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# Ship Shipping Optimization in Terminal for Self-Interest PT. Kawasan Berikat Nusantara (Persero), Marunda Port

**Henry Sitanggang[1*], L. Denny Siahaan[2], Dedeng Wahyu Edi[3], Suharto Abdul Majid[4]**
[1, 2, 3, 4] Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia
*Corresponding Author: henry.sitanggang@rocketmail.com

## Abstract

Research conducted at the Terminal for Self-interest PT. Kawasan Berikat Nusantara (Persero), the port of Marunda is a place where the ship is going in and out and it is affected by the tides of the sea, which is caused by the limitations of the depth of the groove and the pool of the port, so that ship services are not optimal. This study used quantitative method. The main thing examined in the ship service is waiting time for the ship in the queue. To find out the waiting time of the current condition using statistical analysis on average (mean), while waiting time for optimal conditions or without any obstacles when the ship is going in and out by using the discipline queuing theory analysis First Vacant First Served. The difference in waiting time is used to determine the amount of the operating costs of the ship and the value of interest in the cargo during the queue. Dredging is a way to overcome the problem of the limited depth of the port's grooves and ponds, therefore it is necessary to know the costs of dredging and maintenance of the port's grooves and ponds. Then the operating costs of the ship and the value of interest in the cargo during the queue, compared to the cost of dredging and maintenance of the port and pond pool. The results showed that dredging was still more profitable compared to current conditions where the waiting time decrease was 78.07% for dry bulk loads and 36.29% for liquid bulk loads.

**Keywords**: waiting time, mean, First Vacant First Served, dredging

## Introduction

Ship service in the Terminal for Self-interest (TUKS) PT. Kawasan Berikat Nusantara (Persero) is not optimal because it can enter into the TUKS things that can still be done by the tides, which results in waiting times (waiting time) for ships in high queues. This is due to the limited pool and pool of the port. Channel and environmental situation caused by high sedimentation rates, because the TUKS is located in another place in Blencong, Marunda and also because there is no maintenance and port pool.

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Similar to the Bajoe port in Bone Regency, the speed cannot be optimized due to the silting of the harbor pool, it can only apply at high tide (Syahrir Husain & Juswan, 2013), Province of Germany. Therefore, it is necessary to dredge the port pool, while the channel is still safe to navigate.

Others in Tanjung Perak, the factors that influence the waiting time of the ship are the level of use, less than optimal performance of the loading and unloading workforce and also the lack of maximum document processing at the port (Frizky Andrian Perdana, 2017).

## Methodology

In this study using quantitative research method. Method of data collection is carried out by field observations and document study of vessel visit data and load and time of the vessel during the service location obtained from Marunda Class V Port Authority and Harbormaster and Authority offices, PBM, guide officers and vessels served at TUKS because there are 2 (two) conditions to be studied, namely the present condition and the conditions after being optimized, the analysis also uses 2 (two) methods of analysis, namely the descriptive analysis method of the mean (mean) statistics for analyzing the present conditions and the theory analysis method. Queue to analyze the condition after optimal without any obstacle when the ship is in and out.

## DISCUSSION AND RESULT

### Waiting time for the ship (waiting time) current condition

To find out the average waiting time (waiting time) of the ship in the current condition using the average statistical analysis or mean data.

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The formula is:

Where:

Σ = Amount

Xn = X1 + X2 + X3 + ..... Etc.

N = Number of population in distribution

***(Source: A Muri Yusuf (2014)***

With the formula above, the waiting time of the ship is obtained as follows:

a. Waiting time for dry bulk cargo ships is 0.579 days,
b. Waiting time for a liquid bulk cargo vessel of 3,378 days.

**Waiting time after the optimization is done by dredging**

To analyze the data after the optimized condition used the queuing theory method which is the discipline of First Vacant First Served (FVFS) because in the TUKS there is a channel that can only be crossed by a ship or tugboat with a barge beside the ship being serviced at the dock. Service time is taken from the current service conditions by reducing Non Operating Time or NOT activity.

This is a form of equation that can be used to calculate, $\overline{n}$, $\overline{q}$, $\overline{d}$ and $\overline{w}$ for the FVFS queue discipline.

$$P_o = \frac{}{\sum_{n=0}^{K-1}}$$

Where P (0) is the amount of opportunity for conditions where there are no ships in the queue system and K is the number of service places.

