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Factors Affecting Loading and Unloading Productivity: A Case Study of PT. Tangguh Samudera Jaya

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***Abstract*—PT. Tangguh Samudera Jaya is a stevedoring company which operates the wharf 303, 304, and 305 at Terminal 3 in Tanjung Priok Port. Terminal 3 is predominantly serving international container stevedoring and small portions of domestic containers. Every time a vessel berths at Terminal 3 Tanjung Priok Port, especially at the wharf 303, 304, and 305, there is a decrease in the productivity of loading and unloading, which causes Key Performance Indicators (KPI) that company set can't be achieved. Therefore, this study uses the method of Multiple Linear Regression Analysis and Stepwise Regression, to determine the effect of loading and unloading time at the wharfs, loading and unloading time in a container yard, truck cycle time, and the number of ganks on productivity of loading and unloading and identifying the variables that have the greatest influence on loading and unloading productivity at the port. It was found that the independent variables can explain the dependent variable which is the loading and unloading productivity with a value of 99.9% while 1% is found in other variables besides the variables mentioned in this study. Overall or partially the independent variables significantly influence the loading and unloading productivity, and the variable that has the greatest influence on the loading and unloading productivity is loading and unloading time at wharfs.**

Keywords—loading and unloading productivity, Box Container Hour (B/C/H), Multiple Linear Regression Analysis, Stepwise Regression

I. INTRODUCTION

Tanjung Priok Port is a major national and international port that serves as a gateway for national and international economic connectivity that serves as the backbone of national development, with a total volume of freights 60% to and from Indonesia. Tanjung Priok Port also has such an important position in the national transportation and logistics system that demands the Tanjung Priok Port on an ongoing basis must be able to facilitate Indonesia's economic and trade activities, and in the end it is expected that Tanjung Priok Port can encourage the national trade and industry sector to face international free trade.

PT. Tangguh Samudera Jaya is a stevedoring company which operates wharf 303, 304, and 305 at Terminal 3 in Tanjung Priok Port [1]. Priok Terminal 3 is predominantly serving international container stevedoring and a small portion of domestic containers. Stevedoring Company is one of the organizations in port activities that handles the loading and unloading of vessels, and oversees the work of loading and unloading labor.

During the last few months, there has been a decrease in the loading and unloading productivity at wharf 303, 304, 305 which are operated by PT. Tangguh Samudera Jaya [2], where the loading and unloading productivity is below the standard set by the company which is 20 boxes/ containers/ hour.

TABLE 1. LOADING AND UNLOADING PRODUCTIVITY (B/C/H) IN JULY, AUGUST, SEPTEMBER 2018 AT TERMINAL 3 OF TANJUNG PRIOK PORT

JULI		AGUSTUS		SEPTEMBER	
VESSEL	**B/C/H**	**VESSEL**	**B/C/H**	**VESSEL**	**B/C/H**
CTP GOLDEN	16.24	SENDANG MAS	20.07	JONATHAN SWIFT	10.74
CARPENTERS SIRIUS	10.08	ST GREEN	17.94	ST GREEN	15.56
SENDANG MAS	18.5	ALS JUVENTUS	12.65	JOHAN FORTUNE	29.23
ST GREEN	13.42	CTP HONOUR	17.79	ALS APOLLO	11.93
CTP DELTA	15.84	SEGARA MAS	18.47	SEGARA MAS	16.04
SMILEY LADY	12.13	PUTNAM	22.13	CTP GOLDEN	27.05
SEGARA MAS	17.31	CTP GOLDEN	17.26	ISLAND CHIEF	18.27
CTP FORTUNE	14.79	BAVARIA	13.94	MAERSK ABERDEEN	16.64
CTP GOLDEN	11.91	CTP DELTA	17.32	CTP INNOVATION	25.00

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JULI		AGUSTUS		SEPTEMBER	
VESSEL	**B/C/H**	**VESSEL**	**B/C/H**	**VESSEL**	**B/C/H**
CTP INNOVATION	25.38	SMILEY LADY	11.11	HOLSATIA	11.06
SENDANG MAS	17.17	GH MISTRAL	18.54	CTP DELTA	18.88
CTP DELTA	17.34	CARPENTERS SIRIUS	10.47	GH MISTRAL	18.83
ST GREEN	13.81	ST GREEN	15.19	SHAOSHING	6.76
CTP FORTUNE	11.89	SEGARA MAS	17.83	ST GREEN	14.87
SEGARA MAS	15.47	CTP HONOUR	20.07	SZECHUEN	15.51
SHAOSHING	12.79	HANNE DANICA	1.84	ALS JUVENTUS	15.21
FLORA DELMAS	9.73	MAERSK ABERDEEN	13.22	CTP GOLDEN	20.92
CTP GOLDEN	18.83	CTP GOLDEN	19.45	SEGARA MAS	18.04
		CTP DELTA	16.08	SMILEY LADY	14.00
		SINGAPORE BRIDGE	15.44	CTP HONOUR	15.66
		GH MISTRAL	19.09	CTP INNOVATION	16.95
		FLORA DELMAS	14.46	GH MISTRAL	16.19
				CTP DELTA	19.35
				MAERSK ABERDEEN	17.85
				ST GREEN	13.62

Source: Terminal Departure Report (TDR) of Terminal 3 of Tanjung Priok Port

In a previous study conducted by Gunawan [3], using factors that allegedly affected the loading and unloading process at PT. Pelayaran Meratus which are the number of ganks, full empty ratio, total container weights, loading/ unloading equipment, and loading/ unloading time. It was concluded that the container weight factor is the most influential factor on all ships.

This study uses four factors that are suspected to influence loading and unloading productivity, which are loading and unloading time at wharf (using Harbour Mobile Crane and Quay Container Crane), loading and unloading time in Container Yard (using Rubber Tyred Gantry and Reach Stacker), truck cycle time, and the number of ganks.

II. METHODS

The data used in this study are primary data and secondary data. The primary data obtained is by conducting field observations namely counting loading and unloading time on each equipment used in wharf (Harbour Mobile Crane/ HMC and Quay Container Crane/ QCC) and in container yard (Rubber Tire Gantry/ RTG and Reach Stacker/ RS), counting the truck cycle time in the cargodoring process.

For secondary data taken directly from PT. Tangguh Samudera Jaya is the data of vessels in July, August, and September 2018, namely the TDR (Terminal Departure Report) data to find out information about berth and the realization of productivity of loading and unloading, Crane Sequence data to find out reports of the process of loading and unloading of vessels.

For the input variables (independent variables) used, they are:

1. Variable X1: loading and unloading time at the wharfs (HMC, QCC)
2. Variable X2: loading and unloading time in container yard (RTG, RS)
3. Variable X3: truck cycle time
4. Variable X4: number of ganks

A. Ordinary Least Square (OLS) Test

1. Normality Test

Normality test is conducted to determine whether the residual value is normally distributed or not.

According to Gendro Wijoyo [4] for testing normality with One Sample Kolmogrof-Smirnov can be stated normally distributed if the significance is greater than 0.05 (5%).

2. Multicollinearity Test

According to Imam Ghozali [5] "Multicollinearity test aims to test whether the regression model found a correlation between independent variables (independent)." A good regression model should not occur the correlation between independent variables. If the independent variables are correlated with each other, then these variables are not orthogonal.

3. Autocorrelation Test

According to Imam Ghozali [5] Autocorrelation test aims to test whether in the linear regression model there is a correlation between the error of the intruder in the period t with an error in the period t-1 (previous).

4. Heteroskedacity Test

Based on the explanation of Imam Ghozali [5], "The heteroskedacity test aims to test whether in the regression model there is an inequality of variance and other residuals".

