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Designing Cost Production of Concrete

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Abstract. Estimated value of construction industry in Indonesia in 2016 is Rp. 1.303 trillion, in 2017 is Rp. 1.460 trillion and in 2018 is Rp. 1.640 trillion. Especially for the value of the infrastructure industry in 2016 is Rp. 708 trillion, in 2017 is Rp. 795 trillion and in the year 2018 is Rp. 891 trillion (Office of Public Appraisal Services (KJPP), 2016). The Ability to produce concrete of each company is different, depending on the foresight in calculating material costs, carefulness in the management of materials to be wasted a little, buying materials for cheap prices, the use of the right tools, optimizing tool operation, selecting factory location, and placing human resource to manage production process, whose ultimate goal is to get the lowest cost (production cost) in producing concrete. The objectives of this study are to design the cost estimation of Beton Production and to identify factors influencing the cost of Beton Production . The study was conducted on 38 (thirty eight) factories in Java. The method used is doubled linear regression using SPSS (Statistical Package for the Social Sciences) software. This method is chosen because it is a technique that can be used to analyze and predict the contribution of a potential variable for overall reliability. The estimated model is $Y = - 2351{,}577 + 1{,}386\ X_1 + 0{,}856\ X_2 + 0{,}656\ X_3 + 279{,}253\ X_5 + 3{,}041\ X_6 + 2{,}576\ X_8$, with Y = cost of production, X_1= Use of cement (kg/m^3), X_2 = rubble stone usage (m^3/m^3 of beton), X3 = sand usage (m^3/m^3 of beton), X5 = additive usage (liter/m^3)), X6 = tool period (year), X8 = time of equipment operation (hour/month).

1. Introduction

Concrete is a mixture of portland cement or other hydraulic cement, fine aggregate, coarse aggregate and water, with or without additional mixed materials forming a solid mass. Concrete is a mixture of portland cement or any other hydraulic cement, fine aggregate, coarse aggregate and water with or without the use of additives.Concrete as a set of mechanical and chemical interactions of the forming material. The production cost is the cost of the finished product and transferred to product in process during the period. The product cost is the accumulated costs charged to the product or service. Cost is the amount that can be measured in the form of cash paid, or the value of other assets that can be delivered or sacrificed, or services delivered or sacrificed, or payable arising or additional capital in the framework of the ownership of goods or services required by the company, Either from the past (acquisition cost already incurred) or in the future (the acquisition cost that will occur). Production

cost is the accumulation of the costs charged to products produced by the company or the use of various economic resources to produce the product or acquire the assets. generally, the production cost can be interpreted as all costs that are sacrificed in the production process to manage raw materials into finished goods. The purpose of this study is to designing estimation cost of Beton Production and to identify factors influencing the production cost of concrete.

2. Literature Review

According to Blocher, Stout, & Cokins [1], Production Cost is the cost of the finished product and transferred to processing product during the period [1]. According to Susilawati, Clara, Anton [2], product cost is the accumulated costs charged to the product or service. Supriyono stated the product cost is accumulated costs charged to the product or service [3]. Cost is the amount that can be measured in the form of cash paid, or the value of other assets that can be delivered or sacrificed, or services delivered or sacrificed, or payable arising or additional capital in the framework of the ownership of goods or services required by the company, Either from the past (acquisition cost already incurred) or in the future (the acquisition cost that will occur).

According to Daljono, there are two main types of cost that charged to the product, determining the order cost and the process cost [4]. Supriyono said the collection of the cost of goods can be grouped into two methods, job order cost method and process cost method [3]. According to Daljono, there are two methods in determining the cost of goods, namely Full Costing Method and Variable Costing Method [4]. The production cost is the accumulation of the costs charged to products produced by the company or the use of various economic resources to produce the product or acquire the assets.

Cost as a resource that is sacrificed or released to achieve a certain goal. A cost is usually measured in the amount of money that must be paid in order to obtain goods or services. The cost classification is very important to make a meaningful overview on the basis of cost data. Cost is a pre-requisite exchange rate or sacrifice made in order to obtain benefits. Cost is a sacrifice of economic resources measured in money, to obtain goods or services expected to provide benefits at this time or the future.

