OPERATIONAL PERFORMANCE MODEL OF CONTAINER CRANES IN STEVEDOORING PROCESS AT THE NEW CONTAINER TERMINAL MAKASSAR 2

a Ashury, b Sumardi, c Taufiqur Rachman, d Mursalim

ABSTRACT

Purpose: This research scrutinizes the effects of increasing container flow on the operational performance of port services at TPK New Makassar Terminal 2, focusing on the influence of loading and unloading equipment on the utilization and productivity of Rubber Tyred Gantry (RTG) Cranes.

Methodology: Structural Equation Modeling (SEM) using AMOS software and statistical analysis with SPSS are employed to determine the relationships between container handling equipment and operational performance indicators. The study integrates multiple linear regression, F test, and T test to examine the causality between equipment usage and effective time in the loading and unloading processes.

Results: The study reveals a significant correlation between the number of loading and unloading actions and the usage of RTG cranes. It was found that the number of head trucks and reach stackers also impacts RTG productivity, but to a lesser extent. The regression model developed indicates a clear influence of loading and unloading frequency on the effective time of operations.

Conclusion: Conclusions drawn from the analysis highlight the critical role of loading and unloading equipment in optimizing port operational performance. The results suggest that an increase in the number of such equipment correlates positively with the efficiency of RTG Cranes and effective time management at the terminal.

Originality/Value: By integrating various methodological approaches, this study offers comprehensive insights into port operational dynamics, contributing to the strategic planning for equipment allocation and operational scheduling to enhance productivity at TPK New Makassar Terminal 2.

Keywords: AMOS, head truck, reach stacker, RTG, unloading.

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MODELO DE DESEMPENHO OPERACIONAL DE GUINDASTES DE CONTÊINER NO PROCESSO DE ESTEVEDOORING NO NOVO TERMINAL DE CONTÊINER MAKASSAR 2

RESUMO

Objetivo: Esta investigação examina os efeitos do aumento do fluxo de contêiners no desempenho operacional dos serviços portuários no TPK New Makassar Terminal 2, centrando-se na influência do equipamento de carga e descarga na utilização e produtividade dos guindastes de pórtico de borracha (RTG).

Metodologia: A Modelagem de Equações Estruturais (SEM) usando o software AMOS e a análise estatística com SPSS são empregadas para determinar as relações entre o equipamento de manuseio de contêiners e os indicadores de desempenho operacional. O estudo integra regressão linear múltipla, teste F e teste T para examinar a causalidade entre o uso do equipamento e o tempo efetivo nos processos de carga e descarga.

Resultados: O estudo revela uma correlação significativa entre o número de ações de carga e descarga e o uso de guindastes RTG. Constatou-se que o número de caminhões dianteiros e empilhadores de alcance também impacta a produtividade dos RTG, mas em menor grau. O modelo de regressão desenvolvido indica uma clara influência da frequência de carga e descarga no tempo efetivo de operações.

Conclusão: As conclusões retiradas da análise destacam o papel crucial do equipamento de carga e descarga na otimização do desempenho operacional do porto. Os resultados sugerem que um aumento no número de tais equipamentos correlaciona-se positivamente com a eficiência dos guindastes RTG e a gestão eficaz do tempo no terminal.

Originalidade/valor: Integrando várias abordagens metodológicas, este estudo oferece uma visão abrangente da dinâmica operacional do porto, contribuindo para o planejamento estratégico para a alocação de equipamentos e programação operacional para aumentar a produtividade no TPK New Makassar Terminal 2.

Palavras-chave: AMOS, caminhão de cabeça, empilhador de alcance, RTG, descarregamento.

1 INTRODUÇÃO

Port Services are services provided for port business activities including licensing for activities at the port and other activities in carrying out port functions on land and/or in waters (Rahmawan et al, 2023). Port can be interpreted as a place for ships to anchor, maneuver, and berthing, to carry out activities to raise and/or lower passengers and goods safely and securely (Lasse 2012, Triatmodjo 2010).