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$$\bar{n} = \frac{\bar{\quad}}{\quad} \cdot Po + \bar{\quad}$$

$$\bar{q} = \frac{(\quad)\quad \bar{\quad}}{\quad} \cdot Po$$

$$\bar{d} = \frac{(\quad \bar{\quad}}{\quad} \cdot Po + \bar{\quad}$$

$$\bar{w} = \frac{(\quad \bar{\quad}}{\quad} \cdot Po$$

Where:

$\bar{n}$ = number of ships in the system (ship per unit of time)

$\bar{q}$ = number of ships in the queue (ship per unit time)

$\bar{d}$ = the time the ship waits in the system (unit of time)

$\bar{w}$ = the time the ship waits in the queue (unit of time)

Source: (Wohl and Martin, 1967: Morlok, 1978: and Hobbs, 1979)

As in the present condition analysis with statistics, in the queuing theory, analysis also divides into 2 (two) types of cargo. Here are the results of the analysis:

**Dry bulk load**

- WP values are: WP = BT - NOT

  WP = 2,138 days - 0,211 days = 1,927 days,
- Arrival rate ( )

  = 1,116 / 358 = 3,117 ships / day
- Service level (μ)

  μ = 1 / WP = 0.519 ships / day

Using the queuing theory formula is obtained Po = 0.002 Then:

1) The number of vessels in the system or $\bar{n}$ is 6,403 vessels/day ≈ 7 ships/ day
2) The number of ships in the queue or $\bar{q}$ is 0.396 ships / day ≈ 1 ship / day

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3) The time the ship waits in the system or $\bar{d}$ is 2,054 days
4) The time the ship waits in the queue or $\bar{w}$ is 0.127 days

**Liquid bulk load**

- WP values are: WP = BT - NOT

  WP = 3,072 days - 0,175 days = 2,897 days.
- Arrival rate ( )

  = 277/358 = 0.774 ships / day
- Service level (μ)

  μ = 1 / WP = 0.345 ships / day

The magnitude of the probability of the occurrence of conditions where there are no ships in the queue system or Po = 0.076 Then:

1) The number of ships in the system or $\bar{n}$ is 3,907 ships / day ≈ 4 vessels / day
2) The number of ships in the queue or $\bar{q}$ is 1,665 ships / day ≈ 2 ships / day
3) The time the ship waits in the system or $\bar{d}$ is 5,049 days
4) The time the ship waits in the queue or $\bar{w}$ is 2,152 days.

**The Difference between Waiting Time and current conditions after optimization**

Based on the results of research conducted by means of statistical method (mean) and queuing method, a comparison was made to find out the difference in waiting time that could be optimized. From the results of the comparison obtained:

a. The Waiting Time difference in dry bulk cargo vessels is 0.452 days
b. Waiting Time Difference Liquid bulk load vessel is 1,226 days.

**Ship operating costs while waiting in the queue**

Ship operating costs can be obtained from shipping companies operating their vessels at TUKS PT. KBN (P). The amount of costs that must be incurred by the shipping company is taken from the amount of the vessel's rent in a month or based on Time Charter (TC).

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Table 4.6 Operating costs of dry bulk cargo ships while waiting in the queue

| Barge Size (Feet) | Number of Ships (Unit) (1) | Ship Operating Costs ( Rupiah/day) (2) | WT Difference ( Day) (3) | Amount of Savings ( Rupiah ) (1x2x3) |
|---|---|---|---|---|
| 180 | 121 | 11.666.666,00 | 0,452 | 638.073.296,87 |
| 230 | 458 | 13.333.333,00 | 0,452 | 2.760.213.264,33 |
| 270 | 335 | 15.000.000,00 | 0,452 | 2.271.300.000,00 |
| 300 | 202 | 16.666.666,00 | 0,452 | 1.521.733.272,46 |
| **Total** | **1.116** | | | **7.191.319.833,66** |

Sumber: Henry (2018)

