Effect of Berthing Time and Berth Output on Conventional Donation Utilization at PT Pelindo II Palembang Branch

Larsen Barasa*, April Gunawan Malau, Bambang Sumali

Sekolah Tinggi Ilmu Pelayaran, Jakarta Jl. Marunda Makmur No. 1 Cilincing, Jakarta Utara. Jakarta 14150. Indonesia.
*Email larsenbarasa@gmail.com

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ABSTRACT

Boombaru Port which is managed by PT Pelindo II Palembang Branch is a marine transportation infrastructure that plays an important role and function in the transportation wheel in the South Sumatra area. This is because this port is located in the city of Palembang as a center of government, trade and activities tourism in South Sumatra. Based on data in 2017, the problem at this port is the high berthing time of ships at conventional docks, the realization of berth output is lower than the potential amount of cargo unloaded and loaded at conventional docks, and not achieving the target of conventional dock utilization. The purpose of this study is to find out and analyze how much influence berthing time, berth output together on the utilization of conventional docks. This research was conducted by collecting and processing data on ship and goods service performance and facilities and equipment utilization format reports in 2017. In this study it was found the average loading and unloading speed based on berthing time at conventional docks does not meet the loading discharge rate that has been determined based on the service level agreement. There is a difference in value between loading discharging rate with time and the loading discharging rate with working time. To optimize the utilization of conventional docks to match the predetermined RKA, streamlining the berthing time faster so that the output berth will also be optimized properly. To streamline berthing time and optimize berth output by accelerating loading and unloading activities at conventional docks by increasing the number of loading and unloading equipment at conventional docks such as jib cranes and head trucks. For the use of one jib crane/hour unit requires three head truck units. So for the addition of one jib crane unit also requires three head truck units. In order to support the loading and unloading activities at conventional docks and to avoid the high idle time at berthing time of the ship, care and maintenance of the loading and unloading equipment is needed so that the loading and unloading equipment can always be used.

Keywords: Berthing Time, Berth Output, Berth Occupancy Ratio, Dock Utilization
JEL Classifications: L62, R41, R42

1. INTRODUCTION

Port Performance Indicators (Chang, 2013), namely:
1. Service
    Port performance indicators on the service side of the ship are waiting time, approach time, postpone time, not operation time, idle time, effective time, berthing time, working time, and turn around time.

2. Output
    Performance indicators show how many items are loading and unloading in tons/cubic meters, and also boxes.

3. Utilization
    Utilization performance indicator shows the comparison between the time of use of the dock, warehouse buildup, and also the buildup in the field.

According to (Berthon et al., 2012) berthing time (BT) or mooring time is the amount of time during the ship is at mooring, since the ship tied to a rope off the mooring rope.

According to (Knapp and Van De Velden, 2011) time of ship berthed is the amount of time during mooring both working and...
not working for all ships during moorings divided by the number of ships (can be interpreted the same as service time).

According to (Habib et al., 2013) berthing time is the time taken during mooring at the pier to carry out loading and unloading activities which are calculated from the first rope tied to the dock until the release of the last mooring rope from the dock.

According to (Chang, 2013) berth output or berth throughput is the amount of cargo and unloading through the pier divided by the length of the pier in ton/m² units in a reporting period.

According to (Crowley, 2008) berth throughput or berth output is the number of goods unloaded at mooring.

Utilization of conventional piers is used to measure the extent to which conventional pier facilities are used intensively. The level of use of the pier or so-called berth occupancy ratio (BOR).

According to (Ghemawat, 2017) the berth occupancy ratio (BOR) is a comparison between the amount of time of use of each available pier divided by the amount of time available during one period (month/year) stated in the percentage.

According to (Chang, 2013) port performance is shown by the BOR or dock usage level, which is a comparison between the amount of dock time used and the amount of time available during one period expressed in percent. Port performance indicators are used to measure the extent to which dock facilities and supporting facilities are used intensively.

Problems that are often experienced at the Palembang branch of PT Pelindo II are one of the high berthing time of ships at the conventional dock, the realization of output berth is lower than the potential amount of cargo unloaded and loaded at the conventional boat of the Palembang branch of PT Pelindo II and not achieving targets on dock utilization.

1.1. Objectives and Research Benefits

1. Research purposes
   a. To find out and analyze how much the influence of berthing time on conventional dock utilization.
   b. To find out and analyze how much the influence of berth output on conventional dock utilization.
   c. To find out and analyze how much influence berthing time, berth output together to the utilization of conventional docks.

2. Benefits of research
   a. Can be useful theoretically and contribute to the development of science in the port sector. And as a material consideration to better know about the factors that can cause high berthing time and the amount of realization of output berth exceeds the budget work plan that has been at the port.
   b. Can be input to the port of a scientific nature in order to evaluate whether the performance and service commitment At ABC nan as well as preparations were made to minimize the berthing time and berth output so as to reach target at a predetermined dock utilization.

2. METHODOLOGY

2.1. Data Description

2.1.1. Berthing time

This is the time the ship is used during mooring at the dock to carry out loading and unloading activities which are calculated from the first rope tied to the dock until the last mooring rope is released from the dock.

The following is a recapitulation regarding ship berthing time ($X_1$) starting from January 2017 to December 2017, including Table 1:

2.2. Berth Output

This is the number of goods unloaded through each meter of the pier length available.

The following is a recapitulation regarding berth output ($X_2$) from January 2017 to December 2017, including Table 2:

2.3. Conventional Dock Utilization

This is the level of use of conventional wharves used to measure the extent to which conventional wharf facilities are used incentives. The level of use of the pier or so-called BOR is the ratio between the amount of time used for each available pier divided by the amount of time available during 1 period.

The following is a recapitulation regarding the utilization of conventional docks ($Y$) from January 2017 to December 2017, including Tables 3 and 4:

2.4. Research Time

This research was conducted at the time the authors conducted a Land Practice at PT Pelindo II Palembang Branch starting from August 8, 2017 to November 3, 2017.

2.5. Research Sites

This research was conducted by the authors at the Palembang branch of PT Pelindo II, namely at the Boom Baru Conventional Port of Palembang.