Port services play a pivotal role in the global supply chain, facilitating the movement of goods and passengers across international waters. These services
encompass a broad range of activities, from the licensing of port operations to the management of cargo and vessel traffic within the port's jurisdiction.

Ports act as crucial nodes in global trade networks, linking maritime routes to land-based transportation. The efficient management of port services is essential for economic development as ports enable the import and export of goods, thereby contributing significantly to a country's gross domestic product (GDP). Enhancing the quality and speed of port services can lead to increased trade volumes, more robust economic growth, and improved connectivity in international markets.

The introduction of advanced technologies (Dwivedi et al, 2023) such as automated container terminals, port management information systems, and the Internet of Things (IoT) has revolutionized the efficiency of port services. These technologies facilitate real-time tracking of cargo, streamline operations, reduce turnaround times, and enhance security measures. They also enable ports to handle larger volumes of cargo with greater precision and reliability.

With the increasing emphasis on sustainability, port services are also evolving to address environmental concerns. Implementing green port initiatives, such as shore-to-ship power systems and cleaner fuel alternatives for vessels, can significantly reduce the carbon footprint of port operations. Additionally, ports are adopting waste management practices and water conservation methods to mitigate the impact of port activities on marine ecosystems.

Port services often face challenges such as congestion, logistical inefficiencies, and security threats. To combat these issues, ports are employing strategies such as capacity expansion, improved traffic management, and enhanced security protocols. Collaboration with customs and border protection agencies is also vital to ensure the seamless flow of goods while safeguarding against illegal activities.

In research conducted by Supriyono (2010), from the research conducted, several study results were obtained, one of which was that the growth of containers each year affected the arrival interval of containers per unit time, the average number of containers in a queue, and the level of utility or performance alar RTG (percentage of time) which increases every year as container flows increase. The increasing flow of containers each year makes the arrival time interval faster and makes the system busier which reduces the probability of RTG delay time percentage each year.
According to Barasa et al. (2018), produced a simple linear regression equation, namely \( Y = -52.9 + 0.052 \times 0.052 \) points. The influence of loading and unloading equipment on loading and unloading productivity is very significant. The causes of not achieving box crane hours are the age of the equipment, availability of spare parts and equipment maintenance.

Meanwhile, according to Hinriyani (2019) in her research, produced a regression equation, namely \( Y = 5.565 + 0.307 \times X_1 + 0.417 \times X_2 + e \). The delay variable \( X_1 \) has a significant relationship with \( Y \) with a t count of 3.560 which is greater than 2.007, with a significance level of 0.001 which is smaller than alpha 0.05, which means that the first hypothesis in this research has been proven to be true or acceptable. The variable effectiveness of loading and unloading performance \( X_2 \) has a significant relationship with income \( Y \) with a t count of 4.060 which is greater than the T table of 2.007, with a significance level of 0.000 which is smaller than alpha 0.05. From these results, the second hypothesis in this study was proven correct and can be accepted. Together (simultaneously) the delay variable \( X_1 \), and the effectiveness of loading and unloading performance \( X_2 \) together (simultaneously) have a significant relationship to the dependent variable, namely income \( Y \). This is proven by the significant F value of 28.064 which is greater than the F table of 3.18 and the significance level of 0.000 is smaller than alpha 0.05.

Fahirah (2020) From the study carried out, several results were obtained as follows: Container handling time at Makassar New Port, among others, on the RTG crane, effective time and idle time were obtained, respectively ranging from 21:34 – 48:00 (MM:SS) and 11:21 – 28:15 (MM:SS), on the reach stacker the effective time and idle time are 07:04 – 09:20 (MM:SS) and 46:35 – 49:35 (MM:SS), respectively. And the productivity of container handling at Makassar New Port includes: the average productivity of RTG cranes is 30 boxes/hour while the average productivity of reach stackers is 103 boxes/hour.

