International Journal of Sustainable Construction Engineering & Technology (ISSN: 2180-3242)
Vol 4, No 2, 2013

QUANTITATIVE ASSESSMENT OF COST AND TIME IMPLICATION OF SUSCEPTIBILITY OF BUILDING ELEMENTS TO VARIATION IN NIGERIA

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Received 27 April 2013; Revised 16 November 2013; Accepted 25 November 2013

Abstract

A number of research studies have been carried out on the causes and effects of variation on construction project delivery, thereby taking for granted the susceptibility of building elements to variations. This formed the basis of this paper with a view to assessing the cost and time implications of the susceptibility of each building element to variation during construction process in Nigeria. Archival record comprises contract drawings, original bill of quantities, addendum and reduction bill of quantities, and minutes of site meetings among others were used to extract data relating to initial cost, final construction cost, estimated period, final completion period of each building element attributed to variations. The data obtained were analyzed using statistical methods of average, percentage, regression analysis, and analysis of variance (ANOVA). The study identified the building elements having greater than 20% of cost overrun due to variation as earthwork and fillings, frame, windows and external doors, fittings and furnishings, water installation, and external services. The study further identified the building elements having greater than 25% time overrun due to variation as earthwork and fillings, block work (at substructure), upper floors, external walls, wall finishing among others. The results of ANOVA and regression analysis on the building elements cost and time were used to establish models. Thus, the established models are: AFC= 981690 + 1.033AIC; and AFCO= 608390.865 +1.310AIC to predict the average final cost of each building element, and the average final cost overrun of each building element due to variation respectively, where AFC= Average Final Cost, AIC= Average Initial Cost, and AFCO= Average Final Cost Overrun. Also, the study established the model: Y = 1.379(X) – 0.251 for predicting the average actual completion period of each building element, where Y= Average Actual Completion Period, and X= Average Estimated Period (week). The study provides information that enables the clients, consultants/professionals, and other construction stakeholders to understand the building elements that demands specific attention in terms of cost and time implications of variations. The study also provides building clients a foreknowledge of cost variance that is likely to occur on each building element during construction process.

Keywords: *Building elements, construction, cost overrun, time overrun, Nigeria*

1.0 Introduction

It is a fact that very few of building construction project executed is completed within the project sponsors' originally estimated budget and time frame. However, the problem of cost and time overrun in the construction industry is a worldwide phenomenon especially in large transport infrastructure projects are worrisome [1]. For instance, Halloum and Bajracharya,[2] state that 93% of the projects experiencing cost overrun, and more than 90% of the projects witnessing time overun in Abu Dhabi, UAE. In Malaysia, Memon, Rahman and Azis, [3] found that 92% of construction projects witnessing time overrun, and 89% of projects experiencing cost overrun. In such cases where final cost turned out to be several times higher than original estimate, the situation is unsuitable and always affects the sponsors' original plan in terms of cost, time and quality [4]. This affects construction process and also frustrates the client's requirement. Great concern has been expressed in recent years regarding the adverse impact of variations to the construction projects. Construction variations are identified as a major source of conflicts and disputes in the construction industries of many countries [5]. Building projects are liable to variations due to change of mind on the part of the clients, the consultants, or unforeseen problems raised by the main contractor or sub-contractor [6]. Mokhtar, Bedard and Fazio, [7] assert that variations are inevitable in any construction project. Needs of the client may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer [8]. The engineer's or architect's review of the design may bring about changes to improve or optimize the design and the operations of the project. Arain, [9] states that errors and omissions in construction may force a change. Variations are common in all types of construction projects [10 - 12]. The nature and frequency of variations occurrence vary from one project to another depending on various factors [13-14]. The impact of variations varies from one construction project to another. It is generally accepted that variations affect the construction projects with unpalatable consequences in time and cost [15-17]. However, severe criticisms of the industry are generated when projects take far longer than planned [18]. These effects usually undermine the objectives of a client (sponsor) who devotes his/her scarce fund on a developmental project.

Variations in construction had been studied by a number of researchers in the light of its causes and effects on project delivery, thereby taking for granted the susceptibility of building elements to variation. For instance, Ssegawa, Mfolwe, Makuke and Kutua [19] study construction variations on building projects in Botswana; and concluded that variations are unavoidable consequence. Arain and Low [20] investigate developer's views on potential causes of variation order on institutional buildings in Singapore. The authors established that errors and omissions in design; change in specifications by client and consultants are the most significant causes of variations in institutional buildings. Arain and Low [21] study consultants' related variations in school building projects. Their study revealed that non-compliance design with government regulations; design discrepancies; and change in design by consultants are the most frequent causes of consultant related variation in school building projects. Therefore, this study becomes necessary to assess the cost and time implications of the susceptibility of each building element to variation during construction process in Nigeria. The study identified the building elements that demands specific attention in terms of cost and time implications of variations with a view of providing clients; construction professionals; and other stakeholders in the construction industry foreknowledge of cost variance that is likely to occur as result of variations on each building element during construction process. This study also provides useful information to the clients in planning for finance and helps the consultants in controlling construction costs and time.

2.0 Brief Literature Review

2.1 Cost and Time Implication of Variations on Construction Projects Delivery

The construction project delivery system has suffered considerable set back due to variations. For the fact that a project was completed without being abandoned does not mean it has been successful in its entirety. The table 1 shows few examples of cost and time overruns on construction projects by prior researchers.

Table 1: Identified percentage of cost and time overruns on construction projects

S/n	Author and Year	Focus	Country/Study area	Findings
1	Kumaraswamy, Miller and Yogeswaran [22]	Extension of time due to excusable delays	Hong Kong	The authors identified 15-20% time overrun in civil engineering projects.
2	Bordat, McCullouch, Labi and Sinha [23]	Analysis of cost overruns and time delays of INDOT projects	United States	The authors found 55% cost overrun and 12% time overrun in all Indiana Department of Transportation (INDOT) contracts.

S/n	Author and Year	Focus	Country/Study area	Findings
3	Oladapo, [24]	Quantitative assessment of the cost and time impact of variation orders on construction projects	Nigeria	The author found that variations accounted for about 79% cost overrun and 68% time overrun.
4	Priyantha, Karunasena and Rodrigo [25]	Causes, nature and effects of variations in highways	Sri Lanka	The authors identified 9.9% cost overruns of the initial contract sum
5	Halloum and Bajracharya, [2]	Cost and time overrun on Infrastructure construction projects	Abu Dhabi, UAE	The authors identified 8.7% cost overrun and 8.3% time overrun in physical infrastructure
6	Cantarelli, Flyvbjerg and Buhl [1]	Geographical variation in project cost performance	Netherlands, North West Europe, and other geographical areas	The authors identified 11% cost overrun in rail project in Netherlands, 27% cost overrun in North West European countries, and 44% cost overrun in other geographical areas. The authors further identified 7% cost overrun in bridge project in Netherlands, 45% cost overrun in other NW European countries and 27% cost overrun in other geographical areas
7	Memon Rahman and Azis [3]	Time and cost performance in construction projects	Malaysia	The authors found between 5-10% cost overrun and about 5-10% time overrun in construction projects.

It reflects from the table that cost and time overruns on construction projects are global phenomenon, and the magnitude varies from one project to another. Even, the impact also varies from location to another. However, it is widely believed that the consequence of variations undermine the objectives of client.

2.2 Building Elements and Classifications

A building element is a component of the building that fulfils specific function(s) irrespective of its design, construction or specification. Robert and Harrold [26] define building elements as components common to most buildings that usually perform a given function, regardless of the design, specification, construction method, or materials used. Element classification ensures consistency in the economic evaluation of building projects over time and from project to project, and it enhances project management and reporting at all stages of the building life cycle planning, programming, design, construction, operations, and disposal [26]. However, building elements classifications include: The Building Cost Information System of the Royal Institute of Chartered Surveyors (RICS); The Canadian Institute of Quantity Surveyors (CIQS); UNIFORMAT II; Construction Economics European Committee (CEEC) among others. Therefore, the Royal Institute of Chartered Surveyors (RICS) Classification of building element provides the comprehensive list of building elements typical of any building projects. Thus, this study adopted the RICS building elements classification.

2.3 Nature of Variations

Variation involves not only changes to the work or matters relating to the work in accordance with the conditions of the contract but also changes to the working conditions. The nature of variations is usually defined by variation clauses in the conditions of contract. For instance, a variation is defined in clause 5.1 of the JCT' [27] Standard Building Contract as follows:

- an addition, omission or substitution of any work;
- the alteration of contractual standards for the materials or goods;
- the removal from site of work executed or materials that are in accordance with contract;
- any alteration of working restrictions such as access to the site, site hours, working areas
- or the order of work sequencing or;
- the expenditure of provisional sums.

FIDIC [28] clause 13 states that variations may be initiated by the Engineer at any time prior to issuing the taking-over certificate for the works, either by an instruction or by a request for the contractor to submit a proposal. Each variation may include the followings:

(a) Changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation).
(b) Changes to the quality and other characteristics of any item of work.
(c) Changes to the levels, positions and/or dimensions of any part of the works.
(d) Omission of any work unless it is to be carried out by others.
(e) Any additional work, plant, materials or services necessary for the permanent works including any associated tests on completion, boreholes and other testing and exploratory work.
(f) Changes to the sequence or timing of the execution of the Works.

Therefore, variation can be described as a deviation from an outlined planned process of construction work vis-à-vis alteration/deviation from the basis upon which the contract was awarded. The term does not only embrace changes to the work or matters appertaining to the work in accordance with the provision of the contract, but also changes the contract conditions.

2.4 Factors Predispose Building Elements to Variations

Susceptibility of building elements to variation does not just happen on building elements it is due to various factors that made the elements to be susceptible. These factors affect each element differently. Arain, [29] groups the factors into four, this includes: owner related factors; consultant related factors; contractor related factors; and natural related factors. Babatunde, Babalola, Jagboro and Opawole [30] identify nine factors that predispose building elements to variations. These include consultant related factor; contractor related factor; client related factor; workmanship related factor; government related factor; economic related factor; technological related factor; safety related factor; and natural related factor. The predisposing factