

# Estimated Budget Construction Housing Using Linear Regression Model Easy And Fast Solutions Accurate

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**Abstract**—An accurate cost estimate in the early stages of a construction project is very important, it is a key factor in the success of a project. But it is difficult to estimate construction costs quickly and accurately at the planning stage, when image data, documentation and the things are incomplete.

The solution of the difficulty is the model, estimate the budget of the cost house construction using the model is an easy, fast and accurate way without have to prepare the image data and other documentation first, even just enough dreams, for example want to build a house with three bedrooms, Guests, dining room, kitchen, toilets, terrace, with the plan of their respective room, from the imagination of using the model can be predicted how much the construction cost is required. The suggested model has passed statistical test of linear regression analysis.

Estimated construction project cost using model is easier, fast and accurate, so decision for making the investment feasibility can be done very quickly.

**Keywords:** *estimated cost of home construction; Regression Analysis*

## I. INTRODUCTION

House is a place for protect people from outside influences, such as climate, wild animals, bad people, disease danger and so on. For using as the function, a house must be equipped with various facilities needed, such as electricity, clean water, ventilation, storage of important documents, sewerage, and others.

Along with the rate of population growth in Indonesia the need for homes is always increasing, therefore the construction continues to be done either massively by the developer or sole done by individuals, and a lot of people in Indonesia still do the construction their house by themselves or individual. Everytime build the house, it is necessary to ensure the feasibility of investments in order to estimate the cost of construction at the planning stage is very important as has been disclosed [2].

"Furthermore, cost estimating has functions with a very wide spectrum of planning and controlling resources, such as materials, labor, and equipment. Although the uses are same, but the emphasis for each of the participating organizations are different. For the owners, numbers that showing amount of the estimating cost will be one of the benchmarks to determine the feasibility of an investment. For the contractor, the financial benefits to be earned depend on the speed and accuracy of

estimating the cost, while for the consultant, the figure is presented to the owner as a proposal of the best amount of costs for various purposes as the project develops, its credibility with respect to the truth and accuracy of the proposed figures," [2].

Estimating cost that have ever done on the construction of school buildings that is, [8].

The method by combining elements of the parametric and analogical estimation techniques gives a more accurate estimate than the mere parametric or analytical method, [9].

The method of estimating construction costs depends on the expertise of the human as the estimator, therefore the method is called "Rule Based Methods" [10].

Cost estimation method using unit cost analysis method has been arranged in BOW and SNI chapters, The stages calculate the budget plan of construction cost that is [1, 3, 4, 7].

From all of the description cost estimating methods above have been recognized by scientists in their field and widely used in Indonesia either by Ministry of Public Works, developer or contractor, but from all referenced methods all require experience, specific engineering scholarship and human expertise as estimators based on their experience, the construction of a house has a different complexity than the school buildings or other buildings, according to the authors need to do research on the method of estimating the cost of housing construction, because the characteristics of society in Indonesia vary both socially, culturally and economically. Indonesian society is many variants, still very much we are witness the people in Indonesia who do the construction of his house without involving the expert estimator, many done alone without estimating the previous costs, due to economic limitations and the lack of engineering science, so still need to do research in order to produce a method that is easily understood By the people in Indonesia without having to have experience and engineering science specifically.

Therefore, this study intends to produce the model as a method of estimating the cost of home construction more easily, quickly and accurately.

## A. Hypothesis

Based on the literature study, experience and direct observation on the construction of the residence that the variables that affect the cost of housing construction is the component of the house construction that is; 1) Foundation, 2)

Structure, 3) Wall, 4) door frame, 5) Roof, 6) Mechanical and electrical, 7) Sanitary, 8) Floor, 9) Ceiling, 10) Painting, [1, 3, 4, 7]. The greater the volume of construction components will be the greater the cost of development. Construction components are arranged so as to form a building consisting of rooms, there is a closed room and there is open space, enclosed space between them, room, living room, dining room, family room, kitchen, bathroom and others, Open space like terrace and carport. From the engineering arrangement of construction components that form the rooms will eventually be known the building area. According to the authors' hypothesis all building component variables will be represented by one variable that is building area, so to make the model of budget plan of house can be determined dependent variable (y) budget plan, and independent variable (x) building area. Hypothesis model estimation of the cost of housing construction in the set:  $Y = a + b.X$ .

Based on the background and hypotheses that have been described then the scope of the problem in this study are as follows:

- Can the model in the hypothesis be used as a cost estimation method of residential development based on linear regression analysis using SPSS software.
- How the model is used and the accuracy of the estimates.
- This research is conducted on residential development with technical specification as follows; 1) Foundation in pile, foundation of shallow reinforced concrete pile, 2) reinforced concrete slab, 3) reinforced concrete column, 4) reinforced concrete beam, 5) reinforced concrete ladder 6) reinforced concrete floor plate 7) Brick walls, hebel in acrylic patches, 8) light steel roof truss, second class roof tile cover, 9) second class ceramic floor, 10) 9mm gypsum ceiling, 11) SNI cable electrical installation, 12) Frames and wooden doors quality two, 13) painting quality two, 14) sanitary quality two.
- This research was conducted to find out the estimation method of housing development cost with very little initial data of the project.
- The method to be produced is a mathematical model to estimate the cost of housing construction with the smallest building area of 29 m<sup>2</sup> and the largest building area of 290 m<sup>2</sup>.
- The analytical method to produce mathematical modeling is a linear regression analysis using SPSS software.
- The analyzed data is the Housing Budget Plan Budget, the amount of costs in the Budget Plan does not calculate the profits and taxes.

The purpose of this research is to produce cost estimation method of housing cost more easily, quickly and accurately to do cost estimation at planning stage without enough data and without having to master special technique science.

The benefits of this study are expected to facilitate the estimation of the cost of residential development in the early planning stage although the data information is still very small, the estimation using this method can be used by the general public who are planning the construction of single house for private without special technical skills and without experience In the field of construction, and or can be used to

estimate the cost of mass housing construction by construction and construction service entrepreneurs.

## II. RELATED WORK

A review of previous research on the estimated cost of construction of houses, schools, and hospitals is as follows:

### A. Author:

- Muhyarudin, IyanMulyana, ArieQur'ania, 2011, [10]
- YannuMujayanah, 2008, [9]
- Ir. Rosmita Br Karo (02), 2010, [8]
- Ramly W Mandola, 2012 [7]
- Cho, Hong-Gyu<sup>1</sup> Kim, Kyong-Gon<sup>1</sup> Kim, Jang-Young<sup>2</sup> Kim, Gwang-Hee<sup>3\*1</sup>, (13), 2012, [6]
- Gwang-Hee Kim<sup>1</sup>, Jae-Min Shin<sup>2</sup>, Sangyong Kim<sup>3</sup>, Yoonseok Shin<sup>1\*</sup> (1), 2013, [5]
- Fharel Novel Lintang, B.F. Sompie, G.Y. Malingkas (2), 2014, [4]
- PutuAgusApritaAptiyasa, 2014, [3]
- AbelrahmanOsman Elfaki<sup>1,2</sup>, Saleh Alatawi<sup>1,2</sup>, 2015, [2]
- Cláudio Ricardo Bettini, Orlando Celso Longo, Luciane Ferreira Alcoforado, Alana Caroline Gamba Maia, (6), 2016, [1].

### B. Problems:

- In the construction of the house required a specific plan to calculate the cost and time in each work before the house is executed. There is not enough activity to calculate the cost because they are not enough techniques about doing and making cost plans. Furthermore, people who need to build a house can not monitor and meet the requirements, [10].
- In a construction project, the determination of the magnitude of the proportion of costs for the resource must be appropriate. Given that the cost allocation for project resources during the construction period is greatest, so if any discrepancy in the calculation of this proportion may result in a loss to the project. During this time the estimators calculate the cost of the project based on field experience while the description of the amount of allocation for resources does not yet exist, [9].
- Delays in the completion of work and the increased cost of development is a very complicated issue. To avoid this, we must take into account the Basic Budget Plan, materials and time set for completion, [8].
- A cost budget plan is needed by the developer, and whether the initial budgeting plan in 2012 is less than the actual cost of implementation in 2014, [7].
- In the early stages of the construction project, the most important thing is to predict construction costs rationally, [6].
- Accurate cost estimation in the early stages of a construction project is a key factor in the success of a project. But it is difficult to estimate construction costs quickly and accurately at the planning stage, when drawing, documentation and the like are incomplete, [5].
- In the implementation of a construction project, cost planning is the most important function in realizing the project objectives as well as the suitability of cost, time and quality need to be integrated and comprehensive,

especially in terms of the costs required for materials and wages, [3].

