transportation to the dock so that the total cost has increases.

3.2. Total Cost of Crude Oil Procurement by Ship Rental

The procurement cost of crude oil types is estimated with the rental cost of MPO bunker and MDO bunkers for the MR Tanker, Mother Ship and GP Ship. Calculation the total cost of various types of crude oil procurement can be seen in the following table:

| Type of Crude Oil | September 2019 | October 2019 | November 2019 | December 2019 | January 2020 | Total       |
|-------------------|----------------|--------------|---------------|---------------|--------------|-----------|
| Arjuna            | 3,311.094      | 3,311.094    | 1,711.398     | 1,711.398     | 1,711.398    | 11,756.382 |
| Banyu Urip        | 5,915.094      | 4,427.097    | 4,427.097     | 3,311.094     | 2,939.097    | 21,019.479 |
| Gressik           | 2,939.097      | 2,939.097    | 1,711.398     | 1,711.398     | 1,711.398    | 11,012.388 |
| Geragai Crude     | 2,939.097      | 1,711.398    | 1,711.398     | 1,711.398     | 1,711.398    | 9,784.689  |
| **TOTAL**         | **53,572.938** |              |               |               |              |           |

Table 4 shows the estimated cost of procuring crude oil with a ship rental policy. The current policy using mother ships by rent the GP type ship to send crude oil to the dock, so that the total cost of supplying crude oil becomes expensive. Crude oil arrives at the dock takes 2 days by sending crude oil in a smaller capacity using a GP type vessel. As a result, the cost of spending has increased, in addition to weather factors and tides affect the length of time the ship can lean towards the dock.

3.3. Design of Single Point Mooring (SPM)

Single Point Mooring (SPM), also known as Single Buoy Mooring or SBM is an offshore port buoy, which is function as a mooring point and interconnection for gas loading or unloading tankers or liquid products functions as tethering and interconnection for tanker loads or unloading gas products or fluid. For the SPM manufacture requires into the sea with a range of 200 ft - 600 ft. There are several types of SPM. In its SPM development varies in several types. Some types of SPM are turret, Catenary Anchor Leg Mooring (CALM), Single Anchor Leg Mooring (SALM), Vertical Anchor Leg Mooring (VALM), and Single Point Mooring Towers (SPMT) [12]. For the solution given by the author, that is using SPM type Catenary Anchor Leg Mooring (CALM) bouy which is a type where the anchor chain buoy extends to the anchor point at a certain distance from the buoy. This type of SPM has several important parts including anchors (anchors or gravity anchors connecting mooring chains to the sea floor), anchor chains (systems with six or eight chain anchors are the most common), and stopper chains (connecting chains to buoys) [13 ] Costs spent to make the SPB Bouy Catenary Anchor Leg Mooring (CALM) "Costs Estimation for making SPM include engineering costs, and construction costs and construct a 92-kilometer pipeline from the edge of the South Sumatra Sea to dock 2 and dock 10 with a costassumption of around ± $ 400,000,000 ". (source of Pertamina Plant Directur Chrisna Damayanto.2013)

3.4. Comparison Between SPM and GP Ship Rental

Like a design, there must be advantages and disadvantages to the design created. These strengths and weaknesses are important to know, so that management understand the advantages and risks faced from making this design system. The advantage is if it is assumed that the total cost of the oil company in a year is ± $ 128,575,051 and for four years it reaches ± $ 514,300,205 and making SPM only around ± $ 400,000,000, this succeeded in reducing the total oil company cost by $ 114,300,205.
the design minimize idle time, prevent fraud, and the design minimize the sell loss. Some disadvantages to the design are the long manufacturing processes and understand the right selection to minimize leakage and work accidents. If this recommendation is not implemented then the total cost will increase in a certain period and then when the weather is bad, the sender of crude oil to the dock will be late. This condition is very disadvantage, because there is may be a sell loss eliminates the customer or the inventory quantity so that the storage cost increases, this is happened when the crude oil is late arriving at the dock.

4. Conclusion
Based on the previous discussion in oil companies that there are some disadvantages in the Crude Oil procurement system cause the total costs spent by the company. The total costs spent by the company with GP ship rental policy is $53,572,938. To minimize the total costs of oil company spent, using the SPM (Single Point Mooring) method with a total cost of $ 400,000,000 to save costs of $114,300,205 for 4 years scale or $ 28,575,051 in a year. With this SPM method, it can improve the efficiency, effectiveness and productivity of oil companies in South Sumatra.

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