Comparative Study of Biosolar Distribution Cost (A Case Study at PT Pertamina Jambi Fuel Terminal)

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Abstract. As one of the state-owned companies in energy sector, PT Pertamina (Persero) is responsible for fulfilling consumers' energy needs while efficiently maintaining its operating cost. Improvements in product delivery process is one of many ways that can be done to reduce the total logistics cost. A case study at Jambi Fuel Terminal provides an overview of how the reduction in total distribution cost is a direct result of a better marine vessel capacity arrangement. Incorporating five distribution scenarios with four types of tanker capacity to carry Biosolar (B30 product) for the demand of June 2021 from Tanjung Uban Integrated Terminal and Pulau Sambu Fuel Terminal to Jambi Fuel Terminal resulted to 58.5% reduction in the B30 logistics cost, compared to the existing scenario that used nine types of tanker capacity.

Keywords: Logistics cost, Tanker capacity, Fuel terminal, Biosolar B30.

1 Introduction

As Indonesia's state-owned company in energy sector, Pertamina has a strong commitment to ensure the security of energy and developing new and renewable energy. Since 2020, Pertamina plays a strategic role in leading its sub-holdings, ranging from the upstream business under Pertamina Hulu Energy up to the commercial and trading under PT Patra Niaga, while the integrated marine logistics is operated under PT Pertamina International Shipping (PT PIS) [1]. Since Indonesia consists of 16,771 islands (data of the year 2020 from the Ministry of Marine Affairs and Fisheries of Indonesia) [2], distribution of materials, in particular liquid fuels PT Pertamina produces, from one island to another is mostly done using marine vessels. Marine vessels or known as „*Kapal Tanker*" in Bahasa Indonesia, become the answer to overcome the limited number of bridges and undersea tunnels that connect islands.

In fuel supply chain, terminals are important for storing and distributing the products to end-user markets. A typical terminal constantly receives, stores and dispenses the fuels, serving the truck, ship, pipeline and rail that transport the products to end-users [3]. In 2019, PT Pertamina operates fuel terminals in 116 cities around Indonesia, consisting of 1,166 storage tanks with

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total storing capacity of 5.43 million Kiloliters [4]. These terminals are divided into two categories: the waterfront terminals or those which are located right in front of the river or ocean, and the inland terminal or those located on land without any waterway around them. Jambi Fuel Terminal is one of the waterfront terminals in Indonesia, located in front of the Batanghari river, the longest, widest and deepest rivers in the island of Sumatera [5]. This fuel terminal receives, stores, and dispenses five types of fuel products: Biosolar (a type of product for diesel engine), Premium, Pertalite, Pertamax and Pertamax Turbo (four kinds of gasoline type fuel). Fuel supply come to this terminal through various types of tankers from Pulau Sambu Fuel Terminal in the province of The Riau Islands, Tanjung Uban Integrated Terminal in Riau province, and Plaju Fuel Terminal, located near Refinery Unit III Plaju, South Sumatera. This fuel terminal has 2 jetties as receiving facility and 1 other jetty for backloading.

Since fuel distribution is really important to ensure all customers get the energy source they need, a delay can lead to fuel shortage. The choice of route as well as matching cargo with tanker capacity are two techniques that can be applied to manage demand fulfillment while keeping the total logistics cost minimum. This research focuses on those two aspects within the distribution of B30 or Biosolar 30 (the mixture of 70% diesel fuel and 30% biofuel/Fatty Acid Methyl Esther) in the month of June 2021. The monthly demand of this product is fulfilled by 17 voyages completed using 9 types of tankers (nine different capacity of marine vessels). Optimized logistics cost is difficult to achieve when different tanker capacity is used, since the capacity of tanker will result to changes in berthing and unberthing frequency, total rent of tanker, the marine fuel oil consumed, as well as loading and discharge time. For instance is a fuel cargo of 4,000 LongTon, it can be transported by a 5,000 DWT tanker with one voyage or the 3,000 DWT tanker with two voyages. One voyage that deliver all cargo will result to higher loading and unloading time as well as daily ship rent, but the berthing and unberthing frequency will be reduced. This simple illustration describes how choice of tanker capacity and distribution scenario will result variously.

Integrated logistics policy of PT Pertamina covers the following aspects: cost efficient, on-time delivery, on quantity delivery, on quality delivery, safe operation, product availability and zero critical depot, that is why, it is important to design a fuel distribution scenario that can fulfill demand while minimizing total logistics costs. The following **Figure 1** portrays several factors affecting total logistics cost.

