IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 6 Ver. I (Nov. - Dec. 2018), PP 01-08
www.iosrjournals.org

Application of Cost Control to Construction Projects

Opara Hyginus Emeka
Department Of Civil Engineering Imo State University, Owerri.
Corresponding Author: Opara Hyginus Emeka

Abstract: *A high rate project abandonment due to cost over-run has really defaced the most cities. Among the success parameters of construction project namely: cost, quality and time, the project cost was the most significant among the professionals in the construction industry. The sample size of 50 was used for the study. The field data were subjected to statistical analysis using the multiple regression analysis. Among the five independent variables only construction project quality control and the construction methods/techniques indicated significant statistical relationship to the cost control methods adopted for construction project. While the others project design control, socio-economic factors, laws and regulations governing construction projects showed insignificant relationship to the control of the cost of construction projects.*
Keywords: *Cost Control, Project Design, Cost Over-run, Project Quality, Construction Regulations.*

Date of Submission: 01-11-2018 Date of acceptance: 15-11-2018

I. Introduction

Construction projects involves thousands of details and integrated inter-relation among owners, architects, engineers, quality surveyors, project financiers, general contractors, special contractors, manufacturers, material dealers, equipment distributors, government bodies and agencies, labour and others. The contractor assures the responsibility for the delivery of the completed facility at a specified time, material specification and cost. The cost of construction projects involve the labour, material, equipment and subcontractors cost including the taxes associated with the cost of the construction project.

The cost of construction projects most of the time represents a substantial increase over the initial estimates. The factors causing the cost overruns are most of the time not documented. Comparison of the historical cost data, initial cost estimate and the actual cost are updated at the construction project sites. Most construction managers have no method related changes into the Bill of Engineering Measurement and Evaluation (BEME) to reflect accurately the cost of resources. Target cost is often not properly monitored up to the project actualization.

Cost comparison data during the construction activity provide the contractor with opportunities to adjust the factors involved with the activity. The contractors need to determine some information from their insurance partners and Banks.

Project cost control as a modern management technique is designed to achieve the best balance between functional reliability and cost. Its primary purpose is to achieve the optimum balance while fulfilling the specified function at the least possible cost. Active cost control enables the contractor to achieve a profit on construction activities. It is only with highly skilled project management that uncertainties can be kept to a minimum and construction quality and cost objectives fully attained.

II. Materials And Method

The study made use of a combination of simple and multiple regression analysis of respondents answers to research questions using statistical and quantitative methods. The study avoided manual approach and therefore made use of computer-aided methods.

The correlation matrix operation was performed to establish whether there exist any multi-collineanity problems among the variables to be used for analysis.

The sample size of the survey was fifty.

The consultants were mainly project managers, engineers, architects, quantity surveyors, builders and estate surveyors. The contractors include representative in large, medium and small sized construction companies designated either as site agents, or site engineers. The client organization includes private developers State and Federal government agencies and some parastatals that were investing in construction projects.

Six basic questions were asked and the numerical summation of the ratings of a respondent formed the observed value for the variable for that particular respondent. This was repeated for all the variables and all the respondents. All these now formed the distribution for the independent variables. The same was done for the assessment of cost control methods as applicable to construction industry in Nigeria which formed the dependent variable. The questions were based on a five-period scale of rating as made popular by Likert. A respondent was asked to indicate whether he/she "strongly agree", agree "neutral", "disagree", or "strongly disagree" with statements made about the State of control of the cost of construction projects.

2.1 ANALYSIS MODEL FORMULATION

In this study the linear regression model was adopted for analysis. Its formulations are as follows:

$$Y = A_0 + B_1X_1 + B_2X_2 + \ldots\ldots BnXn + e_0$$

Where:

A_0, B_1, B_2 . . . . . Bn represents the coefficients to be estimated.

Y: Is the dependent variable which represents an assessment of the state of application of cost control on construction projects.

X_1: Is a composite variable representing the control of the project design and its effect on the project cost.

X_2: Is the application of quality control measures on construction projects and their impact on project cost.

X_3: Is for the socio-economic variables and their impact on the control of the cost of construction projects.

X_4: Is for the construction techniques and methods applied to construction projects and their effects on the control of the cost.

X_5: Is for the law and regulations governing construction projects contracts and their impact on the control of the cost.

The regression parameters were computed using the following formulae:

$$B_1 = \frac{N\Sigma X_1 Y_1 - [\Sigma X_1][\Sigma Y_1]}{N\Sigma X_1^2 - [\Sigma X_1]^2}$$

And

$$a0 = \frac{\Sigma Y1 - B_1\Sigma X_1}{N}$$

The correlation coefficient [R] is determined using:

$$R = \frac{N\Sigma X_1 Y_1 - [\Sigma X_1][\Sigma Y_1]}{\sqrt{[N\Sigma X_1^2] - [\Sigma X_1]^2][N\Sigma Y^2 - [\Sigma Y_1]^2]}}$$

The coefficient of determination is determined using the formula:

$$R^2 = \frac{SSR}{SST}$$

Where

$$SSR = \frac{B_1[\Sigma X_1 Y_1] - [\Sigma X_1 \Sigma Y_1]}{N}$$

And

$$SST = \Sigma Y^2 - \frac{[\Sigma Y_1]^2}{N}$$

SSR is the sum of square due to regression while SST is the total sum of squares, which is equal to:

$$SSR + SSE$$

Where "n" is the number of observations for each of the projects.

The R^2 [coefficient of determination] measures the proportion of the total variation in the assessment of the application project cost control in the construction industry, that is, our dependent variable [Y], that is explained by the variations in the selected aggregates of construction project cost control, that is, the independent variables, put together.

The value of R^2 is expected to range from:

$$O \leq R^2 \leq \pm 1$$

The Correlation Coefficient [R]

The multiple correlation coefficient [R] measures the strength of contribution of the selected aggregates of construction project cost control on the level of application of cost control to construction project.

This is calculated using the formula:

$$R = \pm \sqrt{R^2}$$

Where:

$$-1 \leq R \leq +1$$

The F-Ration Test

The F-ratio is used to test the significance of the contribution of all the selected variables of construction project cost control on the control of the cost of construction projects in Nigeria.

This is carried out using the analysis of variance table (ANOVA)

ANOVA TABLE

Source of variance	Sum of squares	Degree of Freedom	Mean Squares	F-Rato
Regression	$SSR = R^2 \Sigma Y^2$	K	$MSR = \frac{SSR}{k}$	$F^* = \frac{MSR}{MSE}$
Error	$SSE = \Sigma Y^2 - R^2 \Sigma Y^2$	n – k – 1	$MSE = \frac{SSE}{n-k-1}$	
Total	$SST = \Sigma Y^2 - [\Sigma Y]^2$	n – 1		

Source: Onyeka (1990).

Having computed the F-value, the null hypothesis [H_o] is accepted at ∞ - 0.05 significance level if: $F^* < F_1 - \infty$: k, n-k-1 degrees of freedom.

Otherwise, H_o is rejected in favour of the alternative hypotheses [H_A] for a one-tail test. Here, F_1-∞: k; n-k-a is the critical value obtainable from the F-distribution table.

THE STUDENT T – TEST

If the F-ratio test reject the null hypothesis, that is, accepting that the selected aggregates of construction project cost of control made a significant contribution to the variation in the control of the cost of construction projects, then the student's T-test is carried out to find out which of the selected aggregates of construction project cost control contributed to the significance established by the F-ratio test.

The T-test value is calculated using the formula:

$$T = R \frac{\sqrt{n-2}}{1-R^2} \quad \text{for } n-2 \text{ degrees of freedom}$$

The null hypothesis [H_0] that is b = 0 is accepted at $\infty = 0.05$ significant level and

n – k – 1 degrees of freedom if:

$t\ cal < t_{1-\infty/2}$: n – k – 1

Where

T1 - ∞/2 n – k – 1 is the critical value obtainable from the t-distribution table. Otherwise, the alternative hypothesis [H_A], that is, $B1 \neq O$ is accepted if; t-calculated $\geq t_{1-\infty/2}$ n – k – 1

THE P-VALUE ESTIMATE

This measures the probability of our estimate. That is the probability of our estimate to assume error in estimation to the maximum of our chosen level of significance.

For this study, estimates can only be accepted if the P-value is less than or equal to 0.05.

TESTING FOR MULTI-COLLINEARITY OF ANALYSIS VARIABLES

This test is done using the Correlation Matrix of the variables. The objective of this test is to establish whether the sampled respondents understood the variables as being different from each other and whether the distribution of their responses equally shows the same.

If the correlation coefficient for two variables is chose to unity (1.0), it then means that the respondents were unable to distinguish between those two variables and therefore their assessment of the two variables was not significantly different from each other. This implies a multi-collinearity problem, which leads to the elimination of one of such variables from the analysis of the relationship model.

CORRELATION MATRIX

	Y	**X1**	**X2**	**X3**	**X4**	**X5**
Y	1					
X1	0.08587006	1				
X2	-0.4217232	0.00685623	1			
X3	-0.1717265	0.218009008	0.157847	1		
X4	-0.0001646	0.300778633	0.532889	0.256527	1	
X5	-0.2141381	-0.02668669	0.693781	0.075306	0.476760501	

Source: Computer Analysis

III. Discussion

The distribution of the correlation coefficients for the independent variables shows that the highest value is 0.693781 for variables X_2 and X_5; while the lowest is 0.00686 for variables X_1 and X_2. All the correlation coefficient for independent variables indicated positive correlation among the independent variables except the correlation between X_1 and X_5,which is negative.

Furthermore, the correlation between the dependent variable and the stream of independent variables, shows that X_2 and X_5 X3, and X_4 are all negatively correlated with the dependent variable, meaning that they have negative impact on the application of cost control to construction projects in Nigeria as being represented by the views of construction professionals located in Imo and Abia States.

However, X_1, which stands for variations in project design made a positive impact on the control of the cost of construction projects of these areas.

Above all, the correlation coefficients for all the variables are far away from unity, and therefore are statistically significantly different from each other. It can therefore be concluded that the variables are assessed by our respondents are significantly different from each other and can therefore be used as independent variables for further analysis.

3.1. STEPWISE INTRODUCTION OF INDEPENDENT VARIABLES IN THE CONSTRUCTION PROJECT COST CONTROL MODEL

The selected variables of construction cost and its control were introduced into the cost control model for construction projects in order of their intensity in correlation with the dependent variable Y as indicated by the correlation coefficient matrix. To this end, variable X_2, which shows a correlation level of -0.432, which represents constructions project quality control activities was the first to be introduced.

3.2. REGRESSION OF Y ON X_2

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.43172324
R Square	0.18638495
Adjusted R Square	0.16943464
Standard Error	2.2568186
Observations	50

ANOVA

	Df	**SS**	**MS**	**F**	**Significance F**
Regression	1	56.00495037	10.99596	0.00174508	0.00174508
Residual	48	244.4750496	5.09323		
Total	49	300.48			
	Coefficients	Standard Error	tStat	P-value	
Intercept	30.8036142	3.129575749	9.842744	4.24E-13	

Model 1; $Y = 30.804 – 0.438x_2$

INTERPRETATION OF MODEL 1

The multiple R value of 0.4317 shows that the strength of an association/relationship between construction project cost control (Y) and the control of the quality of the construction works is 43.17%. This implies that if the control of the quality of the construction project is low, it will equally lead to poor control on the cost of the project. The negative correlation between Y and X_2 in the correlation matrix attest to this.

An R square of 0.1864, indicates that variation in the quality control processes of construction projects explains 18.64% of the total variation in the cost of a construction project through cost control.

The F-value calculated of 11.0, which is significant at 0.00175 as indicated by the ANOVA Table, shows that the calculated value is far greater that the standardized F-value of $F_{0.05}(1,48)= 4.03$.This means that the relationship model for construction project cost control: $Y = 30.804 - 0.438X_2$ is highly reliable for the prediction of the state of cost control of a construction project in Nigeria. It further shows that for every 1 unit change in the cost of a construction project in Nigeria, that 43.8% of this change can be explained by variations in the quality control methods adopted for the project.

Furthermore, the statistics value for both the model intercept and the X_2 variable are highly significant as shown by the P-value estimates, which indicates the error in the use of the parameters for prediction of the control of the cost of construction project in Nigeria.

3.3. REGRESSION OF Y ON X_2 AND X_6

The application and observation of construction laws and regulations (X_5) to the control of the cost of construction project in Nigeria was the next in the order of intensity in relationship to the variable representing cost control of construction project (Y). It is based on this X_5 was introduced at this point.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.4477061
R Square	0.2004407
Adjusted R Square	0.1664169
Standard Error	2.2609148
Observations	50

ANOVA

	Df	SS	MS	F	Significance F
Regression	2	60.222842878	30.11421	5.891192	0.005211835
Residual	47	240.2515712	4.111736		
Total	49	300.48			
	Coefficients	Standard Error	tStat	P-value	
Intercept	31.437839	3.211956973	9.787752	6.37E-13	
X2	-0.553633	0.183659778	-3.01445	0.004141	
X5	0.1040096	0.114425434	0.908973	0.368002	

Model 2: $Y = 31.438 - 0.554x_2 + 0.104x_5$

INTERPRETATION OF MODEL 2

The introduction of X_5 variable into the cost control model for construction projects led to the following changes in model 1 earlier established:

i) The multiple R value increased from 0.432 to 0.448. This implies that the introduction of the construction laws and regulation parameter increased the level of relationship between construction project cost control and the variables used in predicting its state.