Table 4.7 Operational costs of liquid bulk cargo ships while waiting in the queue

| Barge Size (Feet) | Number of Ships (unit) (1) | Ship Operating Costs ( Rupiah/day ) (2) | WT Difference ( day ) (3) | Amount of Savings ( Rupiah ) (1x2x3) |
|---|---|---|---|---|
| 180 | 138 | 11.666.666,00 | 1,226 | 1.973.859.887,21 |
| 230 | 110 | 13.333.333,00 | 1,226 | 1.798.133.288,38 |
| 270 | 29 | 15.000.000,00 | 1,226 | 533.310.000,00 |
| **Total** | **277** | | | **4.305.303.175,59** |

Sumber: Henry (2018)

Then, based on tables 4.6 and 4.7 above the total operational cost of the ship while waiting in the queue in a year, that is Rp. 11,496,623,009.25

**The value of the interest in money in charge as long as the ship waits in the queue**

In addition to the increasing operational costs of ships, it is also necessary to know how much money interest is made as long as the ship waits in the queue.

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Table 4.8 Value of money interest in dry bulk cargo during the queue

| Type of charge | Number of Ships | Average Amount of Content | Price of cargo | WT Difference | SBA BI Daily | Losses on the value of money |
|---|---|---|---|---|---|---|
| | (Unit) (1) | (Ton) (2) | (Rupiah/Ton) (3) | ( day ) (4) | (%) (5) | (Rupiah) (1x2x3x4x5) |
| Coal | 475 | 7.277 | 1.229.060,65 | 0,452 | 0,012 | 223.590.732,81 |
| Sand | 641 | 3.500 | 260.000,00 | 0,452 | 0,012 | 30.699.685,21 |
| **Total** | | | | | | **254.290.418,02** |

Sumber: Henry (2018)

Tabel 4.9 Value of money interest in liquid bulk cargo during the queue

| Type of charge | Number of Ships | Average Amount of Content | Price of cargo | WT Difference | SBA BI Daily | Losses on the value of money |
|---|---|---|---|---|---|---|
| | (Unit) (1) | (Ton) (2) | (Rupiah/Ton) (3) | ( day ) (4) | (%) (5) | (Rupiah) (1x2x3x4x5) |
| CPO | 277 | 3213 | 8.182.074,00 | 1,226 | 0,012 | **1.039.538.153,05** |

Sumber: Henry (2018)

Based on tables 4.8 and 4.9 it can be seen the total value of interest on the money from cargo as long as the ship waits in the queue in a year which is RP. 1,293,828,453.00.

**Dredging Fees**

The dredging works carried out here are capital dredging and maintenance of port and pool ponds. To find out the dredging costs, the volume that needs to be dredged is calculated first. Long TUKS PT. KBN (P) is 1,110 meters, while the width of the pool is ± 52 meters and its depth is 3.5 meters - 4.5 meters.

There are 2 (two) calculations that will be made to determine the dredging costs, namely:

a. Dredging the channel and pool of the harbor to increase the depth of 1 meter (BP1)

   The addition of a depth of 1 meter is based on observation in the field that the maximum tide of seawater at the time of going in and out of the ship is about 1

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meter, where at the position of the high tide of the sea water the vessel is safely charged to navigate the channel and a pond.

By using the following formula, the volume can be known, namely:

$V1 = P \times L \times D$ (meter $^3$)

Where:

V1 = Volume of sediment to be dredged (meter $^3$)

P = Length of grooves and ponds (meters)

L = width of grooves and ponds (meters)

D = Depth of grooves and ponds added (meters)

Then:

$V1 = P \times L \times D$ (meter $^3$)

$V1 = 1.100 \text{ m} \times 52 \text{ m} \times 1 \text{ m}$

$V1 = 57.200$ meter $^3$

The amount of dredging costs is based on the Regulation of the Minister of Transportation of the Republic of Indonesia Number: PM. 78 of 2014: PID 130. Dredging with a ship Hopper TSHD 2900 (Distance DA $\leq$ 6 Nmil) production capacity = 5,823 $m^3$ / day of Rp. 44,800 / $m^3$, are:

$BP1 = V1 \times H$

Where:

BP1 = Dredging Fee (Rupiah)

H = Unit price of dredging work (Rupiah / meter $^3$)

Then:

BP1 = V1 x H

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BP1 = 57.200 $m^3$ x Rp. 44.800,-/ $m^3$

BP1 = Rp. 2.562.560.000,-

b. Maintenance of grooves and ponds to maintain their depth (BP2) To find out the amount of cost to carry out the maintenance of the TUKS groove and pond by assuming that the sedimentation rate is 60.839 grams / $m^2$ / week (the level of sedimentation in the Wedung river basin, Demak). TUKS harbor area and pool area are: 1,100 m X 52 m = 57,200 $m^2$. In 1 year there are 52,142 weeks, the level of sedimentation is 60,839 grams /$m^2$ / week, so the annual rate is 60,839 grams / $m^2$ x 52,142 weeks = 3,172,267 grams / $m^2$ / year. Because of the port area and pool area of 57,200 $m^2$, the amount of sedimentation in the TUKS is 181,453,680.3 grams / year or V2 = 181,454 tons / year.

