

Cost Estimation Planning Model For Implementation Of Irrigation Network Improvement Projects In East Java Province, Indonesia

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Abstract: *This study generally examines, and in-depth analyses the estimated model of the planned budget plan for the Irrigation Network Improvement Project at the Public Works and Housing Department in the East Java Province, Indonesia. The research data is secondary data in the form of Recapitulation of Budget Plans (RAB) for Irrigation Works in six Cities / Regencies, such as Surabaya, Lamongan, Tuban, Pasuruan, Sidoarjo and Mojokerto, until 2013 to 2018. To equalize the homogeneity of the data, thus RAB data for each City / Regency is converted based on the HSPK of Surabaya and the project budget value is projected in 2019 based on the prevailing inflation in East Java Province. Data analysis use the Cost Significant Model method then the project budget planning. The results of the study concluded that the regression model for estimating effective, efficient and accurate project cost budget plans to be applied to the Irrigation Network Improvement Project in the Public Works and Housing Department in East Java Province is a regression equation $Y = 112,545 + 11,595 X_4 + 8,493 X_5 + 9,247 X_6$. Which X_4 , X_5 dan X_6 represent landfill work, masonry work and cement mixing work per meter length of channel. Comparison of the accuracy of the estimated project cost budget plan model with the actual HPS cost estimation model obtained an upper limit of 4.20% and a minimum lower limit = - 11.500% with an average comparison of - 2.45% which is stated as excellent accuracy.*

INTRODUCTION

In Indonesia, projects funded by The Regional Government Budget (APBD) or funded by The Indonesian State Budget (APBN) require an initial cost estimate as a proposal to be included in the Budget Implementation List (DIPA), (Pramoedjo and Huda, 2017; Akhsa et al., 2015). In this circumstance, an estimation budget planning on government projects is always made based on experience without any particular method. The specific purposes are needed to find out and compare which work items are influential. Additionally, to which extent the accuracy of the

actual budget planning costs in reducing cost overruns from the pre-construction calculation and to calculate the Self Estimated Price (HPS) before the work is auctioned by the project owner, (Akhsa et al., 2015). The construction budget planning and estimation are vital for the related parties involved in implementing a project, such as investors, consultant planners, contractors and project owners. For investment projects, the estimated project cost budget is needed by investors as the initial estimation in planning the investment capital. Financial aspects in project feasibility studies usually require preliminary data on the project cost budget plan as a basis for calculating cash flow, working capital planning, profit and loss calculation, NPV and other aspects. Whereas for a planning consultant, the accurate project cost estimate can be used as a comparison to determine the accuracy of the calculation of the budget (Azmi & Huda, 2017). Expenses forecast or cost estimation is the art of approximating the possible amount of costs required for an activity based on available information at the time of project implementation. The quality of a cost estimation related to the accuracy and completeness of its elements depends on (1) Availability of data and information, (2) Techniques or methods used, (3) Skill and experience of the estimator and (4) The purpose of the cost estimation. The availability of data and information plays an essential role in terms of the quality of the estimated costs generated. It also required skills, experience and judgment of the estimator and also depended on the cost estimation method used (Handayani et al., 2015; Kesavan et al., 2008). Several types of project cost estimation are often used in Indonesia according to the stage of project development, namely List of unit quantities and prices, Preliminary Estimate (PE), Semi-Detailed Estimate (SE), Definitive Estimate (DE), Element Cost Analysis (ECA), Quantity Take Off (QTO) and Cost Significant Model (CSM) (Handayani et al., 2015). Meanwhile, according to Challal and Tkouat (2012), there are several cost estimation methods such as analytical method, parametric method and analogy method. These methods cannot be used randomly; there must be a coherence of available information; it should consider the progress of the project and the ways that might be the most appropriate to use. Some previous studies related to the problem of estimating the cost budget, for example, concerning the estimated budget for multi-story building costs have been conducted by some scholars An *et al* (2010); Montes *et al.* (2014). Meanwhile, in terms of housing or apartments, researches have been carried out by Kim *et al.* (2004); Kim *et al.* (2005); An *et al.* (2008); Huda *et al* (2017); Amin (2017). Related to the bridge road carried out by: Kim *et al.* (2010); Mohammed and Mouloud (2012); Mahamed (2013); Pramodjo and Huda (2017). Related to hospital building and irrigation is carried out by: Aptiyasa (2015); Akhsa *et al.* (2015). Related to box culverts and dredging river carried out by: Fragkakis *et al.* (2015); Lee et al., (2011). Hyariet al., (2015) found the model that able to predict the cost of engineering services with an acceptable performance for conceptual cost estimation models. While Kim et al., (2011) proposed the model for River Facility Construction Based on CBR with GA.