B. Factor Analysis

The main purpose of factor analysis is to describe the structure of relationships among many variables in the form factors or latent variables or variable formations. Factors that formed a random quantity (random quantities) that previously could not be observed or measured or determined directly.

C. Multiple Regression Analysis

Multiple Regression Analysis is used because the regression model used consists of one dependent variable and has more than one independent variable to find the correlation between the dependent variable and the

independent variable, and to find out the regression model used in the study are as follows:

$$Y = \beta + \beta_1 X_1 + ... + \beta_n X_n + e \quad (1)$$

1. t-Test

T-test aims to find out whether or not there is a partial effect (alone) given the independent variable (x) to the dependent variable (y). On the basis of decision making: If the Sig value <0.05 or t arithmetic> t table then there is the influence of the independent variable (x) on the dependent variable (y), and if the Sig value> 0.05 or t arithmetic <t table then there is no influence of the independent variable (x) with respect to the dependent variable (y).

2. F-Test

The F test aims to determine whether there is a simultaneous influence (together) given the independent variable (x) on the dependent variable (y). On the basis of decision making: If the value of Sig. <0.05 or F arithmetic> F table then there is a simultaneous influence of the independent variable (x) on the dependent variable (y), and if the Sig. > 0.05 or F arithmetic <F table then there is no simultaneous effect of the independent variable (x) on the dependent variable (y).

3. Stepwise

Regression analysis using the stepwise method is used to find out which statement of the independent variable most influences the dependent variable. Stepwise regression involves two types of processes namely forward selection and backward elimination. The incoming variable is the variable that has the highest and significant correlation with the dependent variable, after certain variables enter the model, the other variables in the model are evaluated, if there are insignificant variables, the variable is excluded.

III. RESULTS AND DISCUSSIONS

A. Loading and Unloading Time at Wharfs

The loading and unloading equipments at wharfs are HMC and QCC by taking sample from 56 containers from each vessel that berthed. The following is the average time data from all loading and unloading processes on each vessel.

TABLE 2. LOADING AND UNLOADING TIME (SECONDS) AT WHARFS

No	Vessel	Time	No	Vessel	Time
1	CTP GOLDEN	140.40	34	HANNE DANICA	145.80
2	CARPENTERS SIRIUS	141.60	35	MAERSK ABERDEEN	139.80
3	SENDANG MAS	145.20	36	CTP GOLDEN	134.40
4	ST GREEN	133.20	37	CTP DELTA	151.80
5	CTP DELTA	154.80	38	SINGAPORE BRIDGE	141.60
6	SMILEY LADY	139.80	39	GH MISTRAL	154.20
7	SEGARA MAS	140.40	40	FLORA DELMAS	137.40
8	CTP FORTUNE	153.60	41	JONATHAN SWIFT	183.60
9	CTP GOLDEN	149.40	42	ST GREEN	151.80
10	CTP INNOVATION	188.40	43	JOHAN FORTUNE	144.60
11	SENDANG MAS	137.40	44	ALS APOLLO	188.40
12	CTP DELTA	183.60	45	SEGARA MAS	139.80
13	ST GREEN	151.80	46	CTP GOLDEN	145.80
14	CTP FORTUNE	144.60	47	ISLAND CHIEF	139.80
15	SEGARA MAS	188.40	48	MAERSK ABERDEEN	134.40
16	SHAOSHING	139.80	49	CTP INNOVATION	151.80
17	FLORA DELMAS	145.80	50	HOLSATIA	141.60
18	CTP GOLDEN	139.80	51	CTP DELTA	154.20
19	SENDANG MAS	134.40	52	GH MISTRAL	139.80
20	ST GREEN	151.80	53	SHAOSHING	145.80
21	ALS JUVENTUS	141.60	54	ST GREEN	139.80
22	CTP HONOUR	154.20	55	SZECHUEN	134.40
23	SEGARA MAS	139.80	56	ALS JUVENTUS	151.80
24	PUTNAM	140.40	57	CTP GOLDEN	141.60
25	CTP GOLDEN	153.60	58	SEGARA MAS	154.20
26	BAVARIA	149.40	59	SMILEY LADY	151.80
27	CTP DELTA	188.40	60	CTP HONOUR	144.60
28	SMILEY LADY	137.40	61	CTP INNOVATION	188.40
29	GH MISTRAL	183.60	62	GH MISTRAL	139.80
30	CARPENTERS SIRIUS	151.80	63	CTP DELTA	145.80
31	ST GREEN	144.60	64	MAERSK ABERDEEN	139.80
32	SEGARA MAS	188.40	65	ST GREEN	144.60
33	CTP HONOUR	139.80			