Table 1: Ship berthing time for 2017 (Hours)

| Month               | Berthing time ($X_1$) |
|---------------------|------------------------|
| January 2017        | 1,821.55               |
| February 2017       | 2,713.80               |
| March 2017          | 2,419.35               |
| April 2017          | 2,301.73               |
| May 2017            | 2,379.43               |
| June 2017           | 2,422.37               |
| July 2017           | 2,404.75               |
| August 2017         | 2,701.10               |
| September 2017      | 2,522.60               |
| October 2017        | 2,060.67               |
| November 2017       | 2,984.87               |
| December 2017       | 3,280.62               |
| **Total**           | **3,012.84**           |
| **Average**         | **2,501.07**           |
Table 2: Berth output for 2017 (Ton/M)

| Month        | Utilization of conventional derma (γ) |
|--------------|---------------------------------------|
| January 2017 | 53.18                                 |
| February 2017| 69.96                                 |
| March 2017   | 71.93                                 |
| April 2017   | 60.25                                 |
| May 2017     | 60.86                                 |
| June 2017    | 57.61                                 |
| July 2017    | 63.46                                 |
| August 2017  | 68.17                                 |
| September 2017| 59.48                              |
| October 2017 | 52.95                                 |
| November 2017| 71.89                                 |
| December 2017| 69.35                                 |
| Total        | 759.09                                |
| Average      | 63,2575                               |

Table 3: Conventional dock utilization (BOR) in 2017 (%)

| Month        | Berth Output (Xr) |
|--------------|-------------------|
| January 2017 | 291.76            |
| February 2017| 418.15            |
| March 2017   | 321.64            |
| April 2017   | 295.28            |
| May 2017     | 295.32            |
| June 2017    | 312.44            |
| July 2017    | 296.48            |
| August 2017  | 358.82            |
| September 2017| 349.96            |
| October 2017 | 271.33            |
| November 2017| 395.90            |
| December 2017| 445.87            |
| Total        | 4052.95           |
| Average      | 337,7458          |

Table 4: Data on the number of loading and unloading at conventional wharfs in 2017

| Month | Unloading (ton) | Load (ton) | Number of unloading (tons) |
|-------|-----------------|------------|----------------------------|
| 1     | 44,090          | 94,060     | 138,150                     |
| 2     | 55,301          | 132,040    | 187,341                     |
| 3     | 57,645          | 86,040     | 143,685                     |
| 4     | 42,432          | 89,331     | 131,763                     |
| 5     | 64,191          | 67,810     | 132,001                     |
| 6     | 53,667          | 85,574     | 139,241                     |
| 7     | 52,280          | 80,041     | 132,321                     |
| 8     | 68,720          | 91,599     | 160,319                     |
| 9     | 77,846          | 87,263     | 165,109                     |
| 10    | 53,774          | 67,457     | 121,231                     |
| 11    | 78,000          | 99,013     | 177,013                     |
| 12    | 87,699          | 111,709    | 199,408                     |
| Total | 735,645         | 1,091,937  | 1,827,582                   |

2.7. Data Collection Techniques

In completing this research the writer collected data and information needed to complete this thesis material by using “Field Research.” Field research is research to obtain the data needed through direct observation and interviews and taking secondary data about the company PT Pelindo II Palembang Branch. In this field research using the following techniques.

a. Observation
Observation is a method of collecting data where the research records information as they witnessed it during the study. Witnessing these events can be seen, heard, felt and then recorded subjectively (Sofiati and Limakrisna, 2017).

b. Documentation
According to (Arikunto, 2019), documentation originates from the origin of said documents which means written goods. In carrying out the method of documentation, researchers investigate written objects such as books, magazines, documents, regulations, minutes of meetings, diaries and so on. From the study of this document the authors obtain data in the form of a recapitulation of unloading activities in 2017, which consists of the amount of unloading and loading of goods, loading and unloading time and records of the use of tools during the unloading and loading activities.

c. Literature review
Namely the collection of data by way of reading, viewing, researching, quotes from books or references presented, input or consideration and comparison menegenai what can be seen from existing theories.

This literature study aims to obtain the basics of theory by reading books including regulations and other documents relating to the problem to be discussed.

In taking data by means of literature study taken from books and references, among others:
1. Shipping (Capt. RP Suyono)
2. Port Planning (Bambang Triatmodjo)
3. Management of Sea and Port Transportation Operations (Suranto, SE)
4. Port Business Management (Raja Oloan Saut Gurning, ST., M.Sc., And Dr. Eko Hariyadi Budiyanto, Ak.MM.M.Sc.)

2.8. Research Subjects
The population consists of a group of objects that are the center of attention, which contain information that wants to be known (Blinch et al., 2011).

The sample is a subset of a population, the sample provides a true picture of the population. Taking a sample from a population is
called sampling. The population that is sampled when planning a study is called the target population, while the population studied when conducting research is called the sampling population (Nur‘ainy et al., 2013).

In this case, the population taken by the author in the preparation of this thesis is the data of all the activities of loading and unloading of goods during the last 6 months at the conventional pier, and calculated in the period of months in the period January 2017–December 2017 at the Conventional Pier of the Boom Baru Palembang Port.

3. RESULTS AND DISCUSSION

The following is a recapitulation of ship berthing time (X), berth output (X), and recapitulation of conventional dock utilization (Y) from January 2017 to December 2017, including Table 5:

| Month | X (Y) | X (Y) | Y |
|-------|-------|-------|---|
| 1     | 2,419,35 | 321,64 | 71,93 |
| 2     | 2,422,37 | 312,44 | 57,61 |
| 3     | 2,404,75 | 296,48 | 63,46 |
| 4     | 2,379,43 | 295,32 | 60,86 |
| 5     | 2,419,35 | 321,64 | 71,93 |
| 6     | 2,422,37 | 312,44 | 57,61 |
| 7     | 2,404,75 | 296,48 | 63,46 |
| 8     | 2,379,43 | 295,32 | 60,86 |
| 9     | 2,422,37 | 312,44 | 57,61 |
| 10    | 2,404,75 | 296,48 | 63,46 |
| 11    | 2,379,43 | 295,32 | 60,86 |
| 12    | 2,422,37 | 312,44 | 57,61 |
| Total | 2,828,11 | 2,419,35 | 71,93 |