Next there is research by Naicker and Allopi (2015) obtained the results that the operating and purchasing costs for RTGs are slightly higher than Straddle Carriers, but the costs for maintaining Straddle Carriers are much higher than RTGs, it is very difficult to get accurate production levels from both equipment because there are several factors that need to be taken into account, however, judging from statistics taken from typical shifts it is apparent that the production rate with the RTG-TT system far exceeds that of
the Straddle Carriers system. Therefore, it is recommended that Dubban Container Terminal, Pier 2 adopt the RTG-TT system.

2 METHOD

2.1 STATISTICAL ANALYSIS USING SEM AMOS SOFTWARE

SEM (Structural Equation Modeling) is a statistical technique that is capable of analyzing patterns of relationships between latent constructs and their indicators, one latent construct with another, as well as direct measurement error. SEM allows analysis of several dependent and independent variables directly (Hair et al, 2006).

The data analysis technique uses Structural Equation Modeling (SEM), carried out to thoroughly explain the relationship between the variables in the research. SEM is used not to design a theory, but rather to examine and justify a model. Therefore, the main requirement for using SEM is to build a hypothesis model consisting of a structural model and a measurement model in the form of a path diagram based on theoretical justification. SEM is a collection of statistical techniques that allow testing a series of relationships simultaneously. The relationship is established between one or several independent variables (Santoso, 2018)

There are several suitability indices and cut off values that are used to test whether a model is accepted or rejected (Baumgartner & Homburg 1996) Chi-Square ($X^2$), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), CMIN/DF or Relative $X^2$, Tucker Lewis Index (TLI), Comparative Fit Index (CFI), Non-Centrality Parameter (NCP), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA) (Hulland et al, 1996)

2.2 SPSS (STATISTICAL PRODUCT AND SERVICES SOLUTION)

SPSS is an application program used to carry out statistical calculations using a computer. The advantage of this program is that it can perform statistical calculations quickly from simple to complex, which if done manually would take longer (Sarwono, 2005)

There are two tests in SPSS, namely the T test and the F test. The partial test (T test) is a test carried out to see whether an independent variable has an effect on the dependent variable or not by comparing the tcount value with ttable. Meanwhile, the F test (simultaneous test) aims to find out whether the independent variables jointly
influence the dependent variable. The F test is carried out to see the influence of all independent variables together on the dependent variable. The level used is 0.5 or 5%, if the significant value F < 0.05 then it can be interpreted that the independent variable simultaneously influences the dependent variable or vice versa (Ghozali, 2016).

2.3 CORRELATION ANALYSIS

Correlation coefficient analysis is used to determine the direction and strength of the relationship between two or more variables. Direction is expressed in the form of a positive or negative relationship, while the strength or weakness of the relationship is expressed in the magnitude of the correlation coefficient (Sugiyono, 2010). The signs (+) and (-) contained in the correlation coefficient indicate the direction of the relationship between these variables. The (-) sign indicates a relationship in the opposite direction, which means that if one variable goes up, the other goes down. Meanwhile, the sign (+) indicates a unidirectional relationship, which means that if one variable increases, the other variable increases.

3 THEORETICAL FRAMEWORK

3.1 PORT

Port is a water area that is protected against waves, which is equipped with marine terminal facilities including docks where ships can moor to unload goods, cranes for loading and unloading goods, sea warehouses (transit) and storage areas where ships unload cargo, and warehouses where goods can be stored for a longer time while waiting for delivery to the destination area or shipment (Triatmodjo, 2010).

Operational performance can be interpreted as process suitability and performance evaluation of the Company's internal operations in terms of costs, customer service, delivery of goods to customers, quality, flexibility and process quality of goods and services (Nurjannah et al, 2023).

