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Preleminary Cost Estimate Model for Maintenace And Improvement Of Road Project

1) Dyah Ratnawati, 2) # Miftahul Huda, 3) Priyoto

1) Department of Public Works, Bina Marga East Java Province-Indonesia
1) Student Program Master of Civil Engineering University of 17 August 1945 Surabaya
2)#) Lecturer of Civil Engineering, Faculty of Engineering, University of Wijaya Kusuma Surabaya
3) Lecturer of Civil Engineering, Faculty of Engineering, University of 17 August 1945 Surabaya
Corresponding author: Miftahul Huda

ABSTRACT

This study is a case study on preliminary cost estimation model for road maintenance and upgrading project at Public Works Department of Bina Marga East Java - Indonesia. The purpose of this study is to plan the initial project cost estimate. Data were collected from project cost budgets from 2010 to 2017 obtained from project contractors. The 2010-2017 project budget data is converted to 2017 per m2 on the basis of the inflation value prevailing in the year of project implementation. Data analysis using Cost Significant Model (CSM) and multiple linear regression with the help of SPSS software. The results of the study concluded that 87.23% of jobs affecting the cost of maintenance and upgrading projects consist of; (1) asphalt work, (2) bulking pavement work (3) stone pairs work, and (4) drainage work. The equation model of project cost estimation of maintenance and improvement of highway based on Cost Significant Model is in the form of regression equation, Y = 0,198 + 0,522 X1 + 0,323 X2 + 0,161X3 + 0,085X4. The results of this study have an estimated accuracy of -1.22 % to + 8.22 %, with an average of +2.05% accuracy. When compared to the estimation using the road length parameters per m2 used by the Public Works Department of East Java-Indonesia Province, the accuracy ranges from -18.68 % to +18.05 %, with an average of 1.35% accuracy.

Keywords: *preleminary, estimation, cost, road, CSM*

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I. INTRODUCTION

Estimates of budget planning for construction project costs are indispensable for the parties involved in implementing a project. For investment projects, the project cost estimation is required by the investor as a preliminary estimate for investing capital. The financial aspects of the project feasibility study usually require preliminary project cost budgeting data as the basis for calculating cash flow, working capital planning, profit and loss calculation, NPV and other aspects. While for consultant planners the accurate estimation of project cost budget can be used as a comparison to determine the accuracy of budget cost calculation [1].

In Indonesia, projects funded from the local government budget (APBD) as well as funded from the central government budget (APBN) require an initial cost estimate as a proposal to be included in the Budget Implementation Form (DIPA) [2,3]. Several ways to estimate proposals for project costs before they are approved by parliament. In planning the budget estimation on the project is always made based on experience without any special methods, so it takes certain methods to know and compare what work is influential, how the accuracy of the cost of existing budget planning to reduce cost overrun from pre-construction calculations and for calculating Self-Estimate Prices (HPS) before the work is conducted [3].

Cost estimation is the art of approximating the possible amount of cost required for an activity based on information available at that time. The quality of a cost estimate relating to the accuracy and completeness of its elements depends on the following: (1) Availability of data and information, (2) Techniques or methods used, (3) Expertise and experience of the estimator and (4) cost estimation. The availability of data and information plays an important role in terms of quality estimates of the resulting costs. It also requires the ability, experience and judgment of the estimator and also depends on the cost estimation method used [4,5].

Several types of project cost estimates are often used in Indonesia according to the stage of project development, namely: the list of quantities and unit prices, Preliminary Estimate (PE), Semi-Detailed Estimate (SE), Definitive Estimate (DE), Element Cost Analysis (ECA) Quantity Take Off (QTO) and Cost Significant Model (CSM) [4]. Meanwhile, according to [6] there are several cost estimation methods: analytical method, parametric method and analogy method. These methods can not be used randomly, there must be a synthesis of available information, it should be considered the progress of the project and the methods that may be most appropriate to use. Given the importance of these construction project cost estimates, many studies and studies have discussed the estimated cost of the project budget. As an illustration of some previous researchers who took the theme of research in terms of project cost estimation can be seen in Table 1