- In the early stages of project planning, the owner of the project requires an estimate of the costs to make the project budget. So it is necessary to develop cost estimation model that is easy to use, accurate and reliable,[4].
- Apart from the various estimates of construction project costs, experience and human knowledge can not be ignored. The main question concerning what human knowledge determines is the success of the construction cost estimation process,[2].
- In a real estate project, the estimated construction and revenue costs generally represent the most important values of the feasibility study. When a decision on a project is made, there are often only a few definitions of what will be built, and often not enough to ensure the accuracy of cost estimates. Given the global trend to reduce the return margins above the real market, a slight variation in construction costs could jeopardize the overall success of real estate companies and even financial stability of the builder or developer, [1].

#### C. Method:

- WEB-based applications, [10]
- Analysis Regresi, [9]
- Unit price analysis, [8]
- Unit price analysis, [7]
- Regression Analysis (RA), Neural Network (NN), [6]
- Regression Analysis (RA), Neural Network (NN), Support Vector Machine (SVM), [5]
- Analysis of unit price of SNI, [4]
- Regression analysis (RA), [3]
- Rule-Based Method, [2]
- The Equivalent Area and Equivalent Cost Concepts, [1].

#### D. Solution:

- The solution to solve the problem is to create a Website Development Plan Budget Based Budgeting Plan. This system is built to calculate the cost of the need to build a house. As a result of the implementation and evaluation that has been done, the system can help to calculate the need for a budget plan with an estimated budget. The system can also, produce information such as budget plan budget reports, materials, and recapitulation, [10].
- It was produced mathematical model for the proportion of building resources. In simple buildings, the proportion of the use of materials can use the equation ( $y_1 = 0.641 + 6.04E-012x_1 - 0.001x_2 + 0.008x_3 + 4.79E-005x_4$ ), for human resources is ( $y_2 = 0.203 - 1.76E-011x_1 + 0.001x_2 + 0.021x_3 - 3.52E-005x_4$ ), while for equipment resources ( $y_3 = 0.156 + 1.16E-011x_1 + 0.000x_2 - 0.029x_3 - 1.27E-005x_4$ ). In a non-simple building, the mathematical model for calculating the magnitude of the proportion of material resources is ( $y_1 = 0.745 + 3.38E-012x_1 + 0.000x_2 - 0.012x_3$ ), for human resources is ( $y_2 = 0.580 - 1.05E-012x_1 + 0.000x_2 + 0.01x_3$ ), and for equipment resources are ( $y_3 = 0.192 - 2.17E-012x_1 - 5.08E-005x_2 + 0.001x_3$ ), [9].

- For efficiency and effectiveness in building construction activities, the basic unit cost of construction cost analysis is required. A common cost analysis is BOW and SNI analysis. To obtain the unit price of work, must use the method to obtain an efficient and justifiable cost budget, [8].
- It is known that the Budget Plan The cost of house construction in 2012 is smaller than Budget Realization Construction of the house in 2014, [7].
- By comparing the cost estimates of both models, the neural network model is superior in terms of average error rate and standard distribution,[6].
- Although RA, NN, and SVM work well for their applications, the NN model provides more accurate estimation results than the RA and SVM models, [5].
- From the result of the total cost of project implementation with the amount of real cost then obtained the value of the contractor's profit, [4].
- Model estimation of cost of building of hospital building with "Cost Significant Model" is:  $Y = 5,455. X_{13} + 1.088.000$ . The accuracy of the estimated cost model for the construction of a hospital building using the "Cost Significant Model" method ranges from -12.97% to +26.80%, with an average of 2.865%,[3].
- Predictions and regulations we propose will give big benefits to the construction cost community. For example, using the proposed modeling, the strengths and weaknesses of construction cost estimates should be known. In addition, more than one construction cost estimator can work together equally. The first contribution of this paper is to introduce knowledge-based predicates and knowledge rules that can be used to represent knowledge of construction cost estimators. The experiment has validated and proved the accuracy of our contribution, [2].
- This method is more consistent and coherent than the comparison between traditional direct areas and real or equivalent areas, considering the uniqueness of the reference project and also the project under study. Given the ease of applying this method, and the associated risks, the use of direct area comparison, from now on can not be justified. As a last observation it can be said that artificial neural networks seem to have great potential to improve this work, altering the estimation process at the same time faster, more reliable and even more precise, [1].