If 1 ton of mud is assumed to be equal to 1 $m^3$, then the amount of dredging costs is based on the Regulation of the Minister of Transportation of the Republic of Indonesia Number: PM. 78 of 2014: PID 130. Dredging with a ship Hopper TSHD 2900 (Distance DA ≤ 6 Nmil) production capacity = 5,823 $m^3$ / day of Rp. 44,800 / $m^3$, the dredging costs are:

BP2 = V2 x H

BP2 = 181,454 $m^3$ x Rp. 44.800,-/ $m^3$

BP2 = Rp. 8.129.139,20

Then the total costs needed to dredge the type of capital dredging and maintenance of the port and pool pond is:

BP1 + BP2 = Rp. 2,570,689,140.00

The discussion is carried out by comparing waiting time between the current condition and after optimization and also comparing the operating costs of the ship plus the interest rate of money in the cargo as long as the ship waits in the queue with dredging costs.

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**Comparison of ship waiting time in the queue before and after optimization**

The ship waiting time in the queue is significant where there is a decrease of 78.07% for dry bulk loads and 36.29% for liquid bulk loads.

**Comparison of vessel operating costs plus the value of interest in the cargo during the ship in the queue with dredging costs**

After knowing the operational costs of the ship, the value of interest in the charge is then compared to the dredging costs in the following table.

**Table 4.11 Comparison of vessel operating costs and the value of interest in the cargo during the queue with dredging costs**

| Ship Operating Costs | Value of Interest in Money in Cargo | Dredging Costs | Difference |
|---|---|---|---|
| (Rupiah) (1) | (Rupiah) (2) | (Rupiah) (3) | (Rupiah) (1+2)-(3) |
| 11.496.623.009,25 | 1.293.828.571,06 | 2.570.689.139,00 | **10.219.762.441,31** |

Sumber: Henry (2018)

Based on table 4.11 it can be seen that the amount of the difference in operating costs of the ship plus the value of interest in money in cargo as long as the ship in the queue with dredging costs is Rp. 10,219,762,441.31.

**Conclusion**

From the research conducted by the author on the Terminal for Self-interest PT. Kawasan Berikat Nusantara (Persero) Port of Marunda, we have some obtained several conclusions, as follow :

1. The waiting time of a ship based on the ship's service performance in the present condition is 0.579 days for dry bulk loads and 3.378 days for liquid bulk loads,

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2. Waiting time for ships after optimization by dredging with disciplinary queuing theory, analysis FVFS (First Vacant First Served) is 0.127 days for dry bulk loads and 2.152 days for liquid bulk loads,
3. The difference in waiting time (waiting time) current conditions with after optimization using queuing theory of 0.452 days or a decrease of 78.07% for dry bulk loads and 1.226 days or a decrease of 36.29% for liquid bulk loads,
4. The operational cost of the ship while waiting in the queue is Rp. 7,191,319,833.66 for dry bulk cargo and Rp. 4,305,303,175,59 for liquid bulk loads, the total is Rp. 11,496,623,009,25,
5. The interest rate of money from the cargo as long as the ship waits in the queue is Rp. 254,290,418.02 for dry bulk loads and Rp. 1,039,538,153.05 for liquid bulk loads so the total value of the interest on the money from the charge is Rp. 1,293,828,571.06,
6. Capital dredging costs is Rp. 2,562,560,000.00, while the cost to carry out maintenance (maintanance dredging) of the port's grooves and ponds annually is Rp. 8,129,139.20, the total dredging cost is Rp. 2,570,689,139.00,
7. The comparison between the operational costs of ships plus the value of interest on the money from cargo as long as the ship is in the queue with the dredging costs of the harbor and pool port is Rp. 10,219,762,323.00.

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