Tabel 1. Road map penelitian Estimasi Rencana Anggaran Biaya Proyek Konstruksi

No	Name Researcher	Research object	Methode
1	Kim et al. (2004) [7]	Apartment	Analogy Methode
2	Kim et al. (2005) [8]	Resedential Building	Cost Significant Model
3	Kaming et al. (2009) [9]	Irrigation	Cost Significant Model
4	Kim et al. (2010) [10]	PSC Beam Bridge	Aproximate Cost Estimate
5	An et al (2010) [11]	Building	AHP
6	Lee et al., (2011)[12]	River Dredging Construction	Aproximate Cost Estimate
7	Mianaei et.al (2012)[13]	Drilling Well	Case Based Reasoning (CBR)
8	Mohammed & Mouloud (2012)[14]	Concrete Bridge	Neural Network
9	Mahamed (2013)[15]	Construction Road	Regresi Model
10	Montes et al (2014)[16]	Building	Production Process
11	Akhsa et al (2015)[3]	Irigation	Cost Significant Model
12	Aptiyasa (2015)[17]	Hospital	Multi Regresi Linear
13	Fragkakis et al (2015)[18]	Culverts	Linear Regression
14	Montes et al (2016)[19]	Building	Model POP
15	Amin (2017)[20]	Resedential Bulding	Cost Significant Model
16	Huda et al (2017)[1]	Resedential Bulding	Cost Significant Model
17	Pramoedjo & Huda (2017)[2]	Prestressed Concrete Bridge	Cost Significant Model

Source : Some references

II. MATERIALS & METHODS

2. 1. Concept of Research and Data Collection

This study uses the sampling method, ie by collecting data from 2010-2017 from some populations that are considered to represent the overall characteristics of the desired population. Sampling should produce accurate and precise samples. Inaccurate and incorrect samples will give unexpected research conclusions or produce wrong conclusions [21]. In this research, data collection is done by reference as follows: (1) Data collected in the form of Bill of Quantity of road maintenance and upgrading project, (2) Price of work cost component and work implementation cost collected without Value Added Tax [22]. Technique of collecting data using sampling technique with purposive sampling method based on criteria of project name, location, year and work item appropriate with research purpose [2]. Prior to testing data required conversion due to the influence of inflation and the influence of unit price differences in every city in Indonesia. Furthermore, in order for the data to have homogeneous properties, the price of each component of the cost is converted into square meter of road area [4, 23, 2].

2.2. Data Analysis

Data analysis techniques, initially data grouped by year, location and influence inflation. Then after the results are grouped the feasibility technique of data analysis in this study was conducted based on the classical assumption test consisting of: (1) normality test, (2) Multicolinearity Test, (3) Heteroskedasticity Test and (4) Test Autocorrelation Test. In the normality test, the data will be considered normal if its probability value is more than 0.05 which can be seen with Kolmogorov-Smirnov test statistic. Multicollinearity test aims to determine whether or not there is a linear relationship between independent variables that can be seen from the variance of inflation factor (VIF). If the VIF is smaller than 5, then there is no multicollinear problem. Heteroskedasticity test aims to determine whether or not the inequality of variance and residual one observation to other observations in the regression model. If the level of significance is greater than 0.05, then the regression model does not experience heteroscedasticity. The autocorrelation test aims to test whether there is correlation between the confounding error in period t and the error in the previous period (t - 1) in a linear regression model. If the level of significance above 0.05, then it can be said that the residual is random and there is no correlation relationship [1, 2, 3, 4, 22].

2.3 Research Variables

In general, the project budget plan is prepared based on the price of each component of the work then summed to the total cost of the work. The total price of a job component is referred to as a bound variable (Y), whereas each work item is referred to as a free variable (X). Project item data of maintenance and upgrading of the road project to be researched consist of work items: preparatory work (X1), drainage work (X2), earthwork (X3), road shoulder work (X4), granular work (X5), work asphalt (X6), stone work (X7) and other work (X8). The relationship between variables needs to be modeled as multiple linear equations to describe a problem (dependent variable) that is influenced by more than one factor (independent variable) (Huda et al., 2017). The relationship is formulated as follows:

$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8$ …………….(2)

Where :
Y = dependent variable
X1 through X8 = Independent variable
a0 to a8 = coefficient of the regression equation

2.4. Determine the cost-significant items

Cost-significant items are identified as the largest items whose percentage is equal to or greater than 80% of the total cost. The independent variables identified as cost-significant items will then be analyzed using the SPSS program. By looking at the description of research results, obtained the proportion of each cost component (independent variable) to the total cost (variable erikat). The proportions are sorted from the largest to the smallest [1, 2, 3, 4, 22].

2.5 Model Analysis

The relationship between the dependent variable and the independent variable was analyzed based on the correlation coefficient and the determination coefficient. The resulting correlation coefficient (r) is used to describe the strength of the relationship between the dependent variable and the independent variable. The correlation coefficient that approaches 1, both in the positive and negative directions, indicates that the relationship between the dependent variable and the free variable is stronger. In addition, the accuracy of the regression model can be seen based on the coefficient of determination (R) which is getting closer to 1, it means more accurate. To determine the feasibility to be used in estimating the value of the dependent variable, the regression model needs to be tested by F test and t test. The regression model is considered to be eligible if the probability of t is less than the 0.05 significance.

2.6 Model Accuracy Analysis

Model test is done by dividing the estimated cost based on the regression model with Cost Model Factor (CMF). CMF is the ratio between model estimation cost and actual cost [1, 2, 3, 4, 22]. Accuracy is indicated by the percentage of margin between the estimated price and the actual price. The equations used to calculate accuracy are:

Accuracy = (EV-AV) / AV .... (3)

Where :
EV = estimated bill value (predicted cost)
AV = actual bill value (actual cost)

III. RESULTS AND DISCUSSION

3.1 Research Data

Data were collected from the winning contractors of tender for road improvement and maintenance work in East Jaa province of Indonesia. The results of data collection obtained by 8 time series data in the form of bill of quantity from several cities starting in 2010-2017. The recapitulation of the six work packages is shown in Table 2. Table 2 shows that the cost of road works and maintenance for each project package differs according to the length and width of the road. For data uniformity, the existing data is adjusted to be the cost per square meter of the size of the road. Each variable cost is divided by the width of the road and the results are shown in Table 3. To obtain uniformity of data then the data to be analyzed does not include the cost of applicable taxes and contractor profit plan.

Table 2. Road Maintenance and Improvement Project Data (2010-2017)

No	Project Name	Year Budget	Location	Area (m2)
1	Maintenance road Gresik – Lohgung	2010	Gresik	12.731
2	Maintenance road Lohgung – Sadang	2011	Sadang	4.305
3	Improvement road Bulu – Batas Tuban	2012	Bulu	33.900
4	Improvement road Bulu – Batas Tuban	2014	Tuban	10.080

5	Maintenance road Lohgung – Sadang	2013	Lohgung	14.960
6	Maintenance road Bulu – Sadang	2015	Gresik	43.122
7	Improvement road Bulu – Bts Tuban	2016	Tuban	24,205
8	Maintenance road Bulu – Sadang	2017	Gresik	18,230

Source: Secondary data

Table 3. Budget for Maintenance and Improvement Cost Road (2010-2017)

Var	Work Description	Breakdown of Bridge Budget / Year (x Rp 1000)							
		2010	2011	2012	2013	2014	2015	2016	2017
		Road 1	Road 2	Road 3	Road 4	Road 5	Road 6	Road 7	Road 8
	Area (m2)	12.731	4.305	33.900	10.080	14.960	43.122	24.205	18.230
Y	Total	3.341.980	1.546.894	4.154.554	4.564.540	3.942.524	8.120.725	6.702.290	4.010.377
X_1	Preparation	6.380	12.392	7.395	34.900	19.670	20.100	33.439	7.656
X_2	Drainage	465.550	224.496	657.250	365.750	175.000	875.600	297.500	558.660
X_3	Soil	178.400	235.704	9.755	13.083	124.060	409.020	210.902	214.080
X_4	Road Side	120.750	52.500	326.530	105.250	143.500	327.500	243.950	144.900
X_5	Grain	266.529	62.789	1.254.790	2.019.350	311.301	1.145.210	529.212	319.835
X_6	Asphalt	1.978.43 3	688.067	1.437.147	1.005.244	2.810.630	4.962.966	4.778.071	2.374.119
X_7	Masonry	250.500	235.750	235.890	735.650	252.600	159.133	429.420	300.600
X_8	Others	75.424	32.250	225.769	285.300	105.745	221.151	179.767	90.509

Source: Secondary data

Table 4. Cost Budget per Meter Square (2010-2017)