B. Loading and Unloading Time at Container Yard

The loading and unloading tool at CY is RTG and RS by taking sample from 56 containers in the loading and unloading process to/ from the chassis truck for each vessel that berthed.

TABLE 3. LOADING AND UNLOADING TIME (SECONDS) AT CONTAINER YARD

No	Vessel	Time	No	Vessel	Time
1	CTP GOLDEN	198.00	34	HANNE DANICA	241.80
2	CARPENTERS SIRIUS	144.00	35	MAERSK ABERDEEN	147.60
3	SENDANG MAS	85.20	36	CTP GOLDEN	199.80
4	ST GREEN	153.00	37	CTP DELTA	183.60
5	CTP DELTA	138.00	38	SINGAPORE BRIDGE	195.60
6	SMILEY LADY	132.00	39	GH MISTRAL	195.00
7	SEGARA MAS	81.00	40	FLORA DELMAS	141.60
8	CTP FORTUNE	154.20	41	JONATHAN SWIFT	87.60
9	CTP GOLDEN	184.80	42	ST GREEN	88.20
10	CTP INNOVATION	258.60	43	JOHAN FORTUNE	85.20
11	SENDANG MAS	141.60	44	ALS APOLLO	138.00
12	CTP DELTA	87.60	45	SEGARA MAS	138.00
13	ST GREEN	88.20	46	CTP GOLDEN	241.80
14	CTP FORTUNE	85.20	47	ISLAND CHIEF	147.60
15	SEGARA MAS	138.00	48	MAERSK ABERDEEN	199.80
16	SHAOSHING	138.00	49	CTP INNOVATION	183.60
17	FLORA DELMAS	241.80	50	HOLSATIA	195.60
18	CTP GOLDEN	147.60	51	CTP DELTA	195.00
19	SENDANG MAS	199.80	52	GH MISTRAL	138.00
20	ST GREEN	183.60	53	SHAOSHING	241.80
21	ALS JUVENTUS	195.60	54	ST GREEN	147.60
22	CTP HONOUR	195.00	55	SZECHUEN	199.80
23	SEGARA MAS	132.00	56	ALS JUVENTUS	183.60
24	PUTNAM	81.00	57	CTP GOLDEN	195.60
25	CTP GOLDEN	154.20	58	SEGARA MAS	195.00
26	BAVARIA	184.80	59	SMILEY LADY	88.20
27	CTP DELTA	258.60	60	CTP HONOUR	85.20
28	SMILEY LADY	141.60	61	CTP INNOVATION	138.00
29	GH MISTRAL	87.60	62	GH MISTRAL	138.00
30	CARPENTERS SIRIUS	88.20	63	CTP DELTA	241.80
31	ST GREEN	85.20	64	MAERSK ABERDEEN	147.60
32	SEGARA MAS	138.00	65	ST GREEN	85.20
33	CTP HONOUR	138.00			

C. Truck Cycle Time

Trucks used are trucks owned by PT. Samudera Perdana is a type of hino and volvo truck, by taking a sample of 19 rounds from each vessel that is berthed to see when the trucking turns on the loading and unloading process.