With regards to the importance of the estimated construction budget, there are many studies and researches that discuss the estimated project cost budget in various fields, both in private projects and government projects. Then, this research, in general, will study and analyse in-depth about the estimated model of the budget plan for the Irrigation Network Improvement Project at the Irrigation Sector of Public Works and Housing Department of in East Java Province Indonesia.

METHODS

The object of this study was the Irrigation Networks Improvement Project in the Irrigation Sector of Public Works and Housing Department, East Java Province - Indonesia. The of the project research was carried out in 2013 until 2018. The research data are in the form of a recapitulation of the project cost budget owned by the work contractor. Data collection techniques using purposive sampling method in similar works carried out in 2013-2018. The project location is in the province of East Java - Indonesia, also selected purposively including the City: Surabaya, Lamongan, Tuban, Pasuruan, Sidoarjo and Mojokerto. The research data is secondary data in the form of recapitulation of project costs for the Irrigation Network Improvement Project. Secondary data were chosen purposively by considering the relative number and type of work items for each project carried out in different locations and years. Consideration of the nature and amount of relatively similar work items is expected to obtain relatively comparable data so that statistical analysis can be carried out in general. To anticipate, the occurrence of inflation, the difference in the year of project implementation is con- vested by analyzing net future value in 2019. While to anticipate variations in material prices and labor costs at different City locations, the conversion is doing based on the local unit price index in the same City. In this study, the unit price index in several cities was converted based on the unit price index in Surabaya City.

The stages of the study began with collecting secondary data in the form of cost for the Irrigation Network Improvement Project from the Public Works and Public Housing Service for the Irrigation Sector in East Java Province-Indonesia. The uniformity of data based on dimensions and influence of time value (inflation) and project location (HSPK), would determine the Significant Cost of Items to reach cumulative > 80% of the total project budget, conducting standard assumption tests including Normality Test, Multicollinearity Test and Autocorrelation Test. If all meet the requirements, then continue the Regression test. If one of the criteria does not meet the requirements, it is necessary to redesign the research data, analyzing the regression model includes tests: correlation coefficient, coefficient of determination and autocorrelation. If there is a model that passes the test, the Cost Model Factor (CMF) calculation is performed) and analyzing the comparison of accuracy between CSM and Actual Cost and make conclusions.

Table 1. Project budget data for several cities / regencies in East Java Province - Indonesia 2013-2018

Year	Location	Length (M')	Y (Rp)	X ₁ (Rp)	X ₂ (Rp)	X ₃ (Rp)	X ₄ (Rp)	X ₅ (Rp)	X ₆ (Rp)	X ₇ (Rp)	X ₈ (Rp)
2013	Krian	1,586	1,035,765,750	4,270,000	22,204,049	10,561,552	770,596,969	99,668,022	38,328,655	7,855,385	82,281,131
2013	Tuban	1,951	1,273,991,873	5,252,100	27,310,980	12,990,709	947,834,272	122,591,667	47,144,245	9,662,123	101,205,791
2014	Lamongan	2,213	1,858,340,125	5,625,000	51,040,000	24,278,075	1,371,824,075	109,306,638	153,783,300	42,429,338	100,678,700
2014	Surabaya	3,651	3,066,261,206	9,281,250	84,216,000	40,058,824	2,263,509,724	180,355,952	253,742,445	70,008,407	166,119,855
2015	Sidoarjo	2,282	1,476,115,840	4,960,000	32,358,036	12,703,626	1,170,454,178	111,507,694	71,230,188	13,594,988	59,307,142
2015	Pasuruan	2,380	1,554,270,085	6,407,562	33,319,396	15,848,665	1,156,357,812	149,561,834	57,515,979	11,787,790	123,471,065
2016	Mojokerto	1,218	1,649,048,675	4,920,000	108,655,875	16,073,296	1,171,179,986	130,913,808	77,009,267	46,833,763	93,462,682
2017	Pasuruan	1,856	1,740,782,495	7,176,469	37,317,723	17,750,505	1,295,120,749	167,509,254	64,417,897	13,202,325	138,287,593
2017	Jombang	2,443	1,810,379,986	4,960,000	69,919,285	22,182,224	1,433,375,731	132,863,235	17,082,773	28,187,779	101,808,960
2018	Nganjuk	1,923	1,550,176,324	4,900,000	56,313,706	16,973,830	1,171,378,761	115,798,694	70,626,851	27,477,808	86,706,669
2018	Lamongan	1,659	1,393,755,094	4,218,750	38,280,000	18,208,556	1,028,868,056	81,979,978	115,337,475	31,822,003	75,509,025
2018	Gresik	1,437	929,952,979	3,124,800	20,385,562	8,003,285	737,386,132	70,249,847	44,875,018	8,564,842	37,363,499