Var	Work Description	Breakdown of Bridge Budget / M2 (x Rp 1000)							
		2010	2011	2012	2013	2014	2015	2016	2017
		Road 1	Road 2	Road 3	Road 4	Road 5	Road 6	Road 7	Road 8
	Area (m2)	12.731	4.305	33.900	10.080	14.960	43.122	24.205	18.230
Y	Total	262,507	359,325	122,553	452,831	263,537	188,319	276,896	219,987
X_1	Preparation	501	2,878	218	3,462	1,314	466	1,381	419
X_2	Drainage	36,568	52,147	19,387	36,284	11,697	20,305	12,290	30,645
X_3	Soil	14,013	54,751	287	1,297	8,292	9,485	8,713	11,743
X_4	Road Side	9,484	12,195	9,632	10,441	9,592	7,594	10,078	7,948
X_5	Grain	20,935	14,571	37,014	200,332	20,808	26,557	21,863	17,544
X_6	Asphalt	155,402	159,829	42,393	99,726	187,876	115,091	197,400	130,231
X_7	Masonry	19,676	54,761	6,958	72,981	16,885	3,690	17,740	16,489
X_8	Others	5,924	7,491	6,659	28,303	7,068	5,128	7,426	4,964

Source: Secondary data analysis results

3.2. Calculation of influence of inflation value

Calculation of the effect of time value due to inflation, each variable can be calculated by calculating the index of each price per square meter variable multiplied by the value of inflation in 2010 until 2017. Data magnitude value inflation in the province of East Java-Indonesia from 2010- 2017 can be seen in Table 5. Then the influence of time value on the index of permeter square work unit price can be seen in Table 5

Table 5. General Inflation in East Java Province (2010-2017)

No	Year	Inflation	Coeffisien
1	2010	1.83%	0.0183
2	2011	0.93%	0.0093
3	2012	1.28%	0.0128
4	2013	2.96%	0.0296
5	2014	2.38%	0.0238
6	2015	0.85%	0.0085
7	2016	0.65%	0.0065
8	2017	0.16%	0.0016

Source : *Indonesian Statistics,East Java* (2017)[24]

Table 6. Cost Budget per Meter Square (2010-2017) After Inflation

Var	Work Description	Breakdown of Bridge Budget / M2 (x Rp 1000)							
		2010	2011	2012	2013	2014	2015	2016	2017
		Road 1	Road 2	Road 3	Road 4	Road 5	Road 6	Road 7	Road 8
	Area (m2)	12.731	4.305	33.900	10.080	14.960	43.122	24.205	18.230
Y	Total	292,371	393,011	132,807	484,517	273,871	191,154	278,696	219,987
X_1	Preparation	558	3,148	236	3,704	1,366	473	1,390	419
X_2	Drainage	40,728	57,036	21,010	38,823	12,156	20,610	12,370	30,645
X_3	Soil	15,607	59,884	311	1,388	8,617	9,627	8,769	11,743
X_4	Road Side	10,563	13,338	10,438	11,172	9,968	7,709	10,144	7,948
X_5	Grain	23,317	15,937	15,937	40,111	21,624	26,957	22,005	17,544
X_6	Asphalt	173,081	174,813	45,940	106,704	195,243	116,824	198,683	130,231
X_7	Masonry	21,914	59,895	7,540	78,087	17,547	3,745	17,856	16,489
X_8	Others	6,598	8,193	7,216	30,284	7,345	5,205	7,475	4,964

Source: Secondary data

3.3. Determining Cost Significant Items

Determination of Cost Significant Items by first calculating the mean and standard deviation values of each item variable as shown in Table 7. Then sort the job cost variables from the largest to the smallest value to get the percentage of each work item. Cost Significant Items are identified as the largest items whose percentage is = 80%.

Table 7. Calculation of Mean and Standard Deviation (x Rp 1000)

Variable	Uraian Pekerjaan	Mean (Rp)	Std.Deviasi Rp)	persent
Y	Total	292,347	117,816	100,00
X1	Total	1,553	1,361	0.53 %
X2	Preparation	28,962	16,904	9.91 %
X3	Drainage	14,886	20,511	5.09 %
X4	Soil	14,886	1,669	5.09 %
X5	Road Side	52,043	71,962	17.80 %
X6	Grain	144,470	56,502.	49.42 %
X7	Asphalt	29,512	28,184	10.10 %
X8	Masonry	10,331	8,847	3.53 %

Source: Results of SPSS Analysis

Based on Table 7, the work items are sorted according to the largest percentage value as follows:

1. Asphalt Works (X6) : Percentage = 49.42%

2. Work Grained (X5) : Percentage = 17.80%
3. Masonry Work (X7) : Percentage = 10,10%
4. Drainage Work (X2) : Percentage = 9.91%

Amount = 87.23%

3.4 Normality Test

After analysis Kolmogorof - Smirnof obtained value as seen in Table 8, where the probability value of dominant variables have p > 0,05 so that the data to be analyzed can be concluded normal distribution. Based on the normality test with One-Sample Kolmogorov-Smirnov Test obtained Asymptut sig.sebesar value 0.109 greater than 0.05.

Table 8 Normality Test Based on Kolmogorov Value - Smirnov

Remarks Analisys		Unstandardized Residual
N		8
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	0,01036811
Most Extreme Differences	Absolute	0,263
	Positive	0,141
	Negative	-0,263
Test Statistic		0,263
Asymp. Sig. (2-tailed)		0,109[c]

Source: Results of SPSS Analysis

Since the sig value is greater than 0.05, then the decision is to accept Ho which means that the data is normally distributed. Means the normality assumption for all data N = 8 which consists of: (1). Work Grained (X5), (2). Asphalt Works (X6), (3). Stone Work (X7) and (4). Drainage work (X2), all of which are normally distributed. The test results are shown in Table 4.10

3.5 Multicolinearity Test

The test results are shown in Table 9. Based on multicollinearity test results, it can be seen that the value of variance inflation factor (VIF) of all variables studied is smaller than 5 where the variable is Drainage Work (X2), Pavement Grain (X5), Asphalt Pavement (X6) and Masonry (X7)). Based on Table 9, it can be concluded that in this study there is no violation of multicollinearity assumptions.

Table 9 Multiple Linear Regression Test Results

Variabel	Correlations			Collinearity Statistics	
	Zero-order	Partial	Part	Tolerance	VIF
Drainage Work (X2)	0,241	0,958	0,149	0,329	3,044
Pavement Grain (X5)	0,296	0,987	0,275	0,292	3,419
Asphalt Pavement (X6)	0,755	0,998	0,719	0,895	1,117
Masonry (X7)	0,672	0,977	0,207	0,438	2,283

Source: Results of SPSS Analysis

3.6 Autocorrelation Test

The autocorrelation test is performed by Runs test. From the results of Runs test, obtained a significance of 1,000. Thus, it can be concluded that there is no autocorrelation between residual values. The complete autocorrelation test results can be seen in Table 10.

Table 10 Autocorrelation Test Results

	Unstandardized Residual
Test Value[a]	0,01116[b]
Cases < Test Value	7
Cases >= Test Value	1
Total Cases	8
Number of Runs	3
Z	,000
Asymp. Sig. (2-tailed)	1,000

Source: Results of SPSS Analysis

3.7 Multiple Linear Regression Test

The results of multiple linear regression analysis can be seen in Table 11. From Table 11 it is known that four coefficients, the significance value indicates that the drainage work (X2) = 0,000 < 0.05, the bulked pavement (X5) = 0,000 < 0.05, the asphalt pavement (X6) = 0,000 < 0.05 and the stone installation (X7) = 0,000 < 0.05, meaning that all variables significantly influence the total cost (Y) at 95% confidence level.

Table 11 Multiple Linear Regression Test Results

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0,198	0,169		1,169	0,327
Drainage Work (X2)	0,085	0,015	0,261	5,756	0,010
Pavement Grain (X5)	0,323	0,031	0,508	10,593	0,002
Asphalt Pavement (X6)	0,522	0,019	0,760	27,707	0-,000
Masonry (X7)	0,161	0,020	0,313	7,993	0,004

Source: Results of SPSS Analysis

Based on the value of B constant and coefficient value in Table 11, it can be made linear regression equation (model):

$Y = \alpha + \beta_1 X_2 + \beta_2 X_5 + \beta_3 X_6 + \beta_4 X_7$

Y = 0,198 + 0,085X2 + 0,323X5 + 0,522X6 + 0,161X7

Dimana :

Y = Total Cost

α = Constanta value

X_2 = Drainage Work

X_5 = Pavement Grain

X_6 = Asphalt Pavement

X_7 = Masonry

3.8 Correlation Coefficient and Coefficient of Determination

Correlation analysis aims to measure the strength of the linear relationship between two or more variables. Determination analysis aims to determine the percentage of variation in the dependent variable that can be explained by independent variables. Table 12 shows the results of the correlation analysis, while Table 12 shows the results of the determination analysis.