The sacrifice of economic resources as measured in money that have occurred or are likely to occur to achieve a particular goal. The cost system is the organization of coordinated forms, records and reports that aim to carry out activities and as cost information for management. Supriyono said the cost is the cost of goods that are sacrificed or used in order to obtain income (revenue) that will be used as a deduction of income [3]. Production cost is the cost used to buy raw materials used in producing products and costs incurred in converting raw materials into products. Cost information is useful for determining the cost of production (HPP) of a product produced by the industry. Cost information is needed to calculate the estimated cost of production. Although cost information is not the only information management needs, it can at least reflect the detailed cost elements of the product. Blocher, Stout, & Cokins said in collecting production cost method, there are two kinds of product costing system used in different types of industries, namely costing system based on order (job costing) and costing system based on process (costing process) [1]. The calculation of the production cost of concrete is the cost in executing a job request (project). In 1960, Joseph Orlicky developed a method of production planning called Material Requirements Planning/MR [5]. The elements of cost of production i.e. direct cost and indirect cost.

The steps that need to be done in preparing the budget plan are as follows [6]:
a) To collect data on the type, price and market capability of providing construction materials continuously.
b) Collecting data on the wages of workers applicable in the project site area and / or wages in general if workers are imported from outside the project site area.
c) Calculating material analysis and wage by using analysis of BOW (Burgerlijke Openbare Werken).
d) Calculating the unit price of work by utilizing the results of job unit analysis and quantity list of work.
e) Make a recapitulation.

3. Method

3.1. Purpose
Generally, the production cost can be interpreted as all costs that are sacrificed in the production process to manage raw materials into finished goods. The purpose of determining the production cost is to ensure that the selling price can compete with similar companies, besides it can cover production costs and the achievement of desired profit. Without any calculation of the cost product, The company may not be able to know the profit and loss incurred.

The purpose of this study is to designing estimation cost of Beton Production and to identify factors influencing the production cost of concrete. The benefits of determining the production cost are:
a) Determining the selling price of the product
   To determine the selling price of the product, the production cost per unit is one of the factor that considered besides the other costs.
b) Monitoring the realization of production costs
   Management requires information on actual production costs incurred in the implementation of such production. Therefore, cost accounting is used to collect production cost information, which is issued within a certain period to monitor whether the production process consumes the total cost of production in accordance with the previously considered.
c) Calculating profit or loss in certain period
   The production costs incurred to produce a product within a certain period are used to calculate the profit or loss in that period.
d) Determining inventory cost of finished products and products in the process presented in the balance sheet.
   Cost information is useful for determining the cost of production (HPP) of a product produced by the industry.

The method used to complete designing cost estimation of Beton Production is doubled linear regression method. This method is chosen because it is one technique that can be used to analyze and predict the contribution of a potential variable for overall reliability.

3.2. Research Stages
Research stages are carried out through several stages:
a) Testing requirements for analysis.
   Requirement that must be fulfilled is normality test, that is sample data should fulfill requirement of normal distribution. The test used is Kolmogorov Smirnov.
b) Testing the variables that make up the optimization model, namely:
   1) Deviation of the Classical Multicollinearity Model
      Tests on multicolinearity is intended to determine whether there is a significant relationship between independent variables used in the study. If the value of Varian Inflation Factor (VIF) less than 10 (ten) means no multicollinearity or no relationship between independent variables.
   2) Deviation of Classical Model of Heteroscedasticity
      Heteroscedasticity test is required to test the presence or absence of variable variant symptoms in the equation model. The test used is Park Gleyser test.
   3) Classic Autocorrelation Model Diversion
      Autocorrelation test aims to determine whether there is correlation between residuals on an observation with other observations on the model. The way used for autocorrelation test is by using Durbin-Watson method.
c) Model Design Mathematically
   Model design is done by using multiple linear regression analysis. The design of this model uses SPSS software (Statistical Package for the Social Sciences).

3.3. Analysis

Analysis of research data using descriptive analysis and inferential analysis. Descriptive analysis conducted in this study relates to the presentation of data through tables and graphs, calculation of data dissemination through the calculation of average and standard deviation and calculation of the percentage value of each research variable. Inferential analysis was conducted to make predictions about populations based on observation, sample analysis and generalization based on the results of the sample analysis.