Source: The Irrigation Sector of Public Works and Housing Department in East Java Province

Project data used in this study are presented in Table 1. The average annual data for projects undertaken by each City / Regency is shown in Table 2. The effect of annual inflation is converted in 2018 as in Table 3 while the impact of differences in material unit prices for each Regency is equated with unit prices in Surabaya City by multiplying the unit price index as in

Table 4.

Table2. Annual average recapitulation of irrigation network improvement project of the PUPR office in East Java Province 2013-2018

Year	Location	Length (M')	Y (Rp)	X ₁ (Rp)	X ₂ (Rp)	X ₃ (Rp)	X ₄ (Rp)	X ₅ (Rp)	X ₆ (Rp)	X ₇ (Rp)	X ₈ (Rp)
2013	Tuban	1,768	1,154,878,812	4,761,050	24,757,514	11,776,131	859,215,621	111,129,845	42,736,450	8,758,754	91,743,461
2014	Surabaya	2,932	2,462,300,666	7,453,125	67,628,000	32,168,449	1,817,666,899	144,831,295	203,762,873	56,218,872	133,399,278
2015	Sidoarjo	2,331	1,515,192,963	5,683,781	32,838,716	14,276,146	1,163,405,995	130,534,764	64,373,084	12,691,389	91,389,103
2016	Mojokerto	1,218	1,649,048,675	4,920,000	108,655,875	16,073,296	1,171,179,986	130,913,808	77,009,267	46,833,763	93,462,682
2017	Pasuruan	1,890	1,645,479,409	6,038,235	46,815,714	17,362,168	1,233,249,755	141,653,974	67,522,374	20,340,067	112,497,131
2018	Lamongan	1,673	1,291,294,799	4,081,183	38,326,423	14,395,224	979,210,983	89,342,840	76,946,448	22,621,551	66,526,398

Source: Averaged secondary data

With X₁ = preparation work costs, X₂ = cost of soil excavation work, X₃ = cost of landfill work, X₄ = cost of masonry work, X₅ = cost of cement mixing work, X₆ = cost of plastering work, X₇ = cost of concrete work, X₈ = cost of other work, and Y = Total cost of work (real cost)

Table 3. The influence of inflation data per M1 length of irrigation network improvement project of the PUPR office in East Java Province 2013-2018 (thousands)

Year	Location	Length (M')	Y (Rp)	X ₁ (Rp)	X ₂ (Rp)	X ₃ (Rp)	X ₄ (Rp)	X ₅ (Rp)	X ₆ (Rp)	X ₇ (Rp)	X ₈ (Rp)
2013	Tuban	1,768	1,180,435	4,867	25,306	12,037	878,230	113,588	43,683	8,953	93,773
2014	Surabaya	2,932	1,328,527	4,021	36,488	17,356	980,716	78,143	109,940	30,332	71,976
2015	Sidoarjo	2,331	915,133	3,433	19,834	8,623	702,663	78,839	38,880	7,666	55,197
2016	Mojokerto	1,218	1,694,114	5,055	111,625	16,512	1,203,187	134,492	79,114	48,114	96,016
2017	Pasuruan	1,890	999,651	3,668	28,441	10,548	749,215	86,057	41,021	12,356	68,343
2018	Lamongan	1,673	817,092	2,583	24,251	9,109	619,614	56,533	48,689	14,314	42,095
	MEAN		1,155,825	3,938	40,991	12,364	855,604	91,275	60,221	20,289	71,234
	SD		321,636	925	35,045	3,745	213,251	28,025	28,494	15,884	21,154
	%		100	0.34	3.55	1.07	74.03	7.90	5.21	1.76	6.16

Source: Analysis results

Table 2 is the average cost budget of several projects carried out in the same year, taking into account the prevailing inflation value. Table 3 and Table 4 are the results of the conversion of the project cost budget per m channel length based on the HSPK applicable in each District.