Table 12. Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	$0,999^a$	0,998	0,995	0,01584

Source: Results of SPSS Analysis

Based on Table 4.14 obtained R2 = 0.998 = 99.8% means free variable consisting of drainage work variable (X2), Pavement Grain (X5), Asphalt pavement (X6) and Stone Couple (X7) gives an effect of 99.8% to variable Y = total cost of road improvement and maintenance work in East Java Province.

3.9 Cost Factor Model Analysis

In this study the cost of model estimation is calculated by entering the unit price of independent vairabel X2 X5, X6 and X7 per meter square, into the regression equation. The result of cost estimation with Cost Significant Model is obtained by dividing model estimation cost with Cost Model Factor (CMF). CMF is the average ratio of the estimated cost of the model to the actual cost. Next the calculation of Cost Model Factor (CMF) can be seen in Table 13.

Table 13. Summary of CMF Calculation Results

Var	Work Discription	2010	2011	2012	2013	2014	2015	2016	2017
		Road 1	Road 2	Road 3	Road 4	Road 5	Road 6	Road 7	Road 8
X_2	Drainage	40,728	57,036	21,010	38,823	12,156	20,610	12,370	30,645
X_5	Grain	23,317	15,937	15,937	40,111	21,624	26,957	22,005	17,544
X_6	Asphalt	173,081	174,813	45,940	106,704	195,243	116,824	198,683	130,231

X_7	Masonry	21,914	59,895	7,540	78,087	17,547	3,745	17,856	16,489
Y	Total	292,371	393,011	132,807	484,517	273,871	191,154	278,696	219,987
	Actual cost	295,353	425,238	133,112	478,606	285,319	189,223	284,298	226,609
	CMF	1.02	8.2	0.23	-1.22	4.18	-1.01	2.01	3.01

Source: Analysis results

IV. CONCLUSION

Some of the work that significantly influences 87.23% of the overall cost of road improvement and maintenance projects in the Ministry of Public Works of the Province of East Java -Indonesia are: asphalt work, granular pavement, drainage work and masonry work. Multi-linear regression equation model is: Y = 0,198 + 0,085 X2 + 0,323 X5 + 0,522 X6 + 0,161 X7 . The results of this study have an estimated accuracy of -1.22 % to + 4.18 %, with an average of 2.05% accuracy. Meanwhile, when compared with the result of manual calculation of cost per m2 of road area obtained accuracy between -18,68% to + 18,05%, with average accuracy 1.35%.

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REFERENCES

[1]. Azmi.A.F & Huda, M. The Application on Cost Significant Model on The Estimated Cost of Resedential Project in Surabaya and its Surrounding. *Proceedings of The 2017 International Conference on Technology and Applications Surabaya, Indonesia, 2017. July 29,*

[2]. Pramoedjo, H. Huda, M. Cost Estimate Modelling of Prestressed Concrete Bridge at the Public Works and Housing Department of Bina Marga East Java Province Indonesia. *International Journal of Engineering and Technology* (IJET). Vol. 9, No. 6. 2017. pp. 4543-4550.

[3]. Akhsa, E. Azmeri. Hafnidar. *Model* Estimasi Biaya Pekerjaan Rehabilitasi dan Peningkatan Jaringan Irigasi Menggunakan “Cost Significant Model “ (Studi Kasus : Dinas Pengairan Kabupaten Aceh Tenggara. *Jurnal Teknik Sipil Pasca Sarjana Universitas Syiah Kuala*. Vol.4, No.4, 2015. pp.83-93.

[4]. Handayani, F.S. Sugiyarto. Panuwun, R.T.. Komponen Biaya yang Mempengaruhi Estimasi Biaya Peningkatan Jalan Provinsi. . *e-Jurnal Matrik Teknik Sipil*. September 2015. pp. 903-907.

[5]. Bari, Nor Azmi Ahmad. *Exploring The Types of Construction Cost Modelling for Industrialised Building System (IBS) Projects in Malaysia*. Universiti Putra Malaysia 2012.

[6]. Challal, A. Takiouat, M. The Design of Cost Estimating Model of Construction Project: Application and Simulation. *Open Journal of Accounting*, 2012, 1, 15-26

[7]. Gwang –Hee Kim, Sung -Hoon, Kyung in . “*Comparison of Construction Cost Estimating Models Based on Regression Analysis, Neural Networks, and Case – Based Reasoning*” Building and environment 39. 2004

[8]. Kim, G.H., D.S. Seo and K.I. Kang,. Hybrid models of neural networks and genetic algorithms for predicting preliminary cost estimates. *J. Comput. Civil Eng.*, 19: 2005. pp. 208-211.