TABLE 4. TRUCK CYCLE TIME (SECONDS)

No	Vessel	Time	No	Vessel	Time
1	CTP GOLDEN	964.80	34	HANNE DANICA	973.20
2	CARPENTERS SIRIUS	1450.20	35	MAERSK ABERDEEN	904.20
3	SENDANG MAS	621.60	36	CTP GOLDEN	991.80
4	ST GREEN	484.20	37	CTP DELTA	870.60
5	CTP DELTA	690.00	38	SINGAPORE BRIDGE	806.40
6	SMILEY LADY	486.00	39	GH MISTRAL	784.80
7	SEGARA MAS	602.40	40	FLORA DELMAS	933.60
8	CTP FORTUNE	841.20	41	JONATHAN SWIFT	982.20
9	CTP GOLDEN	690.60	42	ST GREEN	1215.60
10	CTP INNOVATION	688.20	43	JOHAN FORTUNE	724.80
11	SENDANG MAS	933.60	44	ALS APOLLO	488.40
12	CTP DELTA	982.20	45	SEGARA MAS	322.80
13	ST GREEN	1215.60	46	CTP GOLDEN	973.20
14	CTP FORTUNE	724.80	47	ISLAND CHIEF	904.20
15	SEGARA MAS	488.40	48	MAERSK ABERDEEN	991.80
16	SHAOSHING	322.80	49	CTP INNOVATION	870.60
17	FLORA DELMAS	973.20	50	HOLSATIA	806.40
18	CTP GOLDEN	904.20	51	CTP DELTA	784.80
19	SENDANG MAS	991.80	52	GH MISTRAL	322.80
20	ST GREEN	870.60	53	SHAOSHING	973.20
21	ALS JUVENTUS	806.40	54	ST GREEN	904.20

No	Vessel	Time	No	Vessel	Time
22	CTP HONOUR	784.80	55	SZECHUEN	991.80
23	SEGARA MAS	486.00	56	ALS JUVENTUS	870.60
24	PUTNAM	602.40	57	CTP GOLDEN	806.40
25	CTP GOLDEN	841.20	58	SEGARA MAS	784.80
26	BAVARIA	690.60	59	SMILEY LADY	1215.60
27	CTP DELTA	688.20	60	CTP HONOUR	724.80
28	SMILEY LADY	933.60	61	CTP INNOVATION	488.40
29	GH MISTRAL	982.20	62	GH MISTRAL	322.80
30	CARPENTERS SIRIUS	1215.60	63	CTP DELTA	973.20
31	ST GREEN	724.80	64	MAERSK ABERDEEN	904.20
32	SEGARA MAS	488.40	65	ST GREEN	724.80
33	CTP HONOUR	322.80			

D. Number of Ganks

Number of ganks is number workers in one work team.

TABLE 5. NUMBER OF GANKS

JULI		AGUSTUS		SEPTEMBER	
VESSEL	**GANK**	**VESSEL**	**GANK**	**VESSEL**	**GANK**
CTP GOLDEN	2.00	SENDANG MAS	4.00	JONATHAN SWIFT	1.00
CARPENTERS SIRIUS	2.00	ST GREEN	3.00	ST GREEN	3.00
SENDANG MAS	4.00	ALS JUVENTUS	1.00	JOHAN FORTUNE	1.00
ST GREEN	4.00	CTP HONOUR	5.00	ALS APOLLO	1.00
CTP DELTA	2.00	SEGARA MAS	3.00	SEGARA MAS	3.00
SMILEY LADY	1.00	PUTNAM	1.00	CTP GOLDEN	1.00
SEGARA MAS	4.00	CTP GOLDEN	3.00	ISLAND CHIEF	3.00
CTP FORTUNE	3.00	BAVARIA	1.00	MAERSK ABERDEEN	3.00
CTP GOLDEN	4.00	CTP DELTA	1.00	CTP INNOVATION	1.00
CTP INNOVATION	1.00	SMILEY LADY	1.00	HOLSATIA	1.00
SENDANG MAS	4.00	GH MISTRAL	3.00	CTP DELTA	2.00
CTP DELTA	1.00	CARPENTERS SIRIUS	2.00	GH MISTRAL	2.00
ST GREEN	4.00	ST GREEN	4.00	SHAOSHING	3.00
CTP FORTUNE	3.00	SEGARA MAS	3.00	ST GREEN	3.00
SEGARA MAS	4.00	CTP HONOUR	2.00	SZECHUEN	2.00
SHAOSHING	2.00	HANNE DANICA	2.00	ALS JUVENTUS	1.00
FLORA DELMAS	2.00	MAERSK ABERDEEN	3.00	CTP GOLDEN	2.00
CTP GOLDEN	3.00	CTP GOLDEN	2.00	SEGARA MAS	3.00
		CTP DELTA	2.00	SMILEY LADY	2.00
		SINGAPORE BRIDGE	1.00	CTP HONOUR	2.00
		GH MISTRAL	3.00	CTP INNOVATION	1.00
		FLORA DELMAS	1.00	GH MISTRAL	2.00
				CTP DELTA	2.00
				MAERSK ABERDEEN	2.00
				ST GREEN	3.00