ii) The R-square value increased from 0.186 to 0.20. This implies that the inclusion of the construction laws and regulations and the variation/changes in these laws and regulation and their applications has enhanced the explanation of the observed variations in the control of the cost of construction projects in Nigeria.

iii) The F-value calculated decreased from 11.00 to 5.89. The new F-value is significant at 0.005. The implication of the above changes is that the decrease in the F-value is due to mainly to the negative correlation existing between construction project cost control and construction laws and regulations in Nigeria as established by the correlation matrix. Also the increase in the level of significance of F-value implies that the application of construction laws and regulations introduces more error of in the use of mode error of in the use of model 2 in the prediction of the state of construction project cost control in Nigeria.

iv) The t-statistics values for the intercept and X_2 variable are all statistically significant at 5% confidence level, while variable X_5 is highly insignificant. It can therefore be concluded that the control of the quality of a construction project is more significant in the control of the project's cost than the application of the laws and regulations governing construction activities in Nigeria.

3.4. REGRESSION OF Y ON X_2 X_5 AND X_3

In line with the stepwise methodology, the next variable in order of significance to construction project control is variable X_3, which stands for socio-economic factors. The results of the analysis are as follows:

Regression Statistics	
Multiple R	0.4585878
R Square	0.2103028
Adjusted R Square	0.1588008
Standard Error	2.2712198
Observations	50

ANOVA

	Df	SS	MS	F	Significance F
Regression	3	63.19177819	21.06393	4.083391	0.011858903
Residual	46	237.2882218	5.15844		
Total	49	300.48			

	Coefficients	Standard Error	tStat	P-value
Intercept	33.843424	4.525963771	7.477617	1.76E-09
X2	-0.532845	0.186524531	-2.8567	0.005404
X5	0.0998143	0.11508017	0.867346	0.390255
X3	-0.118616	0.156499184	-0.75794	0.452355

Model 3: $Y = 33.843 -0.533x_2 + 0.01x_5 -0.119x_3$

INTERPRETATION OF MODEL 3

The introduction of this variable resulted to the following changes in the construction cost control model being predicted:

1) The multiple R-value increased further from 0.448 to 0.459. It follows that the inclusion of the socio-economic factors in the investigation of the state of cost control of construction in Nigeria has increased the relationship under study marginally by 0.011.
2) The R-square value equally increased marginally from 0.20 to 0.21. This shows that the introduction of the socio-economic factors has equally enhanced the ability of the model at predicting variations in the cost of a construction project and its control thereof.
3) The F-value at this point decreased further to 4.03, which is still greater that the tabulated value of $F_{0.05}(3,46)= 2.80$. This implies that the use of model 3 in the prediction of construction project cost control is still statistically significant. In trying to isolate each of the independent variables, the t-statistics of the model intercept and X_2 were significant at 5% confidence level of confidence. We can therefore conclude that even though that construction laws and regulations and socio-economic factors affect the cost of a construction project but their effect is statistically insignificant as far as this study is concerned.

3.5. REGRESSION OF Y ON X_2, X_5, X_3 AND X_1

The results of the introduction of X_1 variable standing for construction project design are as follows:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.473677205
R Square	0.224370094
Adjusted R Square	0.155424214
Standard Error	2.27577227
Observations	50

ANOVA

	Df	SS	MS	F	Significance F
Regression	4	67.41872587	16.85468	3.25434	0.019900434
Residual	45	233.0612741	5.179139		
Total	49	300.48			

	Coefficients	Standard Error	tStat	P-value
Intercept	31.58595171	5.177907841	6.100138	2.22E-07
X2	-0.53333178	0.186899178	-2.85358	0.006512
X5	0.103354357	0.115377397	0.895794	0.37513
X3	-0.15026762	0.160679049	-0.9352	0.354675
X1	0.127386793	0.141006707	0.903409	0.371119

Model 4: $Y = 31.59 -0533x_2 + 0.103x_5 + -0.15x_3 + 0.127x_1$

INTERPRETATION OF MODEL 4

The effects of the project design factors on the cost control model are as follows:

i) Multiple R (correlation coefficient) increased to 0.4737 from 0.4586.
ii) R-square value increased to 0.2244 from 0.2103.
iii) F-value calculated decreased further to 3.25 from 4.08.
iv) The above F-value calculated is greater than $F_{0.05}$ (4,45) = 2.58 from the F-distribution table. This implies that model 4 is a statistical significant predictor of the state of cost control in the Nigerian construction industry.
v) An isolation of the independent variables shows that at 5% confidence level, only variable X_2 (project quality control) and the model intercept maintained consistence significance. Variables X_5, X_3 and X_1 showed statistical insignificance.