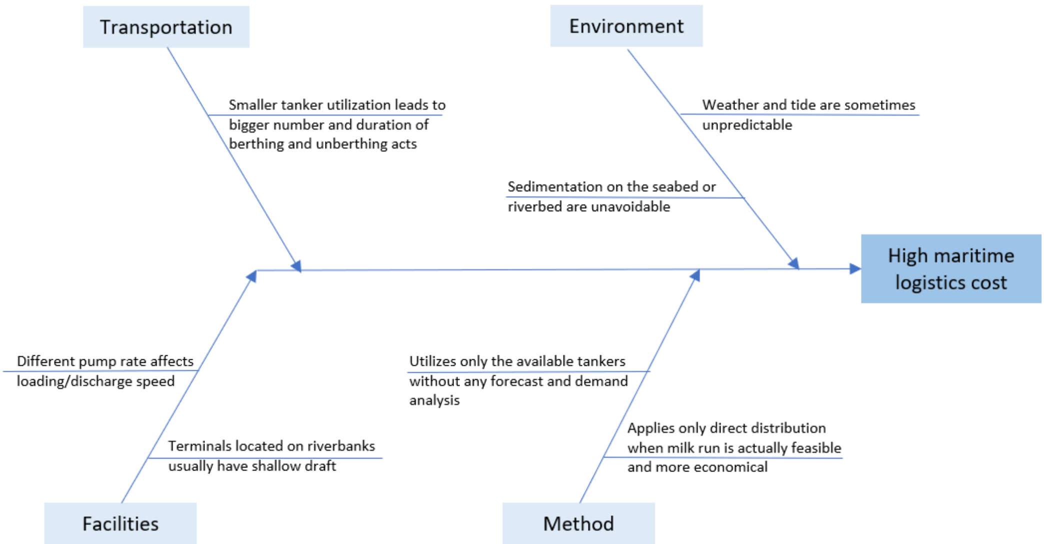

Fig 1. Factors affecting Logistics Cost of Fuel Distribution using Marine Vessels

Based on **Figure 1** above, there are four aspects that directly influence total logistics cost for distribution to Jambi Fuel Terminal, namely: transportation, environment, facilities, and strategic distribution method. High logistics cost is the perceived problem of a not yet optimized distribution scenario, while the cause may be because of the unmatched cargo and tanker capacity that lead to high frequency of berthing unberthing activities, the depth of pond at the receiving facility and the route taken by the tanker. This research is done to create several more optimized distribution scenarios which will help in total cost reduction.

2 Research Methodology

Research methodology consists of steps that should be completed in a research. A systematic methodology is mandatory in order to get good result and minimize error. The following **Figure 2** depicts the flow diagram of this research:

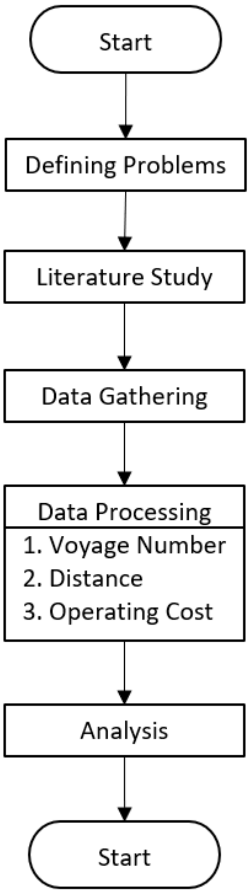

Fig 2. Research Flow Diagram

Based on **Figure 2**, the research process is started by formulating a research question as well as literature study process. Defining the problem is done through identifying the distribution scenario being applied and how it is actually affected by the demand uncertainty at the fuel terminal. The demand uncertainty is mainly caused by a variety of factors often difficult to control that as formulated in **Figure 3** below:

Fig 3. Market Uncertainty in Supply Chain [6]

Although the supply chain of oil and gas is slightly different compared to any consumer goods, the demand uncertainty also affects the order delivery time as well as other aspects in the whole supply chain as portrayed in **Figure 3**. At Pertamina, the demand of fuel is forecasted two month prior and will be revised a month before the actual delivery, that is why, sometimes, the capacity of tankers that Pertamina operates and the number of voyages sometimes get adjusted to cater the changes. Other research regarding demand forecast and market uncertainty risks can be done to support decision making in shipping operations.