E. Ordinary Least Square (OLS) Test Result

There are some test are carried out in OLS test:

1. normality test
2. multicollinearity test
3. autocorrelation test
4. heteroskedacity test

TABLE 6. NORMALITY TEST RESULT

Model	Asymp.Sig (2-tailed)	Criteria	Conclusion
Undstandardized Residual	0,200	>0,05	normal distribution

TABLE 7. MULTICOLLINEARITY TEST RESULT

Variable	Tolerance	VIF	Criteria	Conclusion
loading and unloading time at the wharfs (HMC, QCC)	0,958	1,044	Tolerance ≥ 0,1 VIF ≤ 10	No Multicollinearity Occurs
loading and unloading time in container yard (RTG, RS)	0,956	1,046		

Variable	Tolerance	VIF	Criteria	Conclusion
truck cycle time	0,980	1,020		
number of ganks	0,937	1,067		

TABLE 8. AUTOCORRELATION TEST RESULT

DW	DL	DU	4-DL	4-DU
2,197	1,4758	1,7319	2,5242	2,2681

The results of data processing show that there is no autocorrelation in the regression model because the Durbin Watson (DW) value is between the Durbin Upper (DU) value and the 4-Durbin Upper (DU) value.

TABLE 9. HETEROSKEDACITY TEST RESULT

Variable	Sig.	Criteria	Conclusion
loading and unloading time at the wharfs (HMC, QCC)	0,761	≥ 0,05	No symptoms of heteroscedasticity occur
loading and unloading time in container yard (RTG, RS)	0,843		
truck cycle time	0,172		
number of ganks	0,666		

F. Factor Analysis Result

Initial Eigenvalues indicate the factors formed. If all the factors added together indicate the number of variables (i.e. 1,231 + 1,159 + 0,872 + 0,738 = 4 variables). Whereas the Extraction Sums of Squared Loadings section shows the number of variations or the number of factors that can be formed from 4 variables, where the requirement to be a factor is the Eigenvalue value must be greater than 1. The Eigenvalue Component 1 value of 1.231 or more than 1 will be a factor of 1 and is able to explain 30.787% variation. While the Eigenvalue Component 2 value of 1.159 or more than 1 becomes a factor of 2 and is able to explain 59.752% variation.

TABLE 10. FACTOR ANALYSIS RESULT

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1,231	30,787	30,787	1,231	30,787	30,787
2	1,159	28,966	59,752	1,159	28,966	59,752
3	0,872	21,801	81,554			
4	0,738	18,446	100,000			

The scree plot image also shows the number of factors formed, by looking at the value of component points that have an Eigenvalue> 1. From the images that have been obtained there are two component points that have an Eigenvalue> 1, it can be interpreted that there are two factors that can formed.