Based on previous research findings there are similarities in the problem, all agree that estimating the cost of construction is very important, the error in predicting the cost of construction will lead to losses. The suggested methods and solutions are quite good, but they can not provide the best solution to solve the problem of home construction cost estimation, because the suggested solution still takes a long time even requires special skills. The phenomenon in Indonesia which has special expertise in the field of construction cost estimation is still very small compared to the number of residents in Indonesia, in fact the implementation of residential development in Indonesia is not only done by developers and contractors, there are still many people carry out the construction of their own house without having expertise Which is specialized to estimate costs

and without involving estimator experts, therefore need to conduct research in order to produce a simpler method to be easily understood by the general public, can be done very quickly, easily and accurately.

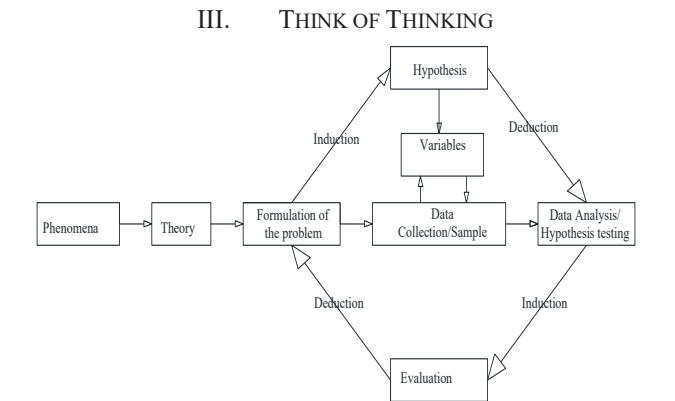


Figure 1. Flowchart of Thought

- A. Fenomena

Phenomenon is a problem that often or ever we meet or feel,mindmapping techniques can be relied upon to identify the phenomenon into the formulation of the problem.
- B. Theory

Theory is the methods that have been used and acknowledged by the scientists in their field, based on these theories of discussion of the problem backed by phenomena in conducting research to get the conclusion.
- C. Formulation of the problem

The formulation of the problem is the basis of problem solving in the form of questions or desires of a thing based on the assumptions of questions that must be answered. For example, how to calculate an easy and practical residential cost budget plan without having any special skills and sufficient experience in the art. The formulation of the problem is a straight line of red thread in the research so that the research focus on the formulation of the specified problem.
- D. Hypothesis

Hypothesis is a temporary answer to the research problem formulation. It is said temporarily because the given answer is based only on theory and not yet using facts. Therefore, any research conducted has a hypothesis or a tentative answer to the research to be performed. From the hypothesis will be further research to prove whether the hypothesis is true or not true. For example, calculate the residential cost budget plan using equation 1:  
 $Y = a + b.x$ ..... (1).  
Y (Dependent variable), a (constant), x(Independent variable), b (parameter value).
- E. Data collection

Based on literature review and hypotheses planned to analyze the identified problem, data required, that is data of Detailed Budget Plan, data obtained from construction service company and individual who have done construction of residential house.

- F. Variables

The variables are dependent variable y(budgeting cost plan) and independent variable x (building area), where the dependent variable will be influenced by the free variable, the variables are determined based on the hypothesis taken from the data / sample.
- G. Hypothesis testing

Data that has been processed in such a way, which has been determined independent variable and dependent variable, then analyzed using SPSS software. The analysis refers to the literature study, through three stages of analysis: (1) Statistic description, (2) Statistical Correlation, (3) Linear Regression. After analyzing and analyzing or analyzing, the analysis test is done by comparing the result of analysis with factual data, with difference determined on the margin of error or standard error in analysis, if not successful then re-analysis by reducing or adding data, or Can also reduce or add variables. After the okay, just made the conclusion.