The next step of this research is literature study, including the activities of methods comparison, data gathering, and baseline scenario checking. While the most important step is actually done right after literature study: developing the distribution scenarios by identifying the demand and the capacity of available tanker ships. Data cleaning is also involved while checking the dataset of tanker's Dead Weight Tonnage (DWT), effective load factor, loading and discharge time, waiting time, cargo loaded into tankers‘ compartments, loading and discharge costs, fuel cost, and tanker charge per day. After all data is verified and validated, calculating the total cost process is started, following these steps:

1. Computing the Round Trip Days:

$$Round\ Trip\ Days = Sea\ Days + Port\ Days \quad (1)$$

$$Sea\ Days = \frac{(distance/speed)}{24} \quad (2)$$

$$Port\ Days = Total\ loading\ duration + Total\ discharge\ duration + Total\ waiting\ time \quad (3)$$

Round Trip Days is the total number of days a tanker ship needs to travel from its loading point (or the origin port) to the discharge port (point of destination), and go back to the loading point. Sea days is the length of travel an oil tanker takes to sail in the ocean, completing its trip from one port to the other. To calculate the number of sea days, the distance between two points is needed. Port days is the duration the tanker needs to stay at the port for berthing, unberthing, loading, unloading, quality and quantity checking, also other administrative activities.

2. Computing the number of voyage:

$$Number\ of\ voyage = \frac{total\ cargo}{ECC\ x\ ELF\ x\ vessel\ DWT} \quad (4)$$

One voyage is defined as the trip completed by a tnaker to load and unload its cargo. So, the number of voyage is computed to check how many trips should be completed by a certain number of tanker to fulfill all demand in a certain discharge point.
ECC is the Effective Carrying Capacity or the percentage of space in the tanker dedicated for cargo, which identified as 56% for gas tanker and 90% for liquid. ELF is Effective Load Factor of the tanker and the value is actually varied for each tanker capacity. While DWT is the Dead Weight Ton or all the cargo, fuel, and supplies carried on the board of the ship.

3. Computing the total operating cost:

This step consists of three computations: total cost for tanker rent, total cost for fuel, and also the cost for loading and unloading activities.

$$Total\ cost\ for\ rent = number\ of\ voyage\ x\ RTD\ x\ hire\ rate \quad (5)$$

Following the voyage charter, the rent is computed based on how many days it needs to travel between ports. The variety of tankers used in baseline scenario as well as their charter rate are described in the following Table 1.

Table 1. Product Tankers' DWT, Rent, Loading and Discharge Costs

Tanker's DWT	Rent (IDR/day)	Loading Cost (IDR)	Discharge Cost (IDR)
1,470	27,999,294.11	59,940,790	59,940,790
2,010	36,261,380.89	59,940,790	59,940,790
2,230	39,627,416.25	59,940,790	59,940,790
2,950	50,643,531.96	59,940,790	59,940,790
3,040	52,020,546.43	59,940,790	59,940,790
3,840	64,260,675.00	60,918,322	60,918,322
4,260	70,686,742.50	60,918,322	60,918,322
4,300	71,298,748.93	60,918,322	60,918,322
4,600	75,888,797.14	60,918,322	60,918,322

After computing the total cost for tanker charter, the next step is calculating the total cost for loading and discharge. Based on the data in Table 1, there is only one rate to load and unload the fuel cargo for 1,420 to 3,040 DWT tankers, while the 3,840 to 4,600 DWT tankers also have the same loading and discharge rate.

$$Loading\ cost = number\ of\ loading\ activity\ x\ loading\ cost \quad (6)$$

$$Discharge\ cost = number\ of\ discharge\ activity\ x\ discharge\ cost \quad (7)$$

When the ship applies direct distribution, means there is one loading and one discharge activities. If the tanker does milk run distribution, the number of loading and discharge should be adjusted.

The last stage in calculating the operating cost is computing fuel cost. A product tanker needs two types of fuel: High Speed Diesel (HSD) for loading and unloading activities, while Marine Diesel Oil (MDO) are needed for berthing, unberthing, and sailing.

$$Total\ fuel\ cost = MDO\ cost + HSD\ cost \quad (8)$$

$$MDO\ cost = RTD\ x\ no.of\ voyage\ x\ MDO\ daily\ consumption\ rate \quad (9)$$

$$HSD\ cost = Total\ no.of\ loading\ and\ discharge\ x\ no.of\ voyage\ x\ HSD\ consumption\ rate \quad (10)$$

So, the total operating cost can be computed as follow:

$$Total\ Operating\ Cost = Charter\ Cost + Loading\ Discharge\ Cost + Fuel\ Costs \quad (11)$$

While the following assumptions are used to simplify the calculation:

1. All compartments of the tanker is filled with the same product (Biosolar 30);
2. Storage tanks at the discharging port can receive and keep all of the incoming products;
3. Tankers sail back to the respective loading point after discharging the cargo at the destination port;
4. Average speed of all tankers during sailing is 10 knot;
5. Loading time for all port of origins (Tanjung Uban Integrated Terminal and Pulau Sambu Fuel Terminal) is 2.46 days;
6. Discharge time at Jambi Fuel Terminal is 1.5 days;
7. Waiting time at all three terminals is 0.5 day each;
8. Effective Loading Factor (ELF) for all tanker is 78.29%;
9. Effective Carrying Capacity (ECC) is 90% for liquid products;
10. Marine Diesel Oil (MDO) consumption is 5.776 MT per day, and it costs IDR 12,149,533 per MT;
11. High Speed Diesel (HSD) consumption is 0.75 MT per loading activity and 0.72 MT per discharge activity, and HSD costs IDR 14,140,811 per MT;

3 Result and Discussion

3.1 Existing Scenario

The existing distribution scenario involved 17 voyages from two loading ports: Tanjung Uban Integrated Terminal and Pulau Sambu Fuel Terminal, located 224 Nautical Miles (NM) and 219 NM from Jambi, respectively. The total demand of B30 in June is 32,436.38 Long Ton with 65.78% was supplied from Tanjung Uban Integrated Terminal. The total distance traveled by the those nine sizes of tanker was 7,566 NM. While the total operating cost can be seen in the following Table 2.

Table 2. Total Cost of Distribution Following Existing Scenario

Components	**Cost (IDR)**
Charter (Rent)	6,453,103.138.89
Loading Cost	1,027,791,218.00
Discharge Cost	1,027,791,218.00
MDO Cost	8,129,504,268.62
HSD Cost	353,378,866.89
Total Cost	16,991,568,719.41

Based on Table 2, it is clear that components with the highest cost are rent and fuel (especially the MDO needed for sailing, berthing and unberthing). This existing scenario can be optimized by checking the maximum capacity of tanker ship. Utilizing this concept (maximizing cargo capacity) is expected to lower the total rent and total MDO cost, since these two are closely related to the number of voyage and distance sailed.

3.2 New Scenarios

The new scenario focuses on optimizing the maximum loading capacity of each tanker, since the number of voyage and the total distance are the two cost components which highly affect the total cost. Thus, the five highest capacity of tankers are iterated to check whether using bigger tanker will definitely result as expected: having fewer number of voyages without adding more money to charter the tankers.

Because the Round Trip Days (RTD) solely depend on the total distance and speed, this component will not directly affect the process of moving from one place to another. The RTD from Tanjung Uban Integrated Terminal is 6.8267 and from Pulau Sambu Fuel Terminal is 6.7850, and this number can be round up to 7 days. Checking this RTD will also help to consider the number of tankers Pertamina should dedicate for Jambi Fuel Terminal.

The following Table 3 describes the voyage data and the complete distribution cost for five types of tankers

Table 3. Voyage and Distribution Cost Data under New Scenarios

Scenarios	**Origin**	**Destination**	**DWT**	**Distance (NM)**	**Number of Voyage**	**Total Distance (NM)**
1	Tanjung Uban	Jambi Fuel Terminal	3,040	246	10	7,108
	Pulau Sambu	Jambi Fuel Terminal	3,040	219	6	
2	Tanjung Uban	Jambi Fuel Terminal	3.840	246	8	5,774
	Pulau Sambu	Jambi Fuel Terminal	3,840	219	5	
3	Tanjung Uban	Jambi Fuel Terminal	4,260	246	8	5,336
	Pulau Sambu	Jambi Fuel Terminal	4,260	219	4	
4	Tanjung Uban	Jambi Fuel Terminal	4,300	246	8	5,336
	Pulau Sambu	Jambi Fuel Terminal	4.300	219	4	
5	Tanjung Uban	Jambi Fuel Terminal	4,600	246	7	4,888
	Pulau Sambu	Jambi Fuel Terminal	4,600	219	4	
6	Tanjung Uban	Jambi Fuel Terminal	4,600	246	7	4,888
	Pulau Sambu	Jambi Fuel Terminal	4,260	219	4	