Table 6: Correlation of variables

| X | Y | X² | Y² |
|---|---|----|----|
| 1,821,55 | 53.18 | 96,870.03 | 3,318,044.40 |
| 2,713.80 | 69.96 | 189,857.44 | 7,364,710.44 |
| 2,419,35 | 71.93 | 174,023.85 | 5,883,254.42 |
| 2,301.73 | 60.25 | 138,679.23 | 5,297,960.99 |
| 2,379,43 | 71.93 | 144,812.11 | 5,661,687.12 |
| 2,422,37 | 57.61 | 139,552.74 | 5,297,960.99 |
| 2,404,75 | 57.61 | 152,605.44 | 5,297,960.99 |
| 2,379,43 | 71.93 | 144,812.11 | 5,661,687.12 |
| 2,422,37 | 57.61 | 139,552.74 | 5,297,960.99 |
| 2,404,75 | 57.61 | 152,605.44 | 5,297,960.99 |
| Total | 2,828,11 | 2,419,35 | 71,93 |

To test the validity of membukitkan variable berthing time ship (X) of the utilization of conventional dock (Y) according to the calculations are obtained in figure correlation coefficient of (0.79), so that the figure validity of (0.79) then do is to look for \( r_{\text{valid}} \) is based on the criteria of the provisions df (degree of freedom) premises the value of n (number of samples) note 12, df = n − 2 then becomes df = 12 − 2 i.e. 10 later than \( r_{\text{table}} \) at \( \alpha = 0.05 \); then it is 0.576 (from \( r_{\text{table}} \)).

Then, the results obtained are \( r = r_{\text{arithmetic}} = 0.79 \), because \( r_{\text{arithmetic}} > r_{\text{table}} (0.79 > 0.576) \). So it can be concluded that the variable berthing time of the ship (X) against the conventional dock utilization (Y) is declared valid.

b. Regression Correlation Coefficient Analysis

To find out the strength or weakness of the relationship between variable X and Y, then this analysis will find out the value of r (correlation coefficient), namely by the formula:

Regression correlation coefficient formula = Validity test formula

To test the validity of membukitkan variable berthing time ship (X) of the utilization of conventional dock (Y) according to the calculations...
be interpreted if the berthing time of the ship increases, it will also increase the utilization of conventional docks. Vice versa, if there is a decrease in the ship berthing time it will reduce the utilization of conventional docks.

c. Analysis The coefficient of determination (KD = R²)
Analysis of the coefficient of determination is to find out how much the contribution of the berthing time variable of the ship (X₁) to the conventional dock utilization (Y) is used the formula of the coefficient of determination as follows:

\[ KD = r^2 \times 100\% \]
\[ KD = (0.79)^2 \times 100\% \]
\[ KD = 0.63 \times 100\% \]
\[ KD = 63\% \]

With the regression line value (r² = 0.63) close to 1, it is said to be feasible to use. Then the coefficient of determination is 63% indicating that the value is worth continuing to predict by using a regression formula in which 63% of the berthing time of a ship affects conventional dock utilization and 37% by other factors.

d. Hypothesis testing
Hypothesis testing about the correlation coefficient. Judging from the calculation of the correlation coefficient, determination and regression line, then the hypothesis test can be done to determine the influence of the berthing time of the ship on the conventional dock utilization at PT Pelindo II Palembang Branch.

1) Partial Correlation Coefficient Test (T Test)
Hypothesis tests used by the authors are as follows:
To prove that \( H_0 \) is accepted or rejected, then what is done is to look for \( t_{\text{arithmetic}} \) by step in entering the value \( (r) \) into the formula, the value of \( n \) (number of samples) is known to be 12, then compared to \( t_{\text{table}} \) at \( \alpha = 0.05 \); \( df = nk \) where \( k \) is the number of variables (free + bound) and \( n \) is the number of observations/samples forming the regression. So \( df = 12 - 2 = 10 \) is 1,812 (from \( t_{\text{table}} \)).

\[ t_i = \frac{r \sqrt{n-2}}{\sqrt{1-(r)^2}} = \frac{(0.79) \sqrt{12-2}}{\sqrt{1-(0.79)^2}} = \frac{(0.79) \sqrt{10}}{\sqrt{1-0.63}} = \frac{(0.79) \cdot 3.16}{0.37} = 2.50 \]
\[ \frac{0.61}{4.10} \]

Then, the results obtained are \( t_i = t_{\text{arithmetic}} = 4.10 \), because \( t_{\text{arithmetic}} > t_{\text{table}} \) (4.10 > 1.812). So \( H_0 \) is rejected and \( H_1 \) is accepted, meaning that there is a significant relationship between \( X_1 \) and \( Y \). So there is a significant relationship between ship berthing time and conventional dock utilization at PT Pelindo II Palembang Branch.

2) Simultaneous Correlation Coefficient Test (Test F)
Hypothesis tests used by the authors are as follows:
To prove that \( H_1 \) is accepted or rejected, what is done is to find \( f_{\text{arithmetic}} \) by step in entering the value \( (r) \) into the formula, the value of \( n \) (number of samples), the degree of freedom (df) for the numerator or known as \( df_1 \), with the symbol \( N \), degree of freedom (df) for the denominator, or known as \( df_2 \), with the symbol \( N \). Then compare the \( f_{\text{table}} \) at \( \alpha = 0.05 \); \( df_1 = k-1 \); \( df_2 = nk \) where \( k \) is the number of observations (free + bound) and \( n \) is the number of observations/samples forming the regression. Can be calculated:

\[ df_1 = k-1 = 2-1 = 1 \]
\[ df_2 = n-k = 12-2 = 10 \]

So that \( N1 = 1 \) and \( N2 = 10 \) then \( f_{\text{table}} = 4.96 \).

\[ f_i = f_{\text{hitung}} = \frac{r^2 / k}{1-r^2 / (n-k-1)} = \frac{(0.79)^2 / 2}{1-(0.79)^2 / (12-2-1)} \]
\[ = \frac{0.63 / 2}{1-0.315} = \frac{0.315}{0.04} = 7.88 \]

Then, the results obtained are \( f_i = f_{\text{arithmetic}} = 7.88 \), because \( f_{\text{arithmetic}} > f_{\text{table}} \) (7.88 > 4.96). So \( H_1 \) is rejected and \( H_0 \) is accepted, meaning that there is a significant relationship between \( X_1 \) and \( Y \). So there is a significant relationship between ship berthing time and conventional dock utilization at PT Pelindo II Palembang Branch.