Loading and unloading activities are activities of unloading imported goods and/or interisland/interinsular goods from a ship using a crane and ship slings to the nearest land on the edge of the ship, which is commonly called a pier, then from the pier using a truck, forklift or train pushed, loaded, and arranged into the nearest warehouse designated by the Port Administrator. Meanwhile, loading activity is the opposite activity (Sasono, 2021).
Loading and unloading activities are the activities of loading and unloading goods from and/or onto a ship, including the activity of unloading goods from the hold onto the dock in the ship's hull or vice versa (stevedoring), the activity of moving goods from the dock in the ship's hull to the storage yard or vice versa (cargodoring) and activities picking up goods from the warehouse or field on trucks or vice versa (receiving or delivery) according to Minister of Transportation Decree No. KM 14 of 2002 Chapter 1 Article 1. Meanwhile loading and unloading productivity is the result or output of speed in handling goods (Setiawati, 2017)

Loading and unloading equipment is a tool driven by a machine or motor that is used to make human work easier in carrying out an activity or operation. Loading and unloading equipment is a production tool that functions to bridge the ship with the loading and unloading equipment terminal consisting of lifting and transport equipment starting from ship operations, haulage, lift on, lift off, receipt and delivery (Supriyono, 2014).

There are eight types of container loading and unloading equipment, namely (Lasse & Muatan, 2012): Ship to shore (STS) crane/container crane, Rubber Tyred Gantry (RTG) crane, Rail Mounted Gantry Crane (RMGC), Reach Stacker, Head Truck and Chassis, Top Leader (Lift Truck), Forklift Side Container Loader. The loading and unloading tool used is a rubber tyred gantry. Rubber tyred gantry is a heavy equipment used for loading and unloading containers or moving container boxes from trailers to temporary container storage or vice versa. This Rubber Tyred Gantry is almost the same as a container crane heavy equipment, but its function and movement are more dynamic. Container cranes are used on docks and attached to the edge of the dock, while rubber tyred gantry are more flexible to use and more efficient than other heavy equipment. Several important components contained in an RTG include the engine and control source, gantry, spreader, and wire rope. The engine room and control source are located on the side of the RTG. The gantry functions to move the position of the rubber tyred gantry to each storage block of the container. Spreaders are used to attach and lock containers that will be moved to another place. Wire rope is an important element in resisting tensile forces in lifting and moving loads (Akhbar & Darmana, 2019)

The RTG type is more widely used for operational reasons, it is more flexible in maneuvering, and it is easy to move around the terminal. RTG can serve 5-6 rows in each block with a height of up to five stacks or one-over four. In each block there is one head
truck-chassis line for transporting containers to be loaded (lift on) or unloaded (lift off) using RTG (Lasse, 2017).

4 RESULTS AND DISCUSSION

4.1 PRESENTATION OF DATA RECAPITULATION

The recapitulation data referred to in this research are the number of ships that dock within the specified time, the number of Rubber Tyred Gantry (RTG) equipment used in the loading and unloading process of a ship, the number of head trucks and reach stackers used, as well as the effective time used to carry out the loading and unloading process. Below is a graph of the relationship between the number of head trucks and RTG on container loading and unloading with total data on 112 ships for 2 months. The graph below shows that the highest loading and unloading was more than 1,000 boxes using 15 head truck units and 10 RTG crane units and the lowest loading and unloading was 88 boxes using 8 head truck units and 7 RTG units. The x-axis is the number of containers that will be loaded and unloaded, while the y-axis is the number of head trucks and RTGs used in the loading and unloading process.

Figure 1. Graph of the Relationship Between the Number of Loading and Unloading Containers to the Number of Head Trucks, and RTG Jumlah Head Truck, dan RTG

We can see a graph of the relationship between the number of head trucks and RTG and effective time in the image below, showing that during the two months, namely May and June 2023, the effective time of container ships experienced fluctuations. The
x-axis is the effective loading and unloading time, while the y-axis is the number of head trucks and RTG used in the loading and unloading process.

Figure 2. Graph of the Relationship between Effective Time and Head Truck and RTG

4.2 VARIABLE HYPOTHESIS TESTING

This hypothesis testing was carried out using structural equation modeling (SEM) analysis in the AMOS version 24.0 application. The main aim of using SEM is to obtain a plausible or fit model for the problem being studied in this research. The purpose of analysis with SEM is also to determine the casual relationship between dependent and independent variables in the model built in this research.