3.6. REGRESSION OF Y ON X_2, X_5, X_3, X_1 AND X_4

The least in order of correlation with the dependent variable (Y) was introduced at this stage. The result of the analysis is as follows:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.539679335
R Square	0.291253784
Adjusted R Square	0.210714442
Standard Error	2.20020986
Observations	50

ANOVA

	Df	SS	MS	F	Significance F
Regression	5	87.51593716	17.50319	3.616292	0.007943053
Residual	44	212.9640628	4.840092		
Total	49	300.48			

	Coefficients	Standard Error	tStat	P-value
Intercept	29.05281441	5.15761307	5.632996	1.17E-06
X2	-0.65344288	0.19004998	-343827	0.001291
X5	0.054034677	0.114132831	0.473437	0.638242
X3	-0.19922063	0.157177472	-1.26749	0.211648
X4	0.417315448	0.204796904	2.037704	0.04762

Model 5: $Y = 29.05 - 0.65x_2 + 0.05x_5 - 0.2x_3 + 0.42x_4$

INTERPRETATION OF MODEL 5

The effect of this introduction of X4 variable is as follows:

i) The multiple R-value i.e. the coefficient of correlation increased significantly from 0.4737 to 0.5397.
ii) The R-square value equally increased significantly from 0.2244 to 0.2913. All the above implies that the construction techniques and methods factors being represented by variable x_4 seem to have a far reaching impact on the process of controlling the cost of a construction project.
iii) The F-value calculated increased from 3.25 to 3.62, which is far greater than the tabulated value of $F_{0.05}$ (5,44) = 2.40. It follows therefore that the final model for the prediction of the state of construction project cost control is statistically significant within maximum error in prediction of 0.008 probability.
iv) In trying to determine the extent of contribution of each of the independent variables, only the model intercept, the project quality control variable x_2 and the construction techniques variable x_4 are statistically significant at 5% confidence level. While X_5, X_3 and X_1 standing for construction laws and regulations, socio-economic factors and project design indicated statistical insignificance contribution in the construction cost control model being proposed.

IV. Findings

1. The control of the quality of the construction project is low, it will equally lead to poor control on the cost of the project.
2. The construction laws and regulations and their applications has enhanced the control of the cost of construction projects.
3. The study observed that socio-economic factors affect the cost of a construction project.
4. Project design indicated statistical insignificance contribution in the construction control model being proposed.

5. That there is a significant relationship among construction professionals on the application of cost control methods to construction projects.

RECOMMENDATIONS

1. Construction project teams should make adequate effort to plan the cost requirement of their project base on realistic estimates made possible by the use of scientific tool of project management.
2. Adequate machinery should be put in motion during implementation stage to ensure that deviations from the plan by way of design variations and their associated cost variations.
3. Adequate project monitoring, review and re-planning using such project management tools.
4. The factor: project design, socio-economic factors, laws and regulations on construction should be adequately monitored by members of the project team.

V. Conclusion

The control of the level of variation in the cost of delivering a construction project can be adequately be put under control through an integrated scheme of quality control, construction methods/techniques control and possibly monitoring of the design variation movements in socio-economic factors and the applications of the laws and regulations governing construction activities.

References

[1]. Ezetal, V.E. (1996). Project construction in Nigeria Journal of the Nigeria Society of Engineer NSE Lagos.
[2]. Onyeador S.O. (1997). Critical Success Variables in Public
[3]. Sector Construction Cost Control in Nigeria: "A Factor Analytical Approach". Journal of Project Management Technology FUTO Owerri.
[4]. Kolamude J.O. (1996) "Project Evaluation and Supervision". Journal of the Nigerian Institute of Building Lagos.
[5]. Opara H.E. (2001) An Evaluation of Factors affecting Cost Control in the Nigerian Construction Industry (Unpublished MBA Thesis FUTO Owerri).
[6]. William R.M & Hal J. (2011) Construction Jobsite Management 3rd edition Delmar Cengage Learning U.S.A.
[7]. Chitkara K.K. (2009) Construction Project Management Planning Scheduling and Controlling Tata McGraw Hill. India
[8]. Onyeka C.A. (1990) Applied statistical Analysis Regression Analysis Nobern Vocation Enugu.

Opara Hyginus Emeka. "Application of Cost Control to Construction Projects." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 15, no. 6, 2018, pp. 01-08