3.2. Correlation of Relationships between Berth Output (X₁) and Conventional Dock Utilization (Y)
Table 7, calculation of the correlation between the variables \( X_1 \) and \( Y \) variables. Based on the table above, the numbers can be obtained through statistics as follows:

a. Validity test
Validity test is done to determine the level keandalah and validity of variables berth output (\( X_1 \)) of the utilization of conventional dock (\( Y \)) used the same formula to the validity of the correlation coefficient formula as follows:

\[ r_{xy} = \sqrt{\frac{n \sum X_1 Y - \sum X_1 \sum Y}{\sqrt{\left( \frac{\sum X_1^2}{n} - \left( \sum X_1 \right)^2 \right) \left( \frac{\sum Y^2}{n} - \left( \sum Y \right)^2 \right)}}} \]
\[ r_{xy} = \sqrt{\frac{(12)(259,508,86)-(4,052,95)(759,09)}{(12)(1,403,729,56)-(4,052,95)^2}} \]
\[ r_{xy} = \sqrt{\frac{(12)(48,542,84)-(759,09)^2}{16,844,754,77-16,426,403,70}} \]
\[ r_{xy} = \frac{3,114,106,32-3,076,553,82}{582,514,09-576,217,63} \]
\[ r_{xy} = \frac{37,552,50}{(646,80)(79,35)} \]
Table 7: Results of analysis of berth output ($X_i$) on conventional dock utilization ($Y$)

| $X_i$ | $Y$ | $X_i Y$ | $X_i^2$ | $Y^2$ |
|-------|-----|---------|---------|-------|
| 291.76 | 53.18 | 15515.80 | 85,123.90 | 2,828.11 |
| 418.15 | 69.96 | 29,253.77 | 174,849.42 | 4,894.40 |
| 321.64 | 71.93 | 23,135.57 | 103,452.29 | 5,173.92 |
| 295.28 | 60.25 | 1790.92 | 87,190.28 | 3,630.06 |
| 295.32 | 60.86 | 17,973.18 | 87,213.90 | 3,703.94 |
| 312.44 | 57.61 | 17,999.67 | 97,618.75 | 3,318.91 |
| 296.48 | 63.46 | 18,814.62 | 87,900.39 | 4,027.17 |
| 358.82 | 68.17 | 24,460.76 | 128,751.79 | 4,647.15 |
| 349.96 | 59.48 | 20,815.62 | 122,472.00 | 3,573.87 |
| 271.33 | 52.95 | 14,366.92 | 73,619.97 | 2,803.70 |
| 395.90 | 71.89 | 28,461.25 | 156,736.81 | 5,168.17 |
| 445.87 | 69.35 | 30,921.08 | 198,800.06 | 4,809.42 |
| 4052.95 | 759.09 | 259,508.86 | 1,403,729.56 | 48,542.84 |

\[ r_{xy} = \frac{37.552,50}{51.323,58} = 0.73 \]

To test the validity of membukitkan variable berth output ($X_i$) of the utilization of conventional dock ($Y$) according to the calculations are obtained in figure correlation coefficient of (0.73), so that the figure validity of (0.73) then do is to find $r_{\text{out}}$ that is based on the criteria with the provisions of df (degree of freedom) with the value of $n$ (number of samples) known 12, df = $n - 2$ then it becomes df = $12 - 2$ which is 10 then compared to $r_{\text{table}}$ at $\alpha = 0.05$; then it is 0.576 (from $r_{\text{table}}$).

Then, the results obtained are $r = r_{\text{arithmetic}} = 0.73$, because $r_{\text{arithmetic}} > r_{\text{table}}$ (0.73 > 0.576). So it can be concluded that the variable berth output ($X_i$) against the conventional dock utilization ($Y$) is declared valid.

3.3. Regression Correlation Coefficient Analysis

To find out the strength or weakness of the relationship between the variables $X_i$ and $Y$, then this analysis will find the value of $r$ (correlation coefficient), namely by the formula:

Regression Correlation Coefficient Formula = Validity Test Formula

\[ r_{xy} = \frac{n \sum X_i Y - \sum X_i \sum Y}{\sqrt{n \sum X_i^2 - (\sum X_i)^2} \sqrt{n \sum Y^2 - (\sum Y)^2}}. \]

\[ r_{xy} = 0.73 \]

From the above calculation, the correlation coefficient figure of (0.73) is obtained, which means that there is a strong influence between the berth output on the utilization of conventional docks. If the correlation results are positive, it can be interpreted if the berth output increases, it will also increase the utilization of conventional docks. Vice versa, if there is a decrease in output berth it will reduce the utilization of conventional docks.

a. Analysis The coefficient of determination ($KD = R^2$)

Analysis of the coefficient of determination is to determine how big contribution of variable berth output ($X_i$) of the utilization of conventional dock ($Y$) used formula coefficient of determination as follows:

\[ KD = r^2 \times 100\% \]

With a regression line value ($r^2 = 0.53$) close to 1, it is said to be feasible to use. Then the coefficient of determination is 53% indicating that the value is worth continuing to predict by using a regression formula where 53% of berth output affects the utilization of the dock and 47% by other factors.

b. Hypothesis testing

Hypothesis testing about the correlation coefficient. Judging from the calculation of the correlation coefficient, determination and regression lines, the hypothesis test can be done to determine the effect of the berth output on the utilization of conventional docks at PT Pelindo II Palembang Branch.