IV. RESULTS AND DISCUSSION

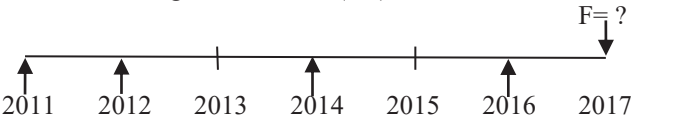
- A. Analysis Data

In this sub-chapter will be discussed about data collection, then predict the variables x (independent variable) which may affect the variable y (dependent variable). Based on previous research findings and hypotheses that the variables that will affect y (budget plan cost) is x (building area). So that the data needed for analysis is data sampling budget plan of house construction cost which have been done by developer and or by individual, data obtained from housing Bogor Nirwana Residence Bogor location as many as 350 units taken 5 samples, housing EsaCibadak Residence Sukabumi location as many as 280 units taken 5 samples, Housing of The Spring, Bintaro location as many as 250 units taken 5 samples, Serpong Housing location as many as 250 units taken 5 samples, MelatiLoka Housing, Tangerang location as many as 275 units taken 5 samples, Nusa Putra Residence, Sukabumi 22 Unit 3 samples taken, individual house of Jakarta location as many as 4 sample, individual house of bogor location as much as 3 sample, individual house of Sukabumi location as much as 3 sample, 30 data analyzed and the rest used as test analysis, summarized data requirement as shown in table 1:

Table1.Data and Source Requirements

Nu	Description	Source
1	Value of budget plan project document	Project Document
2	Building house area	Project Document
3	House Location	Project Document

The data of the project documents in question is the data that has been implemented in the different year of 2011, 2012, 2014, 2016, so it needs to be projected to 2017 with the calculation using Future Value (FV).





Furthermore, to calculate the price projection based on the rate of inflation can use the compound interest rate equation that is using Future Value [1] in more detail described in equation 2:

$$F = P (1 + i)^n \quad (2)$$

Where: F (Value at the specified projection), 1 (Price before the projected), i (Interest rate), n (Year of Projection). The interest rates of commercial banks are described in Table 2:

**Table 2.** Interest rates of commercial-investment banks

Year	Interest (%)
2011	12.12%
2012	11.45%
2013	11.39%
2014	12.21%
2015	12.24%
2016	11.55%

Source: Central Bureau of Statistics (BPS).

The projected cost data for 2011, 2012, 2014, 2016, drawn to 2017, sample projection shown in table 3:

**Table 3.** Projection data to 2017

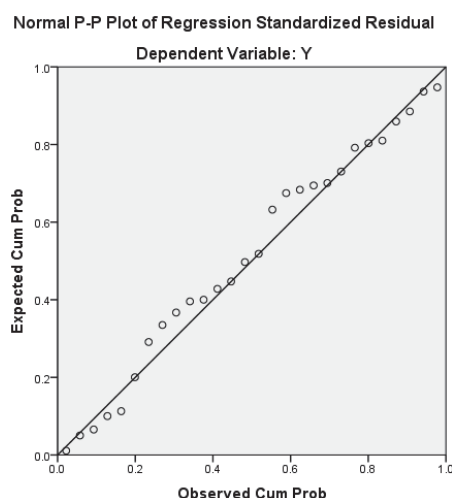
Data years	Budget plan factual (Rp)	Budget plan proyeksi 2017 (Rp)
2011	90,000,000	176,032,339
2012	601,272,469	1,048,811,821
2014	187,195,470	262,996,157
2016	251,189,567	280,201,962

Data in table 3 then performed linear regression analysis using SPSS software.

## B. Regression Analysis

### 1. Descriptive Statistic

Statistic description is done to test the normality of data before doing further analysis, normality data test can be done with normal plot regression, SPSS will present graph and there are diagonal line and dots.



**Figure 2.** Test the normality of data graph method

From the test results of the graph method by looking at the spreading point on the diagonal axis of the graph. Basic decision-making; 1) if the data spreads around the diagonal line and follows the direction of the diagonal line then the regression model meets the assumption of normality; 2) if the data spreads far from the diagonal line and does not follow the diagonal line direction then the regression model does not meet the assumption of normality. (M. NasihunUlwan, 2014), [3].