Fig. 3. Full Model Testing Analisys

Source: IBM SPSS Amos, 2015
4.3 ANALYSIS OF THE MODEL FOR DETERMINING RTG CRANES AND EFFECTIVE TIME

The variables used to carry out this model analysis are the number of loading and unloading units (X₁), the number of head trucks (X₂), the number of reach stackers (X₃) which are independent variables, the number of RTGs (Y) which are intervening variables, and the effective time (Z) which is the dependent variable. Correlation analysis aims to determine the strength of the relationship between the influence of the number of loading and unloading units (X₁), the number of head trucks (X₂), the number of reach stackers (X₃) on the number of RTG (Y), and the influence of the number of loading and unloading units (X₁), the number of head trucks (X₂), number of reach stackers (X₃), number of RTGs (Y) against effective time (Z) as explained as follows:

4.4 RTG CRANE EQUIPMENT DETERMINATION MODEL

After testing multiple linear regression analysis in SPSS on the variables number of loading and unloading (X₁), number of head trucks (X₂), number of reach stackers (X₃) which are independent variables, on the number of RTGs (Y), the following results were obtained:

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>std. Error</td>
</tr>
<tr>
<td>1 (constant)</td>
<td>5.058</td>
<td>0.928</td>
</tr>
<tr>
<td>X1 (Jumlah B/M)</td>
<td>0.005</td>
<td>0.001</td>
</tr>
<tr>
<td>X2 (Jumlah HT)</td>
<td>0.123</td>
<td>0.074</td>
</tr>
<tr>
<td>X3 (Jumlah RS)</td>
<td>0.816</td>
<td>0.445</td>
</tr>
</tbody>
</table>

Based on the results of the correlation test, the r value is obtained for the variable number of loading and unloading (X₁), number of head trucks (X₂), number of reach stackers (X₃), for the number of RTGs (Y) with a significance level of α = 5%. Based on the results of the correlation test as in the table above, the highest r value is found in the variable number of loading and unloading (X₁) to the number of RTGs (Y), namely 0.673, which means it has a high correlation, and the number of head trucks (X₂) to the number of RTGs (Y) which has a moderate correlation while the variable which has a very weak correlation is the variable number of reach stackers (X₃) which is 0.179. Because there is
a high correlation, variables that have a weak correlation are eliminated, so that the RTG

crane equipment equation model can only be formulated as follows:

\[ Y = a + b_1 X_1 + b_2 X_2 \]
\[ Y = 5.058 + 0.005 X_1 + 0.123 X_2 \] (1)

4.5 DETERMINATION MODEL EFFECTIVE TIME

After testing multiple linear regression analysis in SPSS on the variables number of loading and unloading (X1), number of head trucks (X2), number of reach stackers (X3) which are independent variables, on the number of RTGs (Y), the following results were ob

\[ Y = a + b_1 X_1 + b_2 X_2 \]
\[ Y = 5.058 + 0.005 X_1 + 0.123 X_2 \] (1)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>2.526</td>
<td>1.409</td>
<td></td>
<td>1.793</td>
</tr>
<tr>
<td>Bongkar Muat</td>
<td>0.017</td>
<td>0.001</td>
<td>0.894</td>
<td>15.67</td>
</tr>
<tr>
<td>Head Truck</td>
<td>-0.073</td>
<td>0.101</td>
<td>-0.035</td>
<td>-0.724</td>
</tr>
<tr>
<td>Reach Stacker</td>
<td>0.216</td>
<td>0.080</td>
<td>0.014</td>
<td>0.355</td>
</tr>
<tr>
<td>RTG</td>
<td>0.132</td>
<td>0.129</td>
<td>0.056</td>
<td>1.024</td>
</tr>
</tbody>
</table>

Source: SPSS analysis results, 2023

Based on the results of the correlation test, the \( r \) value is obtained for the variables number of loading and unloading (X1), number of head trucks (X2), number of reach stackers (X3), number of RTGs (Y) on effective time (Z) with a significance level of \( \alpha = 5\% \), then the \( r \) value is obtained as follows:

<table>
<thead>
<tr>
<th>Variabel</th>
<th>X1 (Jumlah BM)</th>
<th>X2 (Jumlah HT)</th>
<th>X3 (Jumlah RS)</th>
<th>Y (RTG)</th>
<th>Z (Effective Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1 (Jumlah BM)</td>
<td>1</td>
<td>0.558</td>
<td>0.083</td>
<td>0.672</td>
<td>Tabel 0.912</td>
</tr>
<tr>
<td>X2 (Jumlah RS)</td>
<td>0.558</td>
<td>1</td>
<td>0.016</td>
<td>0.467</td>
<td>0.907</td>
</tr>
<tr>
<td>X3 (Jumlah RS)</td>
<td>0.083</td>
<td>0.016</td>
<td>1</td>
<td>0.178</td>
<td>0.643</td>
</tr>
<tr>
<td>Y (RTG)</td>
<td>0.672</td>
<td>0.467</td>
<td>0.178</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Z (Effective Time)</td>
<td>Tabel 0.912</td>
<td>0.907</td>
<td>0.643</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Source: Data Analysis, 2023
Based on the results of the correlation test as in the table above, the highest r value is found in the variable number of loading and unloading (X₁) to effective time (Z), namely 0.912, which means it has a very high correlation, and the variable number of RTG (Y) to effective time (Z) is 0.643, which means it has a high correlation. While the variable that has a weak correlation is the variable number of reach stackers (X₃) to effective time (Z), namely 0.097. Because there is a high correlation, variables that have a weak correlation are eliminated, so that the effective time equation model can only be formulated as follows:

\[ Z = a + b_1X_1 + b_2X_2 + b_3Y \]

\[ Z = 2,526+ 0,017 X_1 - 0,073 X_2 + 0,132 Y \]  

(2)

4.6 F TEST ANALYSIS

The F test or simultaneous significant test is a test carried out to see the overall influence of the independent variable (X). In the effective time model analysis, the variables that will be included are the number of loading and unloading units, the number of head trucks, the number of reach stackers, and the number of RTGs, while for RTGs, the variables included are the number of loading and unloading units, the number of head trucks, the number of reach stackers.

Table 4. Results of the F Test for Independent Variables on the Number of RTG

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>283,086</td>
<td>3</td>
<td>94,362</td>
<td>33,322</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Residual</td>
<td>305,834</td>
<td>108</td>
<td>2,832</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>588,920</td>
<td>111</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: SPSS analysis results, 2023

To test the statistical hypothesis above, an F test was carried out at the \( \alpha = 5\% \) level. If \( F \text{ count} > F \text{ table} 5\% \), then the regression line equation model is accepted or variable X together can predict Y.

\[ F \text{ tabel} = F ( k;n-k) \]

\[ F = (4;107) \]

\[ F = 2,46 \]  

(3)
The F test (F hit) result of this research is 33.322 with a significance level of 0.001, while the F table (F tab) value obtained through the Distribution Value Table is 2.46. Based on the existing criteria, it can be concluded that F calculated is greater than F table (F calculated > f table), meaning that there is a simultaneous influence of the independent variable on the dependent variable.

Table 5. Independent Variable F Test Results on Effective Time

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>2795.088</td>
<td>4</td>
<td>698.772</td>
<td>136.44&lt;</td>
<td>.001</td>
</tr>
<tr>
<td>Residual</td>
<td>548.100</td>
<td>107</td>
<td>5.122</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3343.187</td>
<td>111</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: SPSS analysis results, 2023

To test the statistical hypothesis above, an F test was carried out at the $\alpha = 5\%$ level. If $F$ count > $F$ table 5%, then the regression line equation model is accepted or variable X together can predict Y.

$$F_{table} = F (k;n-k)$$

$$F = (4;107)$$

$$F = 2.46$$

(4)

The F test (F hit) result of this research is 136.414 with a significance level of 0.001, while the F table (F tab) value obtained through the Distribution Value Table is 2.46. Based on the existing criteria, it can be concluded that F count is greater than F table (F count > F table) there is a simultaneous influence of the independent variable on the dependent variable.

4.7 T TEST ANALYSIS

The t test is used in research to determine the ability of each independent variable to influence the dependent variable. The t test is used to test whether the independent variables individually have a significant relationship or not with the dependent variable. The formula used is as follows:

$$t_{table} = (a/2 ; n-k-1)$$

$$t_{table} = (0.05/2 ; 112-4-1)$$
t_{table} = (0.025 ; 107)

$t_{table} = 1.98$

Tabel 6. Partially Significant Test Results (T Test)

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unstandardized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>2.526</td>
<td>1.409</td>
<td>1.793</td>
<td>0.076</td>
</tr>
<tr>
<td>Bongkar Muat</td>
<td>0.017</td>
<td>0.001</td>
<td>0.894</td>
<td>0.001</td>
</tr>
<tr>
<td>Head Truck</td>
<td>-0.073</td>
<td>0.101</td>
<td>-0.035</td>
<td>0.471</td>
</tr>
<tr>
<td>Reach Stacker</td>
<td>0.216</td>
<td>0.608</td>
<td>0.014</td>
<td>0.355</td>
</tr>
<tr>
<td>RTG</td>
<td>0.132</td>
<td>0.129</td>
<td>0.056</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Source: SPSS analysis results, 2023

Decision making criteria:
1. If t count > t table then there is an influence of the independent variable on the dependent variable.
2. If t count < t table then there is no influence of the independent variable on the dependent variable.

Testing effective time:
1. The sig value for the influence of the amount of loading and unloading on effective time (ET) is t calculated 15.67 > 1.98 so it can be concluded that there is an influence of the number of loading and unloading variables on the effective time variable.
2. The sig value for the influence of the number of head trucks on effective time (ET) is t -0.724 < 1.98 so it can be concluded that there is a lack of influence of the number of loading and unloading variables on the effective time variable.
3. The sig value for the influence of the number of reach stackers on effective time (ET) is t calculated 0.355 < 1.98 so it can be concluded that there is a lack of influence of the variable number of reach stackers on the effective time variable.
4. The sig value for the influence of the number of RTGs on effective time (ET) is t calculated 1.024 < 1.98 so it can be concluded that there is a lack of influence of the variable number of RTGs on the effective time variable.

5 CONCLUSION

Based on the results of data analysis on the Rubber Tyred Gantry (RTG) crane at TPK New Makassar Terminal 2, the following conclusions were obtained:
1. For the influence of the number of loading and unloading equipment, the number of head trucks and the number of reach stackers on the number of Rubber Tyred Gantry (RTG) Cranes at TPK New Makassar Terminal 2, it can be concluded that what has an influence on the Rubber Tyred Gantry (RTG) equipment is the number of loading and unloading equipment (X1).

2. For the influence of the number of loading and unloading units, the number of head trucks, and the number of reach stackers on the effective time, after carrying out the test, the one that has an influence on the effective time is the number of loading and unloading units (X1). The number of head trucks has a significant influence on effective time (Z) if through the intervening variable the number of RTGs (Y).

3. From the hypothesis test carried out, the effect of the number of Rubber Tyred Gantry (RTG) Cranes (Y) on the effective time (Z) is less significant or less influential because it does not meet the required value.

4. To find out the model for determining the number of RTG devices, a correlation analysis was carried out. The results of the correlation analysis for the number of loading and unloading (X1), number of head trucks (X2) and number of reach stackers (X3), with the number of RTGs (Y) show that the variable that has the highest correlation is the variable number of loading and unloading (X1) with the number of head trucks (X2), while with respect to effective time, the one that has the highest correlation is also the variable number of loading and unloading (X1) with the number of head trucks (X2) and the one that has the weakest correlation is the number of reach stackers (X3) so that it is eliminated, we obtain a performance equation model RTG, \( Y = a + b_1X_1 + b_2X_2 = 5.058 + 0.005X_1 + 0.123 \).
REFERENCES


Naicker, R., & Allopi, D. (2015). Evaluating straddle carriers and rubber Tyredgantrys to determine which would be the most suitable container handling infrastructure between the quay and stack area at the Durban Container Terminal; Pier 2. Corporate board: role, duties & composition (Online).