1. Partial correlation coefficient test ($t$ test)

Hypothesis tests used by the authors are as follows:

To prove that $H_1$ is accepted or rejected, then what is done is to look for $r_{\text{arithmetic}}$ by step in entering the value ($r$) into the formula, the value of $n$ (number of samples) is known to be 12, then compared to $t_{\text{table}}$ at $\alpha = 0.05$; $df = nk$ where $k$ is the number of variables (free + bound) and $n$ is the number of observations/samples forming the regression. So df = $12 - 2 = 10$ is 1,812 (from $t_{\text{table}}$).

\[ t_z = t \text{ count} \]

\[ t_z = \frac{r \sqrt{n - 2}}{\sqrt{1 - (r^2)}} = \frac{(0.73) \sqrt{12 - 2}}{\sqrt{1 - (0.73)^2}} = \frac{(0.73) \sqrt{10}}{\sqrt{1 - 0.53}} \]

\[ = \frac{(0.73) \cdot 3.16}{0.47} = \frac{2.31}{0.69} = 3.35 \]

Then, the results obtained are $t_z = t_{\text{arithmetic}} = 3.35$, because $t_{\text{arithmetic}} > t_{\text{table}}$ (3.35 > 1.812). So $H_1$ is rejected and $H_2$ is accepted, meaning that there is a significant relationship between $X_i$ and $Y$. So there is a significant relationship between berth output and conventional dock utilization at PT Pelindo II Palembang Branch.

2. Simultaneous correlation coefficient test ($t$ test)

Hypothesis tests used by the authors are as follows:

To prove that $H_1$ is accepted or rejected, what is done is by finding $f_{\text{arithmetic}}$ by step in entering the value ($r$) into the formula, the value of $n$ (number of samples), the degree of freedom (df) for the numerator or known as $df_1$ with the symbol N1, the degree of freedom (df) for the denominator, or known as $df_2$ with the symbol N2 then compare the $f_{\text{table}}$ at $\alpha = 0.05$; $df_1 = k - 1$; $df_2 = nk$ where $k$ is the number of variables (free + bound) and $n$ is the number of observations/samples forming the regression. Can be calculated:
Table 8: Results of ship berthing time analysis ($X_1$) against berth output ($X_2$)

| $X_1$  | $X_1$ | $X_1$ | ($X_1$)² | ($X_2$)² |
|--------|-------|-------|----------|----------|
| 1,821.55 | 291.76 | 531,455.43 | 3,318,044.40 | 85,123.90 |
| 2,713.80 | 418.15 | 1,134,775.47 | 7,364,710.44 | 174,849.42 |
| 2,419.35 | 321.64 | 778,159.73 | 5,853,254.42 | 103,452.29 |
| 2,301.73 | 295.28 | 5,297,960.99 | 5,782,822.56 | 87,190.28 |
| 2,379.43 | 295.32 | 3,318,044.40 | 5,782,822.56 | 87,190.28 |

To prove the validity test of the berthing time variable ($X_1$) to the berth output ($X_2$) according to the calculations obtained in the correlation coefficient of (0.90), so that the validity number of (0.90) then it is done by finding $r_{table}$ that is based on the criterion with the provisions of df (degree of freedom) with the value of $n$ (number of samples) is known to be 12, $df = n - 2$ then it becomes $df = 12 - 2 = 10$ then compared to $r_{table}$ at $a = 0.05$; then it is 0.576 (from $r_{table}$).

Then, the results obtained are $r_{x12} = 0.90$, because $r_{arithmetic}$ > $r_{table}$ (0.90 > 0.576). So it can be concluded that the variable berthing time ($X_1$) to the berth output ($X_2$) is declared valid.

b. Regression correlation coefficient analysis
To find out the strength or weakness of the relationship between variable $X_1$ and variable $X_2$, then this analysis will find out the value of $r$ (correlation coefficient), namely by the formula:

Regression correlation coefficient formula = Validity test formula

$$r_{x12} = \frac{n \sum X_1 X_2 - \sum X_1 \sum X_2}{\sqrt{n \sum X_1^2 - (\sum X_1)^2} \sqrt{n \sum X_2^2 - (\sum X_2)^2}}.$$

From the above calculation, the correlation coefficient figure of (0.90) is obtained, it means that there is a very strong influence between berthing time on berth output. If the correlation results are positive, it can be interpreted if the berthing time increases, it will also increase the berth output. Vice versa, if there is a decrease in berthing time it will reduce the berth output.

c. Analysis The coefficient of determination (KD = $R^2$)
Analysis of the coefficient of determination is to determine how big contribution of variable berth output ($X_2$) of the utilization of conventional dock ($Y$) used formula coefficient of determination as follows:

$$KD = r^2 \times 100\%$$

| $X_1$ | $X_1$ | $X_1$ | $X_1$ | $X_1$ |
|-------|-------|-------|-------|-------|
| 2,584,945.22 | 2,584,945.22 | 2,584,945.22 | 2,584,945.22 | 2,886,674.87 |
| $r_{x1} = 0.90$ | $r_{x1} = 0.90$ | $r_{x1} = 0.90$ | $r_{x1} = 0.90$ | $r_{x1} = 0.90$ |
With the regression line value \((r^2 = 0.81)\) close to 1, it is said to be feasible to use. Then the coefficient of determination is 81% indicating that the value is worth continuing to predict by using a regression formula where 81% of berthing time affects the berth output and 19% by other factors.

d. Hypothesis testing

Hypothesis testing about the correlation coefficient. Judging from the calculation of the correlation coefficient, determination and regression lines, then the hypothesis test can be done to determine the effect of berthing time on berth output at PT Pelindo II Palembang Branch.

1. Partial correlation coefficient test (t test)

Hypothesis tests used by the authors are as follows:

If \( t_{\text{arithmetic}} > T_{\text{table}} \) then \( H_0 \) is rejected and \( H_1 \) is accepted, meaning that there is a significant relationship between berthing time and berth output at PT Pelindo II Palembang Branch. To prove that \( H_1 \) is accepted or rejected, it is done by finding \( t_{\text{count}} \) by step enter a value \((r)\) into the formula, the value of \( n \) (number of samples) 12, then compared \( t_{\text{table}} \) at \( \alpha = 0.05 \); \( df = nk \) where \( k \) is the number of variables (free + bound) and \( n \) is the number of observations/samples forming the regression. So \( df = 12 - 2 = 10 \) is 1.812 (from \( t_{\text{table}} \)).

\[
t_3 = t \text{ count} = \frac{r \sqrt{n-2}}{\sqrt{1-(r)^2}} = \frac{(0.90) \sqrt{12-2}}{\sqrt{1-(0.90)^2}} = \frac{(0.90) \sqrt{10}}{\sqrt{1-0.81}} = \frac{2.85}{0.44} = 6.48
\]

Then, the results obtained are \( t_3 = t_{\text{arithmetic}} = 6.48 \), because \( t_{\text{arithmetic}} > t_{\text{table}} \) (6.48 > 1.812). So \( H_0 \) is rejected and \( H_1 \) is accepted, meaning that there is a significant relationship between \( X_1 \) and \( X_2 \). So there is a significant relationship between berthing time and berth output at PT Pelindo II Palembang Branch.