Inferential analysis is grouped into:
a) Test requirements analysis (normality test, heteroscedasticity test, multicolinearity test.)
b) Hypothesis testing, either association (correlation test, regression test)
c) Comparative hypothesis (different test of two sets of data, variance analysis).

Inferential analysis that will be conducted in this study relates to test requirements analysis and association hypothesis test.

Before multiple linear regression analysis, classical assumption test must be done first, that is:

a) Normality test

Normality test aims to determine whether the data studied is normally distributed or not. The tool used to test is Kolmogorov-Smirnov test. If the asymmtotic signifinancy value is more than α (0.05), then the data has been normally distributed [7][8]. The result of this test is then made a causal relationship can be a linear regression and analyzed the strength of the relationship.

b) Multicollinearity test [9]

This test is used to determine whether there is correlation between independent or independent variables in multiple regression models. To know the presence or absence of multicolinearity among variables, how to see the value of Variance Inflation Factor (VIF) or Tolerance (Tol) value of each independent variable to the dependent variable. The VIF value describes the increase of the variant of the alleged parameters between the independent variables. The model is said to be non-multicolinear if the VIF < 10 and tolerance limits are commonly used 0.01.

c) Heteroscedasticity Test

Good regression models do not have heteroscedasticity problems. Symptoms of heteroscedasticity will arise if the errors or residuals of the observed model do not have a constant variance from an observation to another observation. Symptoms of heteroscedasticity will be shown by the coefficient of each independent variable to the absolute value of the residue. If the probability value is greater than α (0.05), then it can be assured that the model does not contain heteroscedasticity or thitung element less than or equal to ttable at α (0.05).

d) Test Autocorrelation

The autocorrelation test is used to see whether there is a correlation between residuals in an observation with other observations on the model. The autocorrelation test was performed using a Durbin-Watson test. Gujarati, states, the formula used is [10]:

$$d = \frac{\sum_{t=2}^{t=n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{u}_t{}^2} \tag{1}$$

note:
d   = *Durbin Watson Test* value
$\hat{u}_t$ = residual value
$\hat{u}_{t-1}$ = residual value in previous period
t   = 2,3,4,...., n
n   = sample total

The analysis using Durbin-Watson uses the reference as in table 1.

Table 1. Durbin-Watson [11]

Durbin-Watson (d)	Conclusion
$0 < d < dL$	There is an autocorrelation (+)
$dL \leq d \leq dU$	Without Conclusion
$4 - dL < d < 4$	There is an autocorrelation (-)
$4 - dU \leq d \leq 4 - dL$	Without Conclusion
$dU < d < 4 - dU$	There is no autocorrelation

3.4. Multiple Regression Analysis

Multiple linear regression models are used to denote the Y response to the input value X [11].In this study, multiple regression analysis is used to determine whether or not the influence of independent variables on dependent variable.

The equation for multiple linear regression is [12]:

$$Y = a_0 + a_1 X_1 + a_2 X_2 + ... + a_n X_n \qquad .... (2)$$

Note:

Y = Dependent Variabel
a = Constanta
a_n = The value of regression coefficient of independent variables to – n
X_n = independent Variabel to – n
n = Jumlah variabel independen

This study uses 1 (one) dependent variable and 10 (ten) independent variables. The multiple linear regression equation is expressed in the equation:

$$
\begin{aligned}
Y = a_0 + a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 X_5 + a_6 X_6 + a_7 X_7 \\
+ a_8 X_8 + a_9 X_9 + a_{10} X_{10}
\end{aligned} \qquad (3)
$$

Note:

Y = Cost Production (rupiah/m3)
X_1 = Cement Usage (kg/m3)
X_2 = Rubble Stone Usage (m3/m3 concrete)
X_3 = Sand Usage (m3/m3 beton)
X_4 = Production (m3/month)
X_5 = Additive Usage (liter/m3)
X_6 = Tool Period (tahun)
X_7 = distance of concrete delivery (kilometer)
X_8 = Time of Equipment Operation (hour/month)
X_9 = Rent of Land for Factory (rupiah/year)
X_{10} = Employee Salary (rupiah/month)

3.5. Hypothesis Testing

3.5.1. Correlation Coefficient (r)

The correlation coefficient is used to measure the direction and degree of linear relationship between one variable with another variable [13]. The value of correlation coefficient is $-1 \leq r \leq 1$. If a strong positive linear relationship between variables then the value of r is close to 1 (one). If the negative linear relationship is strong between the variables then the r value is close to -1 (minus one). When

there is no linear relationship between variables or linear relationship but very weak, then the value of r is close to 0 (zero).

