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The Analysis of the Factors Which Affect the Building Costs in Indonesia

Taufik Dwi Laksono[a*]

[a] *Civil Engineering, Faculty of Engineering, Universitas Wijayakusuma Purwokerto; Jl. Raya Beji Karangsalam, Kabupaten Banyumas, Jawa Tengah Province, Indonesia.*

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Abstract

Buildings are the kind of facility needed by everyone. The accuracy in determining the amount of costs required to build a building has become a challenge for all parties involved in the process. This study aims to determine the factors affecting the cost of a building. By using four independent variables, i.e. floor area, number of floors, foundation depth, and project implementation time, and one dependent variable in the form of a contract value of the building project, an analysis to determine the factors that influence the cost of a building has been made. Using 81 samples in several cities in Indonesia and multiple linear regression of stepwise method, the results show three factors that significantly affect the cost of building projects. They are floor area, number of floors, and project implementation time. This is indicated by t_{count} for floor area of 12.770, t_{count} for the number of floors of 46.05, and t_{count} for project implementation time of 2.321.

Keywords: Building Costs; Indonesia; Construction Project; Regression.

1. Introduction

Meeting the needs of government buildings, private buildings, as well as individual buildings is a necessity. Each party that will establish buildings definitely requires an initial estimate of the costs.

Dipohusodo [1] states that a key consideration in the world of construction is the cost because it takes such big amount and vulnerable to the risk of failure. In building construction projects, appropriate use of cost is both a demand and challenge that must be met. Not infrequently, a construction project cannot be completed due to lack of funds provided. Project cost overruns may happen due to various factors such as errors in planning or errors in cost calculations by the contractor. Budi [2] suggests that more than 50% of the causes of loss is due to errors in the estimating the project cost during the tender. Efforts should be made to meet the accuracy of the estimated costs by knowing the factors most responsible for influencing the cost of the construction project. Those factors vary, from both the internal and external of the construction project. These must be considered properly so the challenge of cost overrun that can lead to failure of the construction project can be avoided.

On that basis, this study will analyse factors that affect the cost of building projects in Indonesia. By knowing the factors, it is expected that the problems arising due to imprecision in estimating the cost of a building project can be solved.

2. Review of Related Literature

Many previous studies have discussed the factors that affect the cost of the building project. Henny [3] concludes four factors that have a positive and significant relationship with the incremental cost of building, i.e. fund, labor, cost estimation, and material factors. On the other hand, Ahmed, Dlask, and Hasan [4], find projects that have excess

* Corresponding author: luqman.academia@gmail.com

budget by 27% of the cost that has been provided. Sung, Hunhee, and Ung [5], using 71 building projects, perform cost estimation by using CCERI (Conceptual Cost Estimate Reliability Index) in four categories, namely procedures, project definition, project data, and team estimator. Gwang Jae et al. [6] review the estimated cost of the building by using factors of floor area, floor area, number of floors and number of classes, floor height, and basement. Yuliana [7] produces a study of factors affecting the price per m2 of a simple building (one-single floor building) in Indonesia and confirms that location, type of structure, type of building, room composition, and building size affect the price. Pratikto [8] finds that factors affecting the determination of RAB are the type of work, volume of work and the amount of material that refers to the design of the building associated with the floor area and the building owner desires.

Based on previous studies, many factors influence the cost needed for a building project. Overall, they indicate that factors influencing cost of a construction project can come from both external and internal of the construction projects. This is the basis to conduct research on factors influencing the cost of a building project.

3. Research Method

Construction work is strongly influenced by costs, equipment, materials, and human resources. Yusid [9] states that the number of construction projects in Indonesia in 2015 is huge because the government is boosting infrastructure development. The number of construction workers in Indonesia as many as 7.2 million people, among which only 5% have the certificate. This condition may indicate that the performance of the construction workforce in Indonesia is still low. As according Gugum [10], based on the cost of construction projects that exist, there are currently classification of construction services in Indonesia, namely small-scale construction companies usually working for project up to 25 billion, medium-scale companies which work on projects between 25-100 billion, and large-scale companies to work on projects above 100 billion. However, the problem is that, of the total 186,000 construction companies in Indonesia, 92% are small-scale, 6% are medium-scale, and only 2% large-scale companies. The big numbers of small-scale companies leads to the existence of problems related to the ability to provide the necessary equipment (procurement done by contractors or procurement by the involvement of outside parties), which indirectly affects the costs to be incurred, provision of certified manpower (one of whom related to manpower to estimate the cost of construction projects) as well as the ability to win the construction project.