2. Simultaneous correlation coefficient test (test f)

Hypothesis tests used by the authors are as follows:

To prove that \( H_1 \) is accepted or rejected, it is by looking \( f_{\text{count}} \) is by step enter a value \((r)\) into the formula, the value of \( n \) (number of samples), degrees of freedom/degree of freedom (df) for the numerator or known \( df \) with the symbol \( N1 \), degree of freedom (df) for the denominator, or known as \( df \) with the symbol \( N2 \) then compare the \( f_{\text{table}} \) at \( \alpha = 0.05 \); \( df_1 = k - 1 \); \( df_2 = nk \) where \( k \) is the number of variables (free + bound) and \( n \) is the number of observations/samples forming the regression. Can be calculated:

\[
df = k - 1
\]
\[
df = n-k
\]
\[
df = 12 - 2 = 10
\]

So that \( N1 = 1 \) and \( N2 = 10 \) then \( f_{\text{table}} = 4.96 \). \( f_3 = f_{\text{arithmetic}} \).
time of the ship ($X_1$) and berth output ($X_2$) to the conventional dock utilization ($Y$) is declared valid.

b. Equation of Multiple Linear Regression

Table 9 and 10, to find out how big the correlation between the berthing of ship time ($X_1$) and a berth output ($X_2$) of the conventional dock utilization ($Y$) is by using Equation Regression. Where in general, the data observed by $Y$ are influenced by variables $X_1$ and $X_2$, so the formula of multiple linear regression is:

$$Y = a + b_1X_1 + b_2X_2$$

So, the multiple linear regression equation is

$$Y = a + b_1X_1 + b_2X_2$$

So, the values of $b_1, b_2$, and $a$ are as follows:

$$b_1 = \frac{[\sum X_2^2 \cdot \sum X_1Y] - (\sum X_1Y \cdot \sum X_1X_2)}{[\sum X_1^2 \cdot \sum X_2^2] - (\sum X_1X_2)^2}$$

$$b_2 = \frac{[\sum X_1^2 \cdot \sum X_2Y] - (\sum X_1Y \cdot \sum X_1X_2)}{[\sum X_1^2 \cdot \sum X_2^2] - (\sum X_1X_2)^2}$$

$$a = \frac{\sum Y - (\sum X_1 \sum X_1Y) - (\sum X_2 \sum X_2Y)}{n}$$

Table 9: Results of ship berthing time analysis ($X_1$), berth output ($X_2$) and conventional dock utilization ($Y$)

| Month | $X_1$ | $X_2$ | $Y$ | $X_1^2$ | $X_2^2$ | $Y^2$ |
|-------|-------|-------|-----|---------|---------|-------|
| 1     | 1,821.55 | 291.76 | 53.18 | 3,318,044.40 | 85,123.90 | 2,828.11 |
| 2     | 2,713.80 | 418.15 | 69.96 | 7,364,710.44 | 174,849.42 | 4,894.40 |
| 3     | 2,419.35 | 321.64 | 71.93 | 5,853,254.42 | 103,452.29 | 5,173.92 |
| 4     | 2,301.73 | 295.28 | 60.25 | 5,297,960.99 | 87,190.28 | 3,630.06 |
| 5     | 2,379.43 | 295.32 | 60.86 | 5,661,687.12 | 87,213.90 | 3,703.94 |
| 6     | 2,422.37 | 312.44 | 57.61 | 5,867,876.42 | 97,618.75 | 3,318.91 |
| 7     | 2,404.75 | 296.48 | 63.46 | 5,782,822.56 | 87,900.39 | 4,027.17 |
| 8     | 2,701.10 | 358.82 | 68.17 | 7,295,941.21 | 128,751.79 | 4,647.15 |
| 9     | 2,522.60 | 349.96 | 59.48 | 6,363,510.76 | 122,472.00 | 3,537.87 |
| 10    | 2,060.67 | 271.33 | 52.95 | 4,246,360.85 | 73,619.97 | 2,803.70 |
| 11    | 2,384.87 | 395.90 | 71.89 | 8,909,448.92 | 156,736.81 | 5,168.17 |
| 12    | 3,280.62 | 445.87 | 69.35 | 10,762,467.58 | 198,800.06 | 4,809.42 |
| Σ     | 3012.84 | 4052.95 | 759.09 | 76,724,085.68 | 1,403,729.56 | 48,542.84 |
Table 10: Continued analysis of ship berthing time ($X_1$) and berth output ($X_2$) conventional dock utilization ($Y$)

| Month | $X_1$ | $X_2$ | $X_1Y$ |
|-------|-------|-------|--------|
| 1     | 531,453.43 | 96,870.03 | 15515.80 |
| 2     | 1,134,775.47 | 189,857.45 | 29,253.77 |
| 3     | 778,159.73 | 174,023.85 | 20,815.62 |
| 4     | 679,654.83 | 184,133.99 | 24,460.76 |
| 5     | 702,693.27 | 184,133.99 | 24,460.76 |
| 6     | 756,845.28 | 184,133.99 | 24,460.76 |
| 7     | 712,960.28 | 184,133.99 | 24,460.76 |
| 8     | 969,208.70 | 184,133.99 | 24,460.76 |
| 9     | 882,809.10 | 184,133.99 | 24,460.76 |
| 10    | 559,121.59 | 184,133.99 | 24,460.76 |
| 11    | 1,181,710.03 | 184,133.99 | 24,460.76 |
| 12    | 1,462,730.04 | 227,511.00 | 30,921.08 |
| $\Sigma$ | 756,845.28 | 184,133.99 | 24,460.76 |

