Calculate The Estimated Loading Time of Caustic Soda According on The Amount of Caustic Soda Loaded on MT AKRA 102

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ABSTRACT

Sodium Hydroxide is a chemical with the chemical formula NaOH. At room temperature Sodium Hydroxide is a white powder (ATSDR, 2014), known as Caustic Soda, because it gives a burning effect on the skin and causes yellow spots on fabrics and paper (PHE, 2019). Caustic soda is included in the category of hazardous materials categorized by the International Maritime Organization when transported by ship. In order to reduce costs, it is sought to streamline the loading time of Caustic soda into the ship without ignoring the established safety procedures. For this reason, it is necessary to calculate the loading time, to ensure that the time required during the implementation of loading activities is not too much different from the predetermined time. To estimate the loading time can be done by calculating the maximum transfer rate of caustic soda can also be calculated based on time reports from previous loading activities. It is expected that with an estimate of loading time that can be calculated accurately based on the amount of caustic soda loaded, the calculation of costs associated with loading activities can be estimated more accurately.

1. INTRODUCTION

Sodium Hydroxide is a chemical with the chemical formula NaOH. At room temperature Sodium Hydroxide is an odorless white powder and is able to absorb air moisture (ATSDR, 2014). Sodium Hydroxide is also known as Caustic Soda, because it gives a burning effect on the skin and causes yellow spots on fabrics and paper (PHE, 2019). Caustic Soda is used in Industry Caustic soda is generally in the form of white solids, or powders, and can also be in the form of liquids which are mostly used in the chemical industry which are useful in various fields of industry in daily life including being used as petroleum refiners, textile and cotton bleaching agents, cleaning fluid materials and other industrial purposes. Caustic soda is categorized of hazardous

materials by the International Maritime Organization when shipped by ship. For shipments of Caustic Soda using ships, the ships used must use stainles steel material with a maximum Caustic Soda concentration of 50% at a temperature of 65-75°C. The ship used must be cleaned by spraying hot water at 50°C for 20 minutes, flushing using fresh water, draining tanks, pumps and loading pipelines. Personnel in charge handling Caustic Soda are required to have the qualifications set out in STCW Chapter V Section A-V and safety procedures must be strictly implemented. (www.cargohandbook.com).

To reduce the cost of shipping Caustic soda from producers to consumers, one thing that can be done is to streamline the loading time of Caustic soda into the ship without ignoring the established safety procedures. It is expected that with the shorter time required for the loading process, the costs charged to the loading operator are less and the cost of berthing at the port is also cheaper. For this reason, it is necessary to calculate the loading time, to ensure that the time required during the implementation of loading activities is not too much different from the predetermined time. To estimate the loading time can be done by calculating the maximum transfer rate of caustic soda can also be calculated based on time reports from previous loading activities. It is expected that with an estimate of loading time that can be calculated accurately based on the amount of caustic soda loaded, the calculation of costs associated with loading activities can be estimated more accurately. If there is a shift from the predetermined time, it is hoped that the time shift will not exceed the predetermined tolerance.

2. METHODE

The method used in this research is to take secondary data related to the loading time of the MT AKRA 1.02 Tanker at PT Radyan Jaya Samudera, especially tankers that carry out the Liquid Caustic Soda. The data period used starts from August 1, 2022 to September 30, 2023. To get an estimate of loading time, it is necessary to conduct statistical tests in the form of Descriptive Statistics, calculate the Correlation Test of Cargo of Caustic Soda on Caustic Soda Loading Time, Linear Regression Test of Cargo of Caustic Soda on Caustic Soda Loading Time, Kolmogorov-Smirnov Unstandardized Residual Normality Test. Data processing in statistically using IBM SPSS 23 software and using Microsoft Excel.