### 2. Test Autocorrelation

An autocorrelation test is performed to test a linear regression model whether there is a correlation between residuals from one period to another. A good regression model is free of autocorrelation or serial correlation. Detection of autocorrelation can be seen Durbin-Watson (D-W). In general, the basic criteria of D-W numbers to detect autocorrelation are:

- The D-W figure below -2 means a positive correlation
- D-W numbers below -2 to +2 mean there is no correlation
- D-W number above +2 means there is negative correlation.

**Table 4.** Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df 1	df 2	Sig. F Change	
1	.986 <sup>a</sup>	.973	.972	46,192.224.39	.973	940.96	1	26	.000	1.294

The test results in the summary model section above shows D-W = 1.294 where between -2 to +2 means linear regression model does not occur symptoms or there are problems of autocorrelation. Known from the results of linear regression analysis there are models that show  $R^2 = 0.972$  which means feasible and very big influence.

After the analysis of the summary model as described above. Then analyze anova to know the value of F arithmetic with probability 0.05, with the regulation F count must be greater than F table, whereas the significant value must be 0. Anova analysis is presented in table 5 below:

**Table 5.** ANOVA<sup>a</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	2,007,746,834,799,553,280	1	2,007,746,834,799,553,280.0	940.960	.000 <sup>b</sup>
Residual	55,476,761,434,415,056.0	26	2,133,721,593,631,348.0		
Total	2,063,223,596,233,968,380.0	27			

Based on the results of anova analysis showed that significant value 0, and F arithmetic 940.960 thus show that  $F_{arithmetic} > F_{table}$ . Then the model can be used.

### 3. Linear Regression

Linear regression analysis is done to produce the model and its coefficient value, that is to know the fixed value, a

(constant) dan b (coefficient), the result of analysis is shown in table 6 below:

**Table 6.**Coefficients<sup>a</sup>

Model	Unstandardized Coefficients		Standardize d Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	1783021.705	15,180,964.488		.117	.907
X1	3744303.565	122,063.397	.986	30.675	.000

### C. Estimated Budget Model of House Construction Cost

Based on the results of the data as described in the above tables and graphs, it can be concluded that the estimation model of housing construction cost budget is modeled with  $R^{\text{Square}} = 0.972$  with the coefficient of constants can be explained in the following equation:

$$\text{Model : } Y = 1,783,021.705 + 3,744,303.565X$$

Y (Budget Plan), X (Building Area), meaning that if this model is used to estimate the cost of building a house with a building area of 290 m<sup>2</sup>, then it can be calculated:

$$Y = 1,783,021.705 + 3,744,303.565X * 290$$

$$Y = \text{Rp. } 1,087,631,056.$$

### D. Validation Test

Model that has been in can be done testing of factual data to know whether the model can be used and how accuracy, validation test like table 7:

**Table 7.** Validation test

Building area	Factual budget plan (Y)	Model (Y')	Difference (Y-Y')	Error (%)
222	903.468.551	833.018.413	70.450.138	7,80%
290	1.048.811.821	1.087.631.056	- 38.819.235	-3,70%
72	262.996.157	271.372.878	- 8.376.721	-3,19%
45	158.054.400	170.276.682	- 12.222.282	-7,73%
70	263.544.851	263.884.271	- 339.420	-0,13%
69	248.442.117	260.139.968	- 11.697.850	-4,71%
76	280.201.962	286.350.093	- 6.148.130	-2,19%
194	750.855.324	728.177.913	22.677.411	3,02%
211	814.964.889	791.831.074	23.133.815	2,84%
Average difference amount				-0,89%

## V. CONCLUSION

Based on the hypothesis that 10 independent variables that affect the cost of house construction is the component of the house construction can be represented by 1 independent variable is building area. Based on statistical test of linear regression analysis yielded a model, this model is a solution to estimate the cost of residential construction, because it is simple, very easy, fast and accurate, this model is easy to be used by the general public without having special engineering knowledge, and without There should be complete data. This model is called Paikun Model, the model is as follows:

- $Y = 1,783,021.705 + 3,744,303.565X$ .
- How to use the model as a method of estimating the cost of building a house with a building area of 290 m<sup>2</sup>, namely:

$$Y = 1,783,021.705 + 3,744,303.565X * 290$$

$$Y = \text{Rp. } 1,087,631,056.$$

The accuracy of cost estimation using the model is the difference of error -0.13% to + 7.80%, with an average error of -0.89%.

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