$Y = 28.01 + 0.01X_1 + 0.02X_2$

c. Interpretation of correlation coefficients
1) Value of $a = 28.01$; This means that if the berthing time of the ship ($X_1$) and the berth output ($X_2$) value is 0, then the utilization of conventional docks ($Y$) the value is 28.01%.
2) Value of $b_1 = 0.01$; meaning that if the berth output is considered fixed and the berthing time of the ship increases by one percent, the utilization of conventional docks will increase by 0.01 unit. Positive coefficient means that there is a positive relationship between berthing time and conventional dock utilization, the more berthing time rises, the more conventional dock utilization increases.
3) Value of $b_2 = 0.02$; meaning that if the berthing time is considered fixed and the berth output increases by one percent, the utilization of conventional docks will increase by 0.02 units. Positive coefficient means that there is a positive relationship between berth output and conventional berthing utilization, the more berth output rises, the more the utilization of conventional berth increases.

d. Calculate the multiple regression correlation coefficient
To find out the strength or weakness of the relationship between variable $X_1$ and variable $X_2$ to variable $Y$ then this analysis will find out the value of $r$ (correlation coefficient), namely by the formula:

Regression correlation coefficient formula = Validity test formula

$$r_{xy} = 0.79; r_{x_2y} = 0.73; r_{x_1x_2} = 0.90$$

$$r_{x_1x_2} = \sqrt{r_{x_1y}^2 + r_{x_2y}^2 - 2 \times r_{x_1y} \times r_{x_2y} \times r_{x_1x_2}}$$

$$r_{x_1x_2} = 0.80$$

From the above calculation, the correlation coefficient figure of (0.80) is obtained, which means that there is a very strong influence between berthing time ($X_1$) and berth output ($X_2$) on conventional dock utilization ($Y$).

If the correlation results are positive, it can be interpreted if the berthing time of the ship and the berth output increases will also increase the utilization of conventional docks. Vice versa, if there is a decrease in the berthing time of the ship and the output berth it will reduce the utilization of conventional docks.

e. Calculate the coefficient of determination
Analysis of the coefficient of determination is to find out how much the contribution of the variable berthing time ($X_1$) and berth output ($X_2$) to the conventional dock utilization ($Y$) used the coefficient of determination formula as follows:

$$r^2 = \frac{(b_1 \sum X_1Y + b_2 \sum X_2Y)}{\sum Y^2}$$

$$r^2 = \frac{(0.01 \times 23.247.62 + 0.02 \times 3.129.38)}{524.70}$$

$$r^2 = 0.56$$

$KD = r^2 \times 100\%$

$KD = (0.56) \times 100\%$

$KD = 56\%$

By getting the $KD$ value = 56% shows that the magnitude of the coefficient of determination between berthing time and berth output to conventional dock utilization is 56%. This means that around 56% between berthing time ($X_1$) and berth output ($X_2$) can explain the utilization of conventional docks ($Y$).

f. Hypothesis testing
Hypothesis testing about the correlation coefficient. Judging from the calculation of the correlation coefficient, determination and regression line, the hypothesis test can be performed to determine the effect of berthing time and berth output on the utilization of conventional docks at PT Pelindo II Palembang Branch.

Hypothesis testing used in multiple linear regression by the author is by calculating $t_{\text{ordinary}}$ and $f_{\text{ordinary}}$ as is as follows.

1. Partial correlation coefficient test ($t$ test)
To prove that $H_0$ is accepted or rejected, it is done by finding $t_{\text{count}}$ is by step enter a value ($r$) into the formula, the value of $n$ (number of samples) note 12, then compared $t_{\text{table}}$ at $\alpha = 0.05$; $df = nk$ where $k$ is the number of variables (free + bound) and $n$ is the number of observations/samples forming the regression. So $df = 12 - 3 = 9$ is 1,833 (from $t_{\text{table}}$).

$$t_{\text{count}} = \frac{r \sqrt{n - 2}}{\sqrt{1 - r^2}} = \frac{(0.80)\sqrt{12 - 2}}{\sqrt{1 - (0.80)^2}} = \frac{(0.80)\sqrt{10}}{\sqrt{1 - 0.64}} = \frac{0.80 \times 3.16}{0.60} = \frac{2.53}{0.60} = 4.21$$
Then, the results obtained are \( t_t = t_{\text{arithmetic}} = 4.21 \), because \( t_{\text{arithmetic}} > t_{\text{table}} (4.21 > 1.833) \). So \( H_0 \) is rejected and \( H_1 \) is accepted, meaning that there is a significant relationship between \( X_1, X_2 \) and \( Y \). So that there is a significant relationship between berthing time and berth output to conventional dock utilization at PT Pelindo II Palembang Branch.

2. Simultaneous correlation coefficient test (test \( F \))

To prove that \( H_2 \) is accepted or rejected, it is by step enter a value \( \rho \) into the formula, the value of \( n \) (number of samples), degrees of freedom/degree of freedom (df) for the numerator or known \( df_1 \) with the symbol \( N1 \), degree of freedom (df) for the denominator, or known as \( df_2 \) with the symbol \( N2 \). then compare the \( f_{\text{table}} \) at \( \alpha = 0.05; df_1 = k - 1; df_2 = nk \) where \( k \) is the number of variables (free + bound) and \( n \) is the number of observations/samples forming the regression. Can be calculated:

\[
\begin{align*}
    df_1 & = k - 1 \\
    & = 3 - 1 = 2 \\
    df_2 & = n - k \\
    & = 12 - 3 = 9
\end{align*}
\]

So \( N1 = 2 \) and \( N2 = 9 \) then \( f_{\text{table}} = 4.26 \).

\[
\begin{align*}
    f_t &= f_{\text{hitung}} \\
    f_{\text{hitung}} &= \frac{r^2 / k}{1 - r^2 / (n - k - 1)} = \frac{(0.80)^2 / 2}{1 - (0.80)^2 / (12 - 3 - 1)} \\
    &= \frac{0.64 / 2}{1 - 0.64 / 8} = \frac{0.32}{0.045} = 7.11
\end{align*}
\]

Then, the results obtained are \( f_t = f_{\text{arithmetic}} = 7.11 \), because \( f_{\text{arithmetic}} > f_{\text{table}} (7.11 > 4.26) \). So \( H_0 \) is rejected and \( H_1 \) is accepted, meaning that there is a significant relationship between \( X_1, X_2 \) and \( Y \). So that there is a significant relationship between berthing time and berth output to conventional dock utilization at PT Pelindo II Palembang Branch.