3.5.2. Coefficient of Determination (R^2)

Bluman states, the coefficient of determination is variation measurement of the dependent variable [13]. Coefficient of determination to measure how far the ability of the model in explaining the dependent variables. The value of R^2 is used as an indicator of how well the regression model has alignment with the data [12]. If the value of R^2 approaches to 1 (one) indicates good or strong alignment. If R^2 approaches to 0 (zero) indicates poor or weak alignment.

The coefficient of determination formula is:

$$R^2 = \frac{\sum_i^n (y_i' - \bar{y})^2}{\sum_i^n (y_i - \bar{y})^2} \tag{4}$$

Note:

R^2 = coefficient of determination

y_i = The actual value of Y for the i sample

$\bar{y}$ = Avarage of value Y

y_i' = The Prediction Value of Y for the i sample

i   = 1,2,3,4, ….., n

3.5.3. t test

T test is used to test the effect of independent variables. Test t is done by comparing the value of t table to the value of t arithmetic. If the value of t_{hit} > t table, then the variable has a meaningful influence. The value of t table with significant α = 0.05 and degrees of freedom (df = n-k).

Creswell states the value of t_{hit} can be searched by using the formula [14]:

$$t_i = \frac{b_i}{Sb_i} \tag{5}$$

Note:

t_i = The calculation value of t to i

b_i = Regression Coefficient of the i- independent variable

Sb_i = Basic error regression coefficient of i

i = 1, 2, 3, ..., n

Acceptance hypothesis criteria with level of significance 95% or α = 0,05 with hypothesis criteria:

H_o = The independent variable has no significant effect on Y

H_a = Independent variable has significant influence to Y

Hypothesis testing criteria used are:

H_o rejected if t calculation ≤ t tabel

H_a accepted if t calculation > t tabel

4. Result and Discussion

The calculation of raw materials cost for the production of 1 (one) m3 of concrete class B (K-350) as in table 2.

Tabel 2. Raw materials cost for the production of 1 (one) m3 of concrete class B (K-350)

No	Raw Materials	Unit	Unit Price (Rp)	Volume	Total Price (Rp)

1	Rubble Stone	m3	165.000	0,76	125.400
2	Sand	m3	145.000	0,55	79.750
3	Cement	kg	755	410	309.550
4	Gray Ash	m3	150.000	-	
5	Additive	liter	3.200	1,36	4.352
6	Fly Ash	kg	265	-	
7	Water	liter	260	180	46.800
	Total				565.852

4.1. Direct Equipment Cost

The equipment cost is the cost charged for the use of equipment including the fuel oil involved in the processing of the raw materials to the finished product.Equipment costs are divided into two groups:

a) The cost of direct equipment, ie the cost of equipment directly involved in the production process.

b) The cost of indirect equipment, ie the cost of equipment not directly involved in the production process.

The equipment cost for production of 1(one) m3 concrete class B (K-350) as in table 3.

Table 3. The equipment cost for production of 1(one) m3 concrete class B (K-350)

No	Description	Tool		Fuel Oil				Total Price (Rp)
		Capacity (m3/hours)	Rent (Rp/hours)	Rent (Rp/m^3)	Usage (liter/m^3)	Price (Rp/liter)	Price (Rp/m^3)	
1	Batching Plant	60	350.000	5.833				5.833
2	Whell Loader	60	120.000	2.000	0,2	7.500	1.250	3.250
3	Truck Mixer	7	165.000	23.571	2,0	7.500	15.000	32.143
4	Genset	60	75.000	1.250	0,1	7.500	1.000	2.250
	Total							37.643

4.2. Labor costs

Labor cost is the cost charged for the use of human labor.Direct labor cost is the cost of labor in the form of wages directly involved in the processing of raw materials into finished products.

Labor costs are divided into two groups:

a) Direct labor costs, is labor costs directly involved in the production process.

b) Indirect labor costs, is labor costs not directly involved in the production process. Indirect labor costs are included in overhead costs.

In implementation at the factory, labor costs are included in the General Administration Fee (BAU). The calculation of the cost of producing concrete derived from general administrative costs as in table 4.

Table 4. General Administration Fee (BAU) for Producing Concrete

No	Description	Cost (Rp/month)	Beton Production (m3/month)	Load of BAU (Rp/m^3)	Note
1.	Fee	117.000.000	6.150	19.024	Example on one
2	Overtime Fee	18.880.000		3.070	of the beton
3	Office	4.000.000		650	factories.

	Administration		
4	Guess and Meeting	2.500.000	407
5	Official Travel	3.500.000	569
6	P3K & K3	6.900.000	1.122
7	Accomodation	49.125.000	7.988
8	Electricity, Telephone, Water	15.000.000	2.439
9	Tax and others	15.065.000	2.450
	Total	231.970.000	37.719

4.3. The Caclculation of Beton Production Cost, Indicrect Cost

Indirect costs are generally defined as indirect materials, indirect labor and all other factory costs which can not be easily identified with or charged directly to certain orders, products or other cost objects. Indirect costs are all production costs other than direct materials and direct labor which are grouped into one category called overhead costs.Indirect factory costs as shown in table 5.

Table 5. Indirect Cost

No	Description	Cost (Rp/ project)	Beton Production (m3/project)	BAU (Rp/m3)	Note
1	Land Rent	475.000.000	225.000	2.111	Sample in one of
2	Land Clearing	675.000.000		3.000	the beton
3	Office Building	285.000.000		1.267	factories.
4	Batching Plant Foundation	515.000.000		2.289	
5	Laboratorium tools	165.000.000		733	
6	Hedge	185.000.000		822	
	Total	2.300.000.000		10.222	

4.4. Data Testing With Classical Test

Classical test consist of normality test, multicollinearity test, heteroskedity test and autocorrelation test. This test aims to ensure that the data obtained is valid and reliable.

4.4.1. Nomrmality Test of Kolmogorov-Smirnov Z.

From table 7, we can see that asymp value. sig. (2-tailed) = 0.2 (> 0,05), it can be concluded that the data is normally distributed to meet the normality test criteria and can be used for further analysis.

4.4.2. Multicolinearity Normality Test (TOL and VIF).

From the results of multicollinearity test (table 8), obtained VIF value <10, it can be concluded that the data can be used for further analysis.

Table 6. Normality Test Result Kolmogorov-Smirnov Z.

One-Sample Kolmogorov-Smirnov Test

		Standardized Residual
N		100
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	.94815078
Most Extreme Differences	Absolute	.066
	Positive	.066
	Negative	-.046
Test Statistic		.066
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Table 7. Multicolinearity Normality Test Result (TOL and VIF).

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	-2351.577	302.136		-7.783	.000		
	Cement Usage (kg)	1.386	.576	.072	2.407	.018	.825	1.211
	Rubble Stone Usage (kg)	.856	.086	.567	9.966	.000	.229	4.369
	Sand Usage (kg)	.656	.173	.223	3.794	.000	.214	4.673
	Production/Month (m3)	-.004	.002	-.055	-1.853	.067	.848	1.179
	Additive Usage (Liter)	279.253	79.777	.105	3.500	.001	.817	1.225
	Tool Period (Years)	3.041	1.430	.073	2.126	.036	.632	1.582
	Distance of Beton Delivery (Km)	1.354	.785	.054	1.725	.088	.742	1.348
	Time of Equipment Operation (hours)	2.576	.481	.291	5.355	.000	.250	3.997
	Rent of Land/Year (milion rupiah)	.040	.039	.033	1.025	.308	.723	1.384
	Employee Salary/Month (million rupiah)	.381	.258	.049	1.480	.142	.676	1.480

a. Dependent Variable: PRODUCTION COST (thousands rupiah)