[9]. Kaming, P. F. Ervianto, W.I. Kushartini, (2009). *Pengembangan Cost Significant Model Untuk Estimasi Biaya Proyek Pengairan. Konferensi Nasional Teknik SIpil 3 (KoNTekS 3)*, Universitas Atmajaya. Jakarta.

[10]. Kim, K.J. & K. Kim, Preliminary Cost Estimation Model Using Case-Based Reasoning and Genetic Algorithms. *J. Comput. Civil Eng.*, 24 (6), 2010. 499-505.

[11]. An, S.H., G.H. Kim and K.I. Kang, (2007). A Case-Based Reasoning Cost Estimating Model Using Experience by Analytic Hierarchy Process. Build. Environ., 42: 2573-2579.

[12]. Lee, J.Y. Lee, S. Woo, S. Shin. D.H. Framework of the approximate cost estimating model for river dredging construction, *KSCE Journal of Civil Engineering* (2014) 15(1):33-42

[13]. Mianaei, H. S.and Iranmanesh, S. H.). Case-Based Reasoning Method in Cost Estimation of Drilling Wells. Research Journal of Applied Sciences, Engineering and Technology 5(4): 2012. 1086-1112,

[14]. Project Management Using Cost Significant Items and Neural Network Mohammed, B. & Mouloud, B Proceedings of the 2012 *International Conference on Industrial Engineering and Operations Management Istanbul*, Turkey, July 3 – 6, 2012.

[15]. Mahamid, I. „Early Cost Estimating for Road Construction Projects Using Multiple Regression Techniques‟ ,*Australasian Journal of Construction Economics and Building,* 11 (4), 2011. 87-101

[16]. Montes M.V. Falcón, R.M. and Ramírez-de-Arellano Estimating Building Construction Co sts by Production Processes. *The Open Construction and Building Technology Journal*,2014, 8,171-181.

[17]. Aptiyasa, P. A. A. *Cost Model Konseptual Untuk Bangunan Gedung Rumah Sakit*. Tesis Magister Teknik Sipil (S-2), Program Pasca SarjanaUniversitas Atmajaya Yogyakarta.2016

[18]. Fragkakis, N. I., Marinelli, M., & Lambropoulos, S. Preliminary Cost Estimate Model for Culverts. *Procedia Engineering,* 123, 2013. 153-161.

[19]. Montes, M, Falcón,R. Ramírez, V. Estimating Building Construction Costs: Analysis of The Process - Based Budget Model (POP Model). Revista Ingeniería de Construcción. Vol. 31, No.1 pp. 17-25

[20]. Amin, M. Development of Cost Estimation Model for Residential Building. International *Journal of Civil and Structural Engineering Research*, Vol. 5, Issue 1,2017. pp: (1-4)

[21]. Sugiyarto, Muali, A. Harton, W. (2016). Estimasi Biaya Konstruksi Bangunan GedungDengan Metode Cost Significant Model Studi Kasus Proyek Lanjutan Pembangunan Gedung Di Universitas Sebelas Maret Surakarta. *e-Jurnal Matrik Teknik Sipil*. Pp. 498-504.

[22]. Falahis, V.D. Sugiyarto. Laksito, B. Cost Significant Model Sebagai Dasar Pemodelan EStimasi Biaya Konstruksi Jembatan Beton Bertulang. *e-Jurnal Matrik Teknik Sipil. Desember 2015*. pp. 957-964

[23]. Fikri, R.M & Sekarsari, J. Analisa Estimasi Biaya Proyek Peningkatan Jalan Beton di Kabupaten Tangerang Dengan Metode Cost Significant Model. *Proceeding Seminar Nasional Teknik Sipil V Tahun 2015 – UMS. 2015. Pp. 337-347*

[24]. BPS. (2017) *Data Inflasi Kota Surabaya*. Diakses pada http://klatenkab.go.id/web/ content/ daftarrumah. Pada tanggal 25 Mei 2017, Pk 09.00WIB

MIftahul Huda." Preleminary Cost Estimate Model for Maintenace And Improvement Of Road Project " The International Journal of Engineering and Science (IJES) 7.2 (2018): 41-49