Table 4. Effect of HSPK data per M1 length of irrigation network improvement project of the PUPR office in East Java Province 2013-2018 (thousands)

Years	Location	Length (M')	Y (Rp)	X ₁ (Rp)	X ₂ (Rp)	X ₃ (Rp)	X ₄ (Rp)	X ₅ (Rp)	X ₆ (Rp)	X ₇ (Rp)	X ₈ (Rp)
2013	Tuban	1,768	1,322,087	5,451	28,343	13,481	983,617	127,219	48,925	10,027	105,026
2014	Surabaya	2,932	1,328,527	4,021	36,488	17,356	980,716	78,143	109,940	30,332	71,976
2015	Sidoarjo	2,331	979,192	3,674	21,222	9,226	751,850	84,357	41,601	8,202	59,060
2016	Mojokerto	1,218	1,829,643	5,459	120,555	17,833	1,299,442	145,251	85,443	51,963	103,698
2017	Pasuruan	1,890	1,129,606	4,145	32,139	11,919	846,614	97,244	46,354	13,963	77,228
2018	Lamongan	1,673	906,972	2,867	26,919	10,111	687,772	62,752	54,045	15,889	46,726
	MEAN		1,249,338	4,269	44,278	13,321	925,002	99,161	64,385	21,729	77,286
	SD		332,519	1,021	37,718	3,625	218,700	31,310	27,235	16,748	23,501
	%		100	0.34	3.54	1.07	74.04	7.94	5.15	1.74	6.19

Source: Analysis results

RESULTS AND DISCUSSION

To find out the level of normality of the data which going to be analysed, a normality test is carried out using *Kolmogorov - Smirnov* number or values. After the Kolmogorov-Smirnov analysis, values are obtained as seen in Table 5, where the probability value of the dominant variables has a significance value ($\alpha = 0.05$) or $p > 0.05$, namely Asymp. Sig (2-tailed) of 0.954, so the analysed data were concluded to be normally distributed. Test results with SPSS using Test

for Linearity with a significance level of 0.05. Each of the relationships between the two variables, namely: 1) The value of the project (Y) with the masonry work (X_4), 2). The value of the project with cement mixing work (X_5) and 3) The value of the project (Y) with the plastering work shown successively. Two variables are said to have a linear relationship when the significance (Linearity) is less than 0, 05. The result from analysed it shows that the significance value of the deviation from linearity is all greater than 0.05, it can be concluded that the plastering work variable has a linear relationship with the value of the project. The Durbin Watson value obtained is 1.987, where the value is between -2 to +2, which means there is no autocorrelation. Heteroscedasticity test aims to examine whether the regression model occurs variance or residual inequality from one observation to another observation. Therefore it is decided that this research is free from the assumption of heteroscedasticity. multicollinearity test is performed to see whether there is an interconnectedness between perfect relationships among independent variables. If a conclusion found out that between the independent variables are bound to one another in the test, then it cannot be carried out into to the next stage which is caused by the regression coefficient of the variable cannot be determined. Thus the standard error value becomes infinite. The following multicollinearity test results have presented the results above, and it shows that the tolerance variable values of

Masonry Work Cost (X_4) = 0.347, Cement Mixing Work Cost (X_5) = 0.600 and Plastering Work Cost (X_6) = 0.485 are greater than 0.10. Meanwhile, the variable VIF Value of the masonry work cost (X_4) = 2.883, Cost of cement mixing work (X_5) = 1.666 and Cost of Plastering Work (X_6) = 2,061 are less than 10.00. So can be concluded that Multicollinearity does not occur.

Based on the results of partial regression analysis on each independent variable using the SPSS program, the most robust regression obtained and used for this study was Masonry Work items (X_4), Cement Mixing Work (X_5) and Plastering Work (X_6), to the dependent variable project cost (Y). From the results of calculations using the SPSS program, the results shown in Table 5 and Table 6 are obtained.

Table 5. Multiple Linear Regression Test Results

Model	Unstandardized Coefficient		Collinearity Statistic	
	B	Std. Error	Tolerance	VIF
Constant	112,545	1405,090		
Masonry work (X_4)	11,595	7,241	0,347	2,883
Cement mixing work (X_5)	8,493	6,637	0,600	3,666
Plastering work (X_6)	9,247	7,736	0,485	2,061

Source: Analysis results

Based on Table 5, it can be summarized that the value of B (constant) of each variable, and the regression equation is:

$$Y = 112,545 + 11,595X_4 + 8,493X_5 + 9,247X_6 \quad (1)$$

With Y = Project Cost for Irrigation Network Improvement per m length. (Rp / m), X_4 = Cost of Masonry Work per m length of channel (Rp / m), X_5 = Cost of Cement Mixing Work per m length of channel (Rp / m), and X_6 = Cost of Plastering Work per m length of channel (Rp / m).