Many variables must be taken into account in estimating cost of the construction project. Budi [11] states 20 of the most frequent errors in cost estimation by the estimator are inaccurately calculate the volume of work, inaccurately calculate productivity of labor, errors in calculating earthwork, error in determining implementation time, as well as errors in determining the productivity of the machine.

The variables used in this study consisted of two variables, namely the independent variables and the dependent variable. Independent variables consisted of four variables, namely floor area (X_1), the number of floors (X_2), foundation depth (X_3), and project implementation time (X_4). While the independent variable is the contract value (Y).

The study was conducted using sampling techniques, i.e. by simple probability sampling in which all members of the population can have the same opportunities to be a sample. The population in this study is all building construction projects in Indonesia; therefore, the entire building construction projects in Indonesia have the same opportunities to be a sample.

The number of samples used in this study was 81 samples of building projects. Roscoe [12] suggest that when analysis is done through multivariate regression or correlation form, the number of samples that can be used is at least 10 times the number of variables studied.

Data analysis was performed using multiple linear regressions, so research results obtained were in the form of factors, form a number of variables used in the study, which affected the estimate of cost incurred. Thus, the multiple linear regression equation that will be formed based on the variable used is as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 \quad (1)$$

In which:

Y = contract value (million, IDR)
a_0 = intercept constant
a_1 = regression coefficient for floor area
a_2 = regression coefficient for number of floors
a_3 = regression coefficient for foundation depth
a_4 = regression coefficient for implementation time
X_1 = floor area (m^2)
X_2 = number of floors
X_3 = foundation depth (m)
X_4 = implementation time (days)

To determine the variables that influence cost of building projects, t-test will be used. Trijono [13] says that the t-

test is used to test whether the independent variables significantly influence the dependent variable or not. This t-test is done by comparing the value of t_{table} and t_{count}. If the $t_{count} > t_{table}$, then these variables have a significant effect. The t_{table} have a significance value α of 0.05 and degrees of freedom (df) of (n-k). In multiple linear regressions, SPSS is used and regression uses stepwise method.

4. Results and Discussion

Based on the independent variables and the dependent variable defined in this study, the research sample data obtained and used is as seen in Table 1.

Table 1. The Sample Data Used in This Study

Sample	Year	Floor area (m^2)	Number of Floors	Foundation Depth (m)	Implementation Time (Days)	Contract Value (Million, IDR)
		X_1	X_2	X_3	X_4	Y
1	2015	507.93	1	2	120	1,396.82
2	2015	1,807	1	2	150	4,731.80
3	2015	3,830	4	4.2	170	7,797.80
4	2015	3,938.33	2	2	150	9,737.24
5	2015	840	3	2.85	180	2,650.00
6	2015	636.36	2	2	120	1,398.65
7	2015	336	2	2.8	180	2,348.30
8	2015	777.49	1	2	150	2,332.48
9	2015	429	1	1.2	150	1,528.00
10	2015	1,201.2	2	2	180	5,027.97
11	2015	571.65	2	2	120	1,456.50
12	2015	498	2	3.5	180	1,836.48
13	2015	587.47	2	2	120	1,398.65
14	2015	730	2	2.65	180	1,809.90
15	2015	495	1	2	150	1,919.00
16	2015	1,257	3	2.1	210	6,416.99
17	2015	509.35	1	2	120	1,782.74
18	2015	2,000	2	4.5	200	3,860.02
19	2015	1,359.46	2	2	150	3,865.47
20	2015	4,200	3	2.4	280	12,358.07
21	2015	2,448.98	2	2	180	5,494.78
22	2015	736	1	2	150	3,191.00
23	2015	603.45	2	2	120	1,398.66
24	2015	828.94	1	2	150	2,486.82
25	2015	3,922.7	2	4.5	217	10,941.49
26	2015	512	2	2.8	150	1,237.50
27	2015	165	1	1.1	150	767.62
28	2015	884	3	2	180	1,853.23
29	2015	4,848	2	12	270	12,143.40
30	2015	2,675	2	7	240	6,257.68
31	2015	1,755	3	5	200	8,366.67
32	2015	2,696	3	4.5	180	8,011.88
33	2015	1,020	4	6	150	5,550.55
34	2015	810.53	2	2.6	90	2,860.00
35	2015	1,848	12	3.8	180	5,550.00
36	2015	633.19	1	2	120	1,741.28
37	2015	644	1	2	150	2,408.00
38	2015	1,788	12	6.8	180	6,143.56
39	2015	1,417	1	2.1	180	3,499.09
40	2015	276	2	2	100	2,337.88
41	2015	226	8	2.6	110	1,150.00
42	2015	510	1	2.5	180	1,301.30
43	2015	544	2	2.1	180	2,456.46
44	2015	480	2	2.1	150	1,968.00
45	2015	253.76	2	1.5	180	1,142.00
46	2015	2,413	3	4.75	300	11,000.00
47	2015	1,080	4	4.5	180	3,000.00
48	2015	1,222.5	3	3.5	160	2,371.34
49	2015	1,241.84	2	2	120	2,912.50
50	2015	460	1	1.2	90	1,019.13
51	2014	180	1	2.4	150	680.08
52	2014	657.62	2	2.75	180	996.31
53	2014	648	2	6	195	2,888.35
54	2014	3,500	2	7.6	330	11,836.33
55	2014	460	1	1.2	90	940.50
56	2014	662.64	1	2.35	180	2,343.87
57	2014	553	2	2	180	3,638.16
58	2014	894.6	2	2.25	180	2,233.67
59	2014	396	2	2.9	180	853.35
60	2014	400	2	0.6	195	2,873.48
61	2014	704	2	2.3	150	2,973.48
62	2014	300	2	4	180	1,179.29

63	2014	429.5	2	1.5	180	1,064.11
64	2014	1,222.5	2	3.5	160	2,465.25
65	2014	1,080	5	8.5	180	7,907.72
66	2014	305	2	1.5	120	754.19
67	2014	1,241.84	2	2	120	2,687.80
68	2014	316	2	1.8	120	1,044.96
69	2014	948	2	1.8	180	1,754.66
70	2014	767	2	1.5	180	2,968.60
71	2014	293.38	2	3	140	1,830.36
72	2014	685.44	2	2	150	1,202.76
73	2014	266	2	1.8	110	996.31
74	2014	802.5	1	2.65	90	1,580.27
75	2014	664	1	1.25	120	1,107.10
76	2014	4,280	3	2.5	274	11,890.27
77	2014	2,550	1	2.5	150	1,779.08
78	2014	1,336	2	2.2	180	1,873.21
79	2014	1,875	3	2	200	3,751.71
80	2014	395.4	1	1.3	180	1,470.24
81	2014	4,692	2	8.7	275	12,179.79

Data obtained were sample data for the project in 2014 and 2015. To determine differences in the cost of a construction project then cost comparison based on sample data was done. According to Sugiyarto [14], there are some types of estimates for buildings, i.e. allocation function, estimation based on the cost per m^2 of floor area, estimation based on all components of the building, estimation based on the survey and calculation of preliminary quantity upon which the application of unit prices is only on the job attached, and estimation based on the calculation of the volume of work. Referring to this, then by doing a comparison based on the cost per m^2 of floor area, the following results in Table 2. are obtained.

Table 2. Comparison of Cost of Construction Project

No	Sample Year	Floor area (m^2)	Contract Value in Million (IDR)	Contract Value in Million / Floor area (Rp/m^2)
1	2015	65,454.13	196,214.648	2.9977
2	2014	21,491.73	58,876.549	2.7395

According to Table 2, in 2015 the average cost incurred for a building construction project every m^2 of floor area is IDR 2.9977 million. While in 2014, the average cost incurred for a building construction project every m^2 of floor area is IDR 2.7395 million. Thus, it can be said that the price increase per m^2 of floor area of the building from 2014 to 2015 as much as IDR 258,200.

Further analysis was conducted to determine the factors that affect the cost required for a building project based on the variables used in this study. The analyses were performed using multiple linear regression analysis.