3. RESULT AND DISCUSSION

Knowledge of dangerous cargo plays a major role in the regulation of dangerous cargo for transportation safety (Zhang et al, 2019). Human factors are still the main cause of shipping accidents related to dangerous goods (Khan et al, 2022). A frequent violation is the presence of dangerous goods that are not informed in detail and transparently to the authorities (Maternova et al, 2022) International Maritime Organization (www.imo.org) classifies dangerous cargo into 9 (nine) categories. Caustic soda is classified into the 8th category because Casutic Soda is corrosive. If caustic soda swallowed can cause oesophageal necrosis, severe gastric injuries accompanied by gastrectomy and digiunostomy (Rodanelli et al, 2016), the level of injury due to ingestion of caustic soda depends on the concentration level of caustic soda and the duration of Caustic soda (Martínez-Caballero et al, 2020). Caustic soda when exposed to the skin

can cause pain, burns, redness, irritation. Eye contact with caustic soda causes pain, eyelid twitching, watery eyes, inflammation, sensitivity to light, at high concentration levels can cause permanent damage to the eyes. Caustic soda is irritating to the nose and throat when inhaled in high concentrations (PHE, 2019).

According on the loading activities of Caustic soda on MT AKRA 1, the period August 2022 to September 2023 obtained data on the amount of Caustic Soda cargo and the time required when carrying out loading activities obtained the following data

Table 1. **Descriptive Statistics**

		Statistic	
		Loading Time (Hours)	Cargo Caustic Soda (liter)
Mean		36.3636	5004216.63
95% Confidence Interval for Mean	Lower Bound	35.9637	5002851.75
	Upper Bound	36.7636	5005581.52
5% Trimmed Mean		36.3485	5004107.42
Median		36.0000	5003445.50
Variance		.814	9476534.71
Std. Deviation		.90214	3078.398
Minimum		35.00	5.00E+6
Maximum		38.00	5.01E+6
Range		3.00	10179.00
Interquartile Range		1.00	5860.00
Skewness		.021	.418
Kurtosis		-.646	-.985

Graphic 1. **Caustic Soda Loading Time (Hours)**
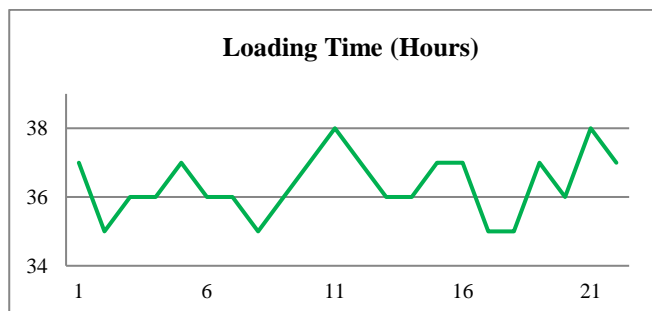
Graphic 2. Amount of Caustic Soda Cargo (Liters)
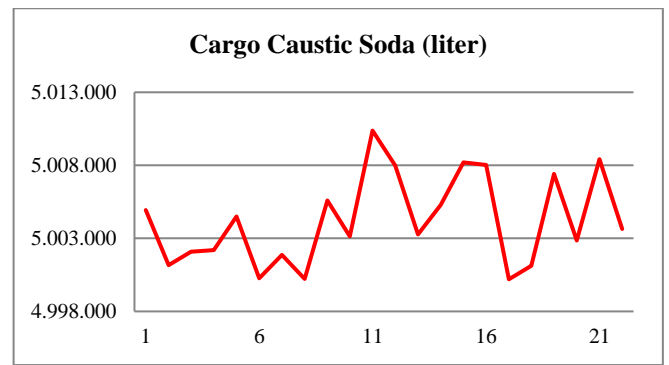
Normality test

Normality test for Loading time

    H_0 : Loading Time have a Normal Distribution

    H_1 : Loading Time did not have a Normal Distribution

H_0 is rejected if the significance value <0.05

Table 2 Test Of Normality for Loading Time

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Loading Time (Hours)	.214	22	.010	.884	22	.014

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The Kolmogorov-Smirnov Normality Test Significance value for load time shows a value of 0.01 < 0.05 and the Shapiro-Wilk Normality Test has a value of 0.018 < 0.05, which means H_0 is rejected or the Caustic Soda loading time data did not have normal distribution.