In accordance with the regression equation above, then to predict the project cost of irrigation network improvement, the regression equation model above can be used. Shown that X_5 has the most significant coefficient of regression equation compared to X_4 and X_6 , and X_5 have the most influence in contributing to the work of an irrigation project in East Java.

Table 6. R square (R^2) test result

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.998 ^a	0.996	0.991	60,403

Source: Analysis results

From Table 6, a summary of the model obtained the standard error number of the estimate = 60,403 < standard deviation = 253,623. Thus, the regression model is feasible to be used as an irrigation network project cost model in East Java Province. For the coefficient of determination (R Square) = 0.996 which means that the influence of the variables X_4 , X_5 and X_6 on Y is 99.6% while the remaining 0.4% is influenced by other X variables that are not contained in the regression model.

The estimated model cost per meter of channel length (Y estimate) of 2018 Irrigation Network improvement Project is obtained:

$$Y = 112,545 + 11,595X_4 + 8,493X_5 + 9,247X_6 \quad (2)$$

The actual cost per meter of channel length (actual Y) is 906,972. CMF for the East Java Province Irrigation Network Improvement Project is obtained from a comparison between the estimated cost of the model and the actual cost:

$$CMF = \frac{747,805}{906,972} = 0,824 \quad (3)$$

Furthermore, the results of the Cost Model Factor (CMF) calculations can be seen in Table 7.

Table 7. Summary of CMF calculation results

Year	X_4	X_5	X_6	The Results of The Regression Equation (Y Model)	HPS Actual Cost (Y HPS)	CMF
2013	655,778	84,817	32,618	1,236,151	1,322,087,0	0,935
2014	782,834	62,376	87,757	1,329,856	1,328,527,0	1,001
2015	594,538	66,707	32,897	1,020,318	979,192,0	1,042
2016	1,079,938	120,715	71,010	1,833,302	1,829,643,0	1,002
2017	701,655	80,594	38,417	1,116,051	1,129,606,0	0,988
2018	602,152	54,940	47,317	747,805	906,972,0	0,824
		Total		7,283,483	7,496,027	
Source: Results of SPSS					CMF Average	0.972

The Cost Significant Model estimation results obtained from the calculation are compared with the implementation costs (actual costs) of the project under review. The level of accuracy is to calculate the differences from the estimated Cost Significant Model with the implementation costs, divided by the implementation costs, and multiplied by 100%. As a comparison, the accuracy of the method used so far has also been calculated, namely the stone length parameter to

the implementation cost. The results of the accuracy of the model are obtained every year as in Table 8 below.

Table 8. The accuracy of significant cost model

Year	Actual Total Cost	<i>Cost Significant Model</i>	
		Estimation Cost	Accuracy (%)
2013	2,185,515,578,0	2,337,449,816,0	(6.50)
2014	3,899,136,405,2	3,895,241,164,0	0.10
2015	2,378,361,407,2	2,282,496,552,0	4.20
2016	2,232,962,184,3	2,228,505,174,0	0.20
2017	2,109,335,875,9	2,134,955,340,0	(1.20)
2018	1,342,867,278,1	1,517,364,156,0	(11.50)
		Max	4.20%
		Min	-11.50%
		Average	-2.45 %

Source: Analysis results

Table 8 shows that the accuracy of the model has the greatest difference + 4.20% and the lowest - 11.50%, so that the accuracy of the regression model compared to the actual cost is - 2.45%.

CONCLUSIONS

Based on the results of the analysis above, it can be concluded that the estimated model of the project cost budget plan that is effective, efficient and accurate to be applied to the irrigation network improvement project in the Irrigation Sector of Public Works and Housing Department of East Java Province is in the form of regression equation is $Y = 112,545 + 11,595X_4 + 8,493X_5 + 9,247X_6$ with: Y = Irrigation Network Improvement Project Cost per meter length (Rp / m), X_4 = Cost of masonry work per meter length of channel length (Rp / m), X_5 = Cost of cement mixing work per meter length of channel length (Rp / m), X_6 = Cost of plastering work per meter length of channel length (Rp / m).

The accuracy comparison of the estimated model of the project cost budget plan with the actual HPS cost estimation model that has been used at the Irrigation Sector of Public Works and Housing Department in East Java Province obtained a maximum upper limit = 4.20% and a minimum lower limit = - 11,500% with an average ratio of - 2.45% which is stated as very good accuracy.

CONFLICT OF INTEREST

The author confirms that there is no conflict of interest to declare for this publication.

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