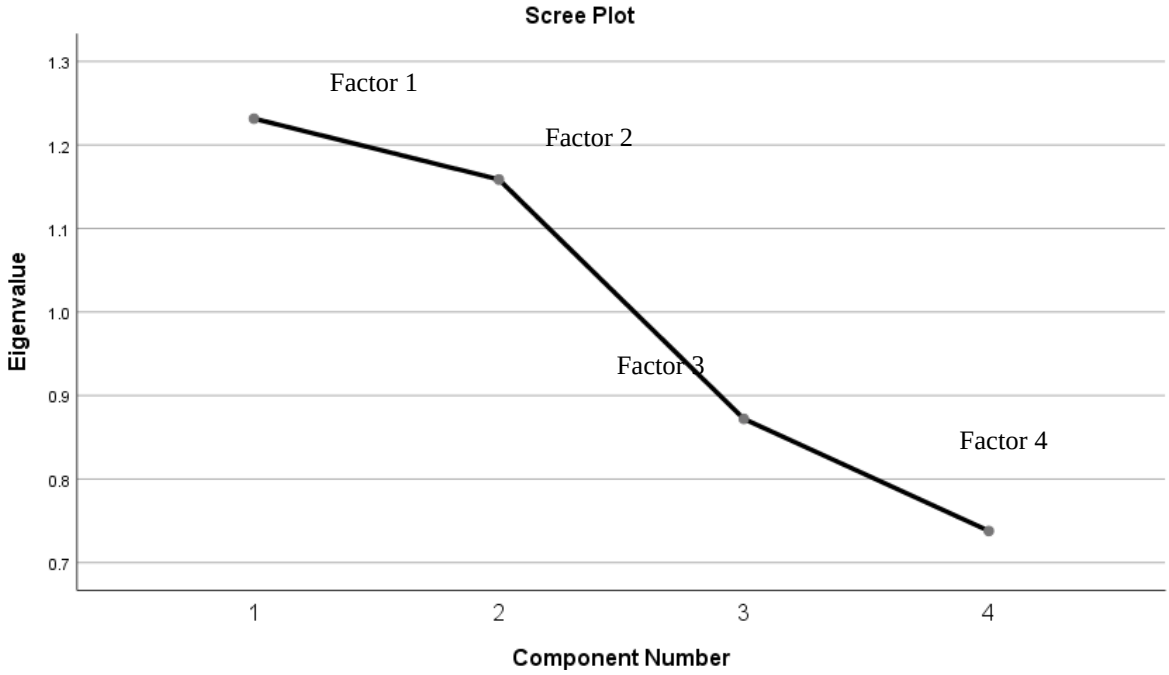

Fig 1. Scree Plot

G. Multiple Regression Analysis Result

Based on the regression analysis results using the stepwise method, it can be seen that the loading and unloading time at wharfs or the X1 variable have a statistical influence on the regression equation model with an X1 coefficient value of 0.107 and an R2 value of 0.999. With the equation obtained, Y = 0.005 + 0.107 X1.

TABLE 11. MULTIPLE REGRESSION ANALYSIS RESULT

Variable	Coefficients	R-Square	Adjusted R-Square	T Stat	Sig. t	F	Sig. F.
Intercept	0,005	0.999	0.999			24153.364	0.000
X1	0.107			0.531	0.597		

IV. CONCLUSIONS

The variable that has the most influence on loading and unloading productivity is the loading and unloading time at wharfs variable. The slower the loading and unloading equipment (HMC and QCC) at wharfs will decrease the loading and unloading productivity. To increase the loading and unloading process time that has an affect on loading and unloading productivity, PT. Tangguh Samudera Jaya should pay more attention to the condition of the loading and unloading equipment (QCC and HMC) especially in terms of maintenance or the company can add the equipment used so that the loading and unloading productivity can reach KPI which have been set. In addition, companies should pay attention to the human resources involved in the loading and unloading process, especially the crane operators (QCC and HMC), good human resources will make the performance better and the results of loading and unloading productivity will increase.

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