Normality test Amount Cargo of Caustic Soda

    H_0 : Amount Cargo of Caustic Soda have a Normal Distribution

    H_1 : Amount Cargo of Caustic Soda did not have a Normal Distribution

H_0 is rejected if the significance value < 0.05

Table 3 Test Of Normality for Amount Cargo of
Caustic Soda

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Cargo Caustic Soda (l)	.123	22	.200*	.933	22	.139

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on calculations using SPSS, the Significance value of the Kolmogorov-Smirnov Normality Test shows a value of 0.200 > 0.05, and the Shapiro-Wilk Normality Test shows a value of 0.139 > 0.05, which means H_0 is accepted so that the amount of Caustic Soda Cargo have a Normal Distribution.

Correlation test

Hypothesis for Correlation Test Amount of Cargo Caustic soda with Caustic Soda loading time.

H_0 : There is a correlation between the amount of cargo and the loading time of Caustic Soda

H_1 : There is no correlation between the amount of cargo and the loading time of Caustic Soda

H_0 is rejected if the significance value > 0.05

Table 4 Pearson Correlation

Correlations

		Loading Time (Hours)	Cargo Caustic Soda (l)
Loading Time (Hours)	Pearson Correlation	1	.840**
	Sig. (2-tailed)		.000
	N	22	22
Cargo Caustic Soda (l)	Pearson Correlation	.840**	1
	Sig. (2-tailed)	.000	
	N	22	22

**. Correlation is significant at the 0.01 level (2-tailed).

The significance value of the Pearson correlation between loading time and the amount of Caustic Soda Cargo is 0.000 <0.05, which means H_0 is accepted or there correlation between the amount of cargo and the loading time of Caustic Soda. The Pearson Correlation value is 0.840, indicating a very strong correlation between the amount of cargo and the loading time of Caustic Soda.

Linear Regression Test

Regression test is carried out by taking the variable Amount of Cargo of Caustic soda loads as the independent variable and the dependent variable is the Loading time of Caustic Soda. With hypothesis:

H_0 : The variable Amount Cargo of Caustic Soda has a relationship with the length of loading time and a linear regression model can be used to predict the variable loading time of Caustic Soda.

H_1 : The variable Amount Cargo of Caustic Soda has a relationship with the length of loading time and a linear regression model cannot be used to predict the variable loading time of Caustic Soda.

H_0 is rejected if the significance value > 0.05

Table 5 Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.840a	.706	.691	.50118

a. Predictors: (Constant), Jumlah Muatan
b. Dependent Variable: Waktu Bongkar/Muat

The coefficient of determination R Square is 0.706 indicating that the dependent variable is influenced by the independent variable by 70.6%,

while the remaining 29.4% of the dependent variable is influenced by factors other than the independent variable (ghozali et al, 2016). The R Square value of 0.706 indicates that the dependent variable has a moderate relationship with the independent variable (Hair et al, 2011).

Table 6. ANOVA

ANOVAᵃ

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.067	1	12.067	48.042	.000ᵇ
	Residual	5.024	20	.251		
	Total	17.091	21			

a. Dependent Variable: Waktu Bongkar/Muat
b. Predictors: (Constant), Jumlah Muatan

- The Anova Significance value shows a value of 0.00 <0.05 which indicates that H_0 accepted or the regression model can be used to predict Caustic soda loading time (Liters) According on the amount of Caustic Soda to be loaded (Hours)
- Based on SPSS calculations, the (F_{value}) 48.042 > 4.351 (F_{table}) so it can be concluded that the regression model can be used to predict the loading time of Caustic Soda

Based on the significance value and comparison of the calculated (F_{value}) with the (F_{table}) value, it can be concluded that the amount of Caustic soda load (X) can be used to predict the loading time of Caustic soda (Y).

