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Estimation of Construction Cost of Road Works in Central Sulawesi Using Quadratic Regression

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ABSTRACT

Cost estimation is an attempt to forecast or estimate the value of a job by analyzing calculations based on experience or information obtained at that time. Cost estimation has great benefits for project owners, consultants, and contractors. This research is based on cost estimates that provide great benefits to owners, contractors, and consultants, but there are often errors in cost estimates due to the lack of experience and information possessed by an estimator. The purpose of this study is to develop an equation that can guide an estimator in estimating costs with a level of accuracy that is close to the actual cost and speed up the estimation process. The method used in this study is data collection by taking directly from road projects that are in the middle of the ulawesi, data tabulias, correlation and quadratic regression. The outputs to be achieved in this study are scientific articles published in research journals and reports on the results of activities.

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INTRODUCTION

Cost estimation is an effort made to predict or estimate the value of a job through the analysis of calculations obtained at that time. Cost estimation needs to be done carefully because in construction management, this estimation has a fundamental role including as materials: planning, feasibility studies, bidding, employment contract agreements, control, and supervision, estimating material/equipment/labor needs, determining selling/buying prices, estimating profits (Rizal, et al)

Cost estimation must be done carefully because in construction management estimates or estimates play an important role as input for planning, feasibility studies, bidding at the time of auction, work contracts, quality and cost control, as well as supervision, for the needs of materials, tools, workers, determination of sales/purchase prices, and profit estimates. (Musyafa, 2016).

In the field of statistics, there is a concept that makes it possible to predict or estimate qualitative or quantitative properties. One of the methods used is the Quadratic Refraction method. With this method, it is hoped that the project cost estimation process can speed up the estimation process and the results are close to the expected value.

Regression is a statistical analysis method used to look at the influence between two or more variables. The variable relationship is functional and is embodied in a mathematical model. Regression analysis is used to find out how bound variables can be predicted through sec araindividual independent variables.

Regression analysis is a technique that can be used to generate relationships in numerical form and to see how two or more (simple regression) variables are related to each other. Generally, the regression analysis used is a simple or multiple linear regression analysis, which has indications of dependent variables and independent variables used numerically. In addition, linear regression also requires the fulfillment of several classical assumptions in the data, namely the assumptions of normality, homogeneity, autocorrelation and multicollinearity (N.R. Drapper, et al., 1992).

Linear regression analysis has several advantages over other analyses, including that this method is very easy to interpret, has very clear calculations, and has a model that can be visualized in the form of graphs. However, this method also has disadvantages, namely that it cannot be used if the analyzed data is not in the form of numerical data, is very sensitive to the addition of variables, and also cannot be used if the classical assumptions are not met (N.R. Drapper, et al., 1992). For this reason, if linear regression analysis cannot be used, one of the methods that can be used is quadratic regression analysis.

Quadratic regression analysis is a development of linear regression, where the data modeled in quadratic regression has or forms a quadratic pattern if visualized into graphs or diagrams. The common forms of quadratic regression are (D. Gujarati, 2003):

$\hat{y} = b0 + b1X1 + b2X12 + \cdots + bnXn + bn{+}1Xn2 + \hat{e}$ (1)

with:

y = Non-free variable

X = Free variable

$b0$ = Konstant / Intercept

b

n = Slope

Once the regression equation is formed, there are several steps that must be taken in its analysis procedure, namely:

1. Simultaneous testing of regression parameters using the F test on the ANOVA table
2. Partial testing using the t test
3. Determining the value of R-square or the determination coefficient of N.R. Drapper, et al. (1992).

Before conducting regression analysis, ideally, the data to be modeled should be analyzed using correlation analysis. Correlation means a reciprocal relationship (S. Hadi, 2004). The magnitude of the correlation is always expressed in the form of a number which is then called the correlation coefficient. The correlation coefficient is used to determine the closeness of the relationship and the direction of the relationship between two variables. Correlation equations used:

$$r = \frac{n\sum x_i y_i - (\sum x_i y_i)}{\sqrt{\{n\sum x_i^2 - (\sum x_i)^2\}\{n\sum y_i^2 - (\sum y_i^2 - (\sum y_i)^2)\}}} \qquad (2)$$

with:

r = correlation coefficient

n = Number of X and Y data pairs

Σx = Total Sum of Variable X

Σy = Total Sum of Variable Y

Σx2 = Total Number of Variables X that are squared first

Σy2 = Total Number of Variables Y that were first squared

Σxy = Total Number of Variables X and Variable Y multiplied first

Table 1. Correlation Coefficient

Correlation Coefficient (r)	Relationship Level
0	No Corelaso
0 - 0.2	Very Low
0.21 – 0.40	Low
0.41 – 0.60	Relatively low
0.61 – 0.80	Quite High
0.81 – 0.99	Tall
1	Very High