Scenarios	**Rent (IDR)**	**Loading Cost (IDR)**	**Discharge Cost (IDR)**	**MDO Cost (IDR)**	**HSD Cost (IDR)**	**Total Operating Cost (IDR)**
1	97,050,200.03	59,940,790	59,940,790	4,790,661,298.04	20,786,993.27	9,469,526,478.99
	569,624,983.41	59,940,790	59,940,790	2,856,852,853.17	20,786,993.27	
2	959,626,065.07	60,918,322	60,918,322	3,832,529,038.43	20,786,993.27	8,044,491,746.19
	586,378,659.38	60,918,322	60,918,322	2,380,710,710.98	20,786,993.27	
3	1,055,588,688.00	60,918,322	60,918,322	3,832,529,038.43	20,786,993.27	7,593,946,787.80
	516,014,220.25	60,918,322	60,918,322	1,904,568,568.78	20,786,993.27	
4	1,064,727,984.02	60,918,322	60,918,322	3,832,529,038.43	20,786,993.27	7,607,553,730.76
	520,480,867.19	60,918,322	60,918,322	1,904,568,568.78	20,786,993.27	
5	991,613,615.96	60,918,322	60,918,322	3,353,462,908.63	20,786,993.27	7,088,880,584.83
	553,988,219.12	60,918,322	60,918,322	1,904,568,568.78	20,786,993.27	
6	991,613,615.96	60,918,322	60,918,322	3,353,462,908.63	20,786,993.27	7,050,905,585.96

Scenarios	Rent (IDR)	Loading Cost (IDR)	Discharge Cost (IDR)	MDO Cost (IDR)	HSD Cost (IDR)	Total Operating Cost (IDR)
	516,013,220.25	60,918,322	60,918,322	1,904,568,568.78	20,786,993.27	

Based on Tables 2 and 3**,** it can be seen that the best new scenario is scenario number 6 which incorporates two sizes of tankers. total cost between the new scenario number 6 is 58.5% lower compared to the existing scenario. Although scenarios 5 and 6 have the same number of voyage (and also scenarios 3 and 4), but the total rent is the thing that makes difference. This reduction is achiavable because the number of voyages get lowered, from 17 to 11 when the existing scenario is compared to the best scenario, incorporating two types of tankers, the 4,260 DWT for deliveries from Pulau Sambu Fuel Terminal and he 4,600 DWT for deliveries from Tanjung Uban Fuel Terminal. Besides the total rent, when existing scenario is checked side by side with new scenario number 6, the total distance for the new scenario is 35.4% lower. The reduction in total distance directly affects the total cost of Marine Diesel Oil (MDO).

Since Jambi Fuel Terminal needs 7 or 8 voyages of tankers which have 3,840 to 4,600 DWT to deliver B30 from Tanjung Uban Integrated Terminal and 4 voyages from Pulau Sambu Fuel Terminal, it is safe to say that Pertamina should dedicate 3 units of tanker ship for distributing B30 to Jambi Fuel Terminal. 2 tankers to deliver B30 supply from Tanjung Uban Integrated Terminal and the other one is for Pulau Sambu Fuel Terminal. There are two tankers needed for Tanjung Uban Integrated Terminal to Jambi Fuel Terminal trip because the 6.8267 RTD (or simply rounded up as 7 days per trip). Within a month, a tanker that doesn't need any off-hire days can deliver 4 times (completing four voyages), that is why, the Tanjung Uban Integrated Terminal – Jambi Fuel Terminal route needs 2 dedicated tankers, while the Pulau Sambu Fuel Terminal – Jambi Fuel Terminal needs only one tanker, with the same formula. Having 3 units of refined product tankers, with the similar capacity and characteristics, dedicatd for a certain product will make the operating and maintenance easiser compared to having a big range of tankers capacity delivering the same kind of product. The smaller tankers need more voyages, and the differences in the round trip days for one voyage (when the real sailing speed and loading/discharging durations are also applied) might not be big.

4 Conclusion and Further Research

Based on the research, Jambi Fuel Terminal spends IDR 16,991,568,719.41 to deliver all B30 demand of June 2021. The cost was high because the baseline (existing) scenario utilized 17 voyages using 9 different tanker capacity, ranging from 1,470 DWT to 4,600 DWT. By optimizing in carrying scenarios, having the iterations for tankers with capacities ranging from 3,040 to 4,600 DWT, it can be concluded that new scenario number 6 is the best since it resulted in the lowest voyage number, total operating cost, and total distance. The operating cost can be reduced 58.5% to IDR 7,050,905,585.96, while the number of voyage is reduced from 17 to 11, with total distance of 4,888 Nautical Miles.

For the next research, a real measurement of loading and discharge time, waiting time as well as ship sailing speed can be done to get better estimate, including the measurement of total emission for each tanker capacity. This research is a lot simpler compared to the daily real challenges faced by Pertamina in distributing fuel throughout Indonesia. But a better planning is mandatory to acquire the more effective and efficient maritime fuel distribution activities.

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