4.4.3. Heteroskedity test.

Table 8. Heteroskedity Test Results.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-269.071	185.285		-1.452	.150		
	Cement Usage (kg)	.117	.353	.037	.330	.742	.825	1.211
	Rubble Stone Usage (kg)	.005	.053	.022	.103	.918	.229	4.369
	Sand Usage (kg)	.100	.106	.206	.945	.347	.214	4.673
	Production/Month (m3)	-.001	.001	-.100	-.915	.363	.848	1.179
	Additive Usage (Liter)	90.314	48.923	.206	1.846	.068	.817	1.225
	Tool Period (Years)	.809	.877	.117	.922	.359	.632	1.582
	Distance of Beton Delivery (Km)	.237	.481	.058	.493	.623	.742	1.348
	Time of Equipment Operation (hours)	.117	.295	.080	.398	.692	.250	3.997
	Rent of Land/Year (milion rupiah)	-.024	.024	-.119	-1.006	.317	.723	1.384
	Employee Salary/Month (million rupiah)	.121	.158	.094	.765	.447	.676	1.480

a. Dependent Variable: ABRESID

From the result of heteroskedity test concluded that variable have significant value Sig> 0,05 so that the further analysis can be done.Uji Autokorelasi (Durbin – Watson)

4.4.4. Autocorrelation Test (Durbin – Watson)

Tabel 9. Result of Durbin – Watson Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.967[a]	.934	.927	21.716	1.908

a. Predictors: (Constant), Employee Salary/Month (millions rupiah), Time of Equipment Operation (hours), Distance of Beton Delivery (KM), Production/Month (m3), Cement Usage (kg), Rent of Land/Year (millions rupiah), Additive Usage (Liter), Tool Period (Years), Rubble Stone Usage (kg), Sand Usage (kg)

b. Dependent Variable: Production Cost (thousands rupiah)

From table 10, we get that value of Durbit-Watson is 1,908. It mean that At the level of 5% significance can be concluded that there is no autocorrelation in all independent variables.

4.4.5. Multiple Regression Test

Table 10. Multiple Regression Test
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2351.577	302.136		-7.783	.000
	Cement Usage (kg)	1.386	.576	.072	2.407	.018
	Rubble Stone Usage (kg)	.856	.086	.567	9.966	.000
	Sand Usage (kg)	.656	.173	.223	3.794	.000
	Production/Month (m3)	-.004	.002	-.055	-1.853	.067
	Additive Usage (Liter)	279.253	79.777	.105	3.500	.001
	Tool Period (Years)	3.041	1.430	.073	2.126	.036
	Distance of Beton Delivery (Km)	1.354	.785	.054	1.725	.088
	Time of Equipment Operation (hours)	2.576	.481	.291	5.355	.000
	Rent of Land/Year (milion rupiah)	.040	.039	.033	1.025	.308
	Employee Salary/Month (million rupiah)	.381	.258	.049	1.480	.142

a. Dependent Variable: Production Cost (thousands rupiah)

From the table 11, we can get model of regression with 6 independent variables because there are 4 variables not significance i.e. Production/Month (m3), Distance of Beton Delivery (Km), Rent of Land/Year (milion rupiah), and Employee Salary/Month (million rupiah):

$$Y = -2351{,}577 + 1{,}386\,X_1 + 0{,}856\,X_2 + 0{,}656\,X_3 + 279{,}253\,X_5 + 3{,}041\,X_6 + 2{,}576\,X_8$$

where Y = cost of production, X_1= Use of cement (kg/m^3), X_2 = rubble stone usage (m^3/m^3 of beton), $X3$ = sand usage (m^3/m^3 of beton), $X5$ = additive usage (liter/m^3)), $X6$ = tool period (year), $X8$ = time of equipment operation (hour/month).

5. Conclusion

The most influence factor on the production cost is the use of rubble stone with t statistics 9,966. The least influence factor onthe production cost is land rent for factories with t statistics of 1.025. Designing production cost of concrete is obtained as follows:

$$Y = -2351{,}577 + 1{,}386\,X_1 + 0{,}856\,X_2 + 0{,}656\,X_3 + 279{,}253\,X_5 + 3{,}041\,X_6 + 2{,}576\,X_8$$

where:

Y	= Production Cost (Rp./m3)
X1	= Cement Usage (kg/m3)
X2	= Rubble Stone Usage (m3/m3 concrete)
X3	= Sand Usage (m3/m3 concrete)
X5	= Additive Usage (liter/m3)
X6	= Tool Period (year)
X8	= Time of Equipment Operation (hours/month)

Based on the conclusion that the most influence factor on the production cost is the use of rubble stone with t statistics of 9,966 and the least influence factor is the land rent for the factory with t statistics

1,025, so that to lower the production cost the significant effect is the use of rubble stone for producing concrete. The less the use of rubble stone, the lower the production cost.

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