The correlation coefficient (r) is a statistical measurement between two variables. The magnitude of the correlation coefficient shows the strength of the linear relationship and the direction of the relationship

between two random variables. If the correlation coefficient is positive, then the two variables have a unidirectional relationship. This means that if the value of variable X is high, then the value of variable Y will also be high. On the other hand, if the correlation coefficient is negative, then the two variables have an inverse relationship. This means that if the value of variable X is high, then the value of variable Y will be low (and vice versa). The following Table 1 is to facilitate the interpretation of the strength of the relationship between the two variables (H. Usman and R.P.S. Akbar, 1995)

METHODOLOGY

The stages carried out to complete this research are the data collection stage, the data analysis stage and the results stage.

Data Collection Stage. At this stage, the data collected is in the form of secondary data, namely the Road Project RAB which is located at the research location.

Data Analysis Stage. After the data collection stage is carried out, the data analysis stage is carried out using the correlation and quadratic regression methods. Yield Stage. At this stage, an equation will be obtained that will be used in estimating costs.

Table 2. Cost Budget Plan (RAB) Data

No	Job Package	Year	Total Cost
1	A	2018	Rp 2.476.547.000,00
2	B	2018	Rp 2.999.000.000,00
3	C	2018	Rp 1.299.000.000,00
4	D	2018	Rp 1.999.493.000,00
5	And	2018	Rp 2.999.944.000,00
6	F	2018	Rp 2.999.283.000,00
7	G	2019	Rp 451.216.677,00
8	H	2021	Rp 1.989.400.000,00
9	I	2021	Rp 1.475.873.966,00
10	J	2021	Rp 1.854.000.000,00
11	K	2021	Rp 1.950.536.000,00
12	L	2021	Rp 1.523.140.000,00
13	M	2021	Rp 1.008.965.746,00
14	N	2021	Rp 1.253.733.424,30
15	Or	2021	Rp 494.596.481,42
16	P	2021	Rp 1.989.880.000,00
17	Q	2024	Rp 11.400.689.000,00
18	R	2024	Rp 29.120.946.603,00
19	S	2024	Rp 15.077.733.000,00
20	T	2023	Rp 13.101.624.200,00
21	In the	2023	Rp 22.509.425.011,15

RESULTS AND DISCUSSION

From Table 1, a correlation analysis was then carried out. The results of the correlation analysis can be seen in table 2.

No	Variable	Correlation	P Value	Relationship
1	X1 and Y	0,961681377	1.60486E-10	Tall
2	X2 and Y	0,233663272	0,321439722	low
3	X3 and Y	0,919442974	1.0101E-08	Tall

Based on the correlation analysis that has been carried out, the largest correlation variable is the independent variable which has a very strong influence on the dependent variable Y. For regression analysis,

the variables to be used are the general 1st division variable (X1) and the granular pavement division variable (X3).

The next analysis carried out is regression analysis. The regression analysis carried out is based on the correlation analysis that has been carried out. The variables used based on the results of the correlation analysis are variables X1 and X3. Using the excel program, the regression analysis results can be seen in Table 3.

Table 3 Regression Analysis Results

Variable	*Coefficients*	*Standard Error*	*t Stat*	*P-value*
Intercept	1,76E+09	1,15E+09	1,535932	0,145377
X1	-53,8199	33,61375	-1,60113	0,130194
X12	4.03E-07	1.39E-07	2,899797	0,010999
X3	1,942194	0,537546	3,613072	0,002556
X32	-1.7E-10	5.28E-11	-3,1652	0,006404

From Table 3, it can be seen that the significant variables in the regression equation are the variables X12, X3 and X32. This can be seen in the P value of each variable that has a value below the alpha value (5%). The insignificant variables that have a P value above the alpha value (5%). So the quadratic regression equation obtained is y = 4.03E-07 X12 + 1.942194 X3 - 1.7E-10 X32.

CONCLUSION

Based on the results and discussions that have been carried out, it can be concluded that the regression modeling obtained is y = 4.03E-07 X12 + 1.942194 X3 - 1.7E-10 X32 with a determination coefficient of 0.957 where the variables that affect the total cost (Y) of road work in Central Sulawesi in the quadratic regression model are the general 1st division variable (X1) and the 6th division variable of granular pavement (X3).

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