Based on the results of data analysis above, it can be detailed as follows:

- The amount of berthing time = 30,012.84 h
- Total berth output = 4,052.95 tons/m
- Total loading and unloading = 1,827,582 tons
- Loading discharge rate based on all commodities = 107 TGH.

The loading discharging rate for each commodity is based on the Service Level Agreement as follows in Table 11.

| Description   | Unit | Performance |
|---------------|------|-------------|
| General Cargo | TGH  | 80          |
| Cargo Bag     | TGH  | 40          |
| Liquid Bulk   | TGH  | 200         |

The realization of the Loading Discharging Rate based on the Berth Working Time in the 2017 domestic period is as follows Table 12.

Average loading and unloading speed based on berthing time is

\[
\text{Average loading and unloading speed based on berthing time} = \frac{1,827,582}{30,012.84} = 61 \text{ TGH}
\]

So that the average loading and unloading speed based on berthing time at conventional docks does not meet the loading discharge rate that has been determined based on the service level agreement.

There is a difference in value between loading discharging rate with a time time and loading discharging rate with a working time of 63.68 TGH which is caused by the idle time in the berthing time element. Idle time is caused by weather factors such as rain, loading and unloading equipment damage, lack of readiness of ship crane equipment, waiting trucks, and draining tanks for types of liquid bulk loads.

Ideal Berthing time based on the realization of the amount of unloaded and loaded loads, namely:

\[
\text{Number of loading and unloading} = \frac{1,827,582}{107} = 17,080 \text{ h}
\]

So for the amount of cargo unloaded and loaded as much as 1,827,582 tons, it should take 17,080 h for the time to dock or berthing time with a loading discharge rate of 107 TGH but the realization is 30,012.84 h with a loading discharge rate of 61 TGH.

### 4. CONCLUSION

Based on the results of research and discussion of regression analysis and correlation coefficient, coefficient of determination, validity test, and hypothesis testing between berthing time and berth output on the utilization of conventional docks at PT Pelindo II Palembang Branch in the period January 2017–December 2017, then it can be taken The conclusion is:
1. To meet the conventional dock utility standard of 70%, it can be done by shortening the berthing time of the ship. Shorten mooring time or berthing time can be done by speeding up loading and unloading activities at conventional docks by increasing the number of jib cranes used for loading and unloading activities and increasing the number of head trucks used to transport cargo. For the use of one jib crane/hour unit requires three head truck units. So for the addition of one jib crane unit also requires three head truck units. In order to support the loading and unloading activities at conventional docks and to avoid the high idle time at berthing time of the ship, care and maintenance of the loading and unloading equipment is needed so that the loading and unloading equipment can always be used. TGH standards (tons of gangs per hour) and SOP (ship output per day) were improved so as to reduce berthing time when the ship was planned.

2. To optimize the berth output at conventional docks can be done by speeding up the time of loading and unloading activities in order to achieve loading discharging rate based on all commodities of 107 TGH. The realization of loading discharging rate based on existing berthing time only reached a figure of 61 TGH so that additional loading and unloading equipment is needed to speed up loading and unloading activities time by increasing the number of jib cranes and increasing the number of head trucks used to support loading and unloading activities at conventional docks. For the use of one jib crane/hour unit requires three head truck units. So for the addition of one jib crane unit also requires three head truck units. In order to support the loading and unloading activities at conventional docks and to avoid the high idle time at berthing time of the ship, care and maintenance of the loading and unloading equipment is needed so that the loading and unloading equipment can always be used.

3. If the berthing time value of the ship is low, the speed of the berthing ship will increase faster so that the value of the output berth will be well optimized. With the number of loading and unloading at the conventional dock in 2017 amounting to 1,827,582 tons, it should take 17,080 h for the berthing. But its realization is 30012.84 h, should be able to produce the number of loading and unloading larger with an average speed of loading and unloading of 107 TGH so that the value berth output also will increase. Based on the above, if all is well realized it can increase the productivity of loading and unloading activities at PT Pelindo II Palembang Branch. In order to speed up loading and unloading activities, an alternative can be done is to increase the number of loading and unloading equipment at conventional docks such as jib cranes and head trucks. For the use of one jib crane/hour unit requires three head truck units. So for the addition of one jib crane unit also requires three head truck units. In order to support the loading and unloading activities at conventional docks and to avoid the high idle time at berthing time of the ship, care and maintenance of the loading and unloading equipment is needed so that the loading and unloading equipment can always be used.

4. In order to optimize the utilization of conventional dock to fit the predetermined RKA, then from the PT Pelindo II Palembang Branch itself should be able to handle the efficiency of berthing time faster so both output also will be optimized.

To streamline berthing time and optimize berth output by accelerating loading and unloading activities at conventional docks with the number of loading and unloading at conventional docks of 1,827,582 tons and the average loading and unloading speed at conventional docks of 107 TGH will result in a mooring time of 17,080 h. But its realization is 30012.84 h, should be able to produce the number of loading and unloading larger with an average speed of loading and unloading of 107 TGH so that the value berth output also will increase. Based on the above, if all is well realized it can increase the productivity of loading and unloading activities at PT Pelindo II Palembang Branch. In order to speed up loading and unloading activities, an alternative can be done is to increase the number of loading and unloading equipment at conventional docks such as jib cranes and head trucks. For the use of one jib crane/hour unit requires three head truck units. So for the addition of one jib crane unit also requires three head truck units. In order to support the loading and unloading activities at conventional docks and to avoid the high idle time at berthing time of the ship, care and maintenance of the loading and unloading equipment is needed so that the loading and unloading equipment can always be used.

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