Based on the available sample data, then multiple linear regression analysis was performed using stepwise method and the results are as seen from Table 3.

Table 3. Model Summary of Stepwise Method

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.904[a]	0.818	.816	1378.92065
2	0.925[b]	0.856	.853	1232.76859
3	0.930[c]	0.866	.861	1199.50939

a. Predictors: (Constant), Floor area (X_1)

b. Predictors: (Constant), Floor area (X_1), Implementation Time (X_4)

c. Predictors: (Constant), Floor area (X_1), Implementation Time (X_4), Number of Floors (X_2)

Table 4. ANOVAa Stepwise Method

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	675201110.124	1	675201110.124	355.103	0.000[b]
	Residual	150212350.975	79	1901422.164		
	Total	825413461.099	80			
2	Regression	706875426.645	2	353437713.323	232.568	0.000[c]
	Residual	118538034.454	78	1519718.390		
	Total	825413461.099	80			

3	Regression	714624106.418	3	238208035.473	165.558	0.000[d]
	Residual	110789354.681	77	1438822.788		
	Total	825413461.099	80			

a. Dependent Variable: Y

b. Predictors: (Constant), Floor area (X_1)

c. Predictors: (Constant), Floor area (X_1), Implementation Time (X_4)

d. Predictors: (Constant), Floor area (X_1), Implementation Time (X_4), Number of Floors (X_2)

Table 5. Partial Influence of Variable on Stepwise Method Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	503.065	223.853		2.247	0.027
		2.517	0.134	0.904	18.844	0.000
2	(Constant)	-1899.260	562.982		-3.374	0.001
	Floor area (X1)	2.033	0.160	0.730	12.728	0.000
	Implementation Time (X4)	17.902	3.921	0.262	4.565	0.000
3	(Constant)	-2186.751	561.626		-3.894	0.000
	Floor area (X1)	1.995	0.156	0.717	12.770	0.000
	Implementation Time (X4)	17.581	3.818	0.257	4.605	0.000
	Number of Floors (X2)	168.634	72.667	.098	2.321	0.023

a. Dependent Variable: Y

ANOVA test or analysis of variance, often referred to as the F-test, has the objective to determine significant difference of the mean of more than two samples and to know whether the two samples have the same population variance or not. Based on the test results of the sample data performed using stepwise method, the following results are obtained:

- The fit regression model was obtained after the three steps of stepwise, in which the last step resulted in the variable of floor area, number of floors, and implementation time significantly influenced the overall project.
- Simultaneously, three significant variables have a correlation with the contract value of 0.930 qualifies as a very strong correlation.
- The high correlation of the independent variables simultaneously was also associated with their coefficient of determination. R Square highest value was on the third model. The determination coefficient showed the contribution of the independent variables on the dependent variable. The ability of independent variables in explaining the variation of the variable contract value was 86.6%.
- The adjusted determination coefficient (R^2_{adj}) has increased from 0.816 in the first model to 0.861 in the third model, meaning that all variables affected contract value of 86.1%.
- Floor area, number of floors, and project implementation time simultaneously on recent calculations had a significant effect on contract. This was indicated by F_{count} (165.558) greater than F_{table} (2.72) and the significance value of less than 0.05.
- The test on partial effect showed that, based on the t value, floor area, number of floors, and implementation time had a significant influence on the value of the contract.
- The statistical value for floor area, number of floors, and project implementation time was positive. This shows that the cost of building projects will increase if the floor area, number of floors, and project implementation time also increases. Karnadi [15] states that the floor area is calculated to the outer most walls. The wider the floor of a building, the greater the cost to be provided by the project owner will be. In connection with the project implementation time, Dimyati and Nurjaman [16] state the direct costs will increase if the projects are accelerated, and yet the direct costs will also rise if the projects are slowing down.

5. Conclusion

Based on the results of research and discussion, of the four factors used as independent variables in this study, three factors significant affect the cost of the construction project. These factors are floor area, the number of floors, and the project implementation time. This is indicated by t_{count} for floor area of 12.770, t_{count} for the number of floors of 4.605, and t_{count} for project implementation time of 2.321. The results of this study can give such areal picture that addition to the floor area, number of floors, and the project implementation time can increase costs, so we need an accurate calculation on the project cost estimation phase.

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