Table 7. Coefficients

Coefficientsᵃ

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1195.90	177.78		-6.727	.000
	Cargo Caustic Soda (l)	.000246	.000	.840	6.931	.000

a. Dependent Variable: Jumlah Cargo Caustic Soda (l)

- The Significance value for the Constant is 0.000 < 0.05 and the significance value for the Amount of Cargo Caustic Soda is 0.000 < 0.05, so it can be concluded that the Amount of Cargo Caustic soda and the constant value have an influence on the loading time of Caustic soda
- The (t_{value}) for Constant is -6.727 < -2.086 (t_{table}) and the (t_{value}) for Total Cargo Caustic Soda is 6.931 > 2.086 (t_{table}) so that the constant value and Total Cargo Caustic Soda give influence to the loading time of Caustic Soda.

Unstandardized Residual Normality Test

H_0 : Amount Cargo of Caustic Soda have a Normal Distribution

H_1 : Amount Cargo of Caustic Soda did not have a Normal Distribution

H_0 is rejected if the significance value < 0.05

Table 8 Unstandardized Residual Normality Test

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		22
Normal Parametersᵃ,ᵇ	Mean	.0000000
	Std. Deviation	.48910040
Most Extreme Differences	Absolute	.134
	Positive	.134
	Negative	-.103
Test Statistic		.134
Asymp. Sig. (2-tailed)		.200ᶜ,ᵈ

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Graphic 3. Unstandardized Residual Histogram

Histogram
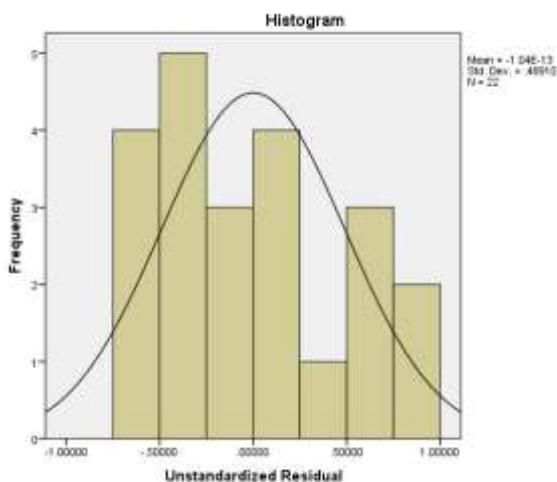
Kolmogorov-Smirnov Normality Test Significance value for Unstandardized Residual is $0.200 > 0.05$, means that H_0 is accepted indicating that the Unstandardized Residual are normally distributed, reinforced by the Unstandardized Residual histogram which has a pattern close to the Normal distribution curve.

4. CONCLUSIONS

Accosding on statistical calculations of data on the amount cargo of Caustic Soda Load, as well as data on the time required to carry out Caustic Soda Loading activities to the MT AKRA 102 Ship, the results show that:

- The Pearson Correlation value shows a positive and fairly strong relationship between the amount Cargo of Caustic Soda Load (l) and the time required during the implementation of Casutic Soda loading activities to the MT AKRA 102 ship.

- The coefficient of determination R Square is 0.706 indicating that the dependent variable (Loading time of Caustic Soda) is influenced by the independent variable (Amount cargo of Caustic soda) by 70.6%. Where the Determination value of 70.6% is categorized as the independent variable giving a moderate influence on the dependent variable.

- ANOVA significance value $0.00 < 0.05$, and (F_{value}) $48.042 >$ (F_{tabel}) 4.351 it can be concluded that the amount Cargo of Caustic soda cargo can be used to predict the Loading time of Caustic soda.

- Total Cargo Caustic Soda (t_{value}) $6.931 > 2.086$ (t_{table}) so that the constant value and Total Cargo Caustic Soda affect on the loading time of Caustic Soda .

- The Significance Value of the Kolmogorov Smirnov Normality Test for Unstandarized residuals is $0.200 > 0.05$, indicating Unstandarized residuals are normally distributed.

So it is concluded that the amount Cargo of Caustic Soda has an influence on the loading time of Caustic Soda, and the amount of Cargo Caustic Soda can be used to predict the loading time of Caustic Soda to MT AKRA 102 Ship with the equation

Load Time = 0.00246 Amount Cargo -1195.909

Where each addition of every 1 liter of Liquid Caustic Soda provides an additional time of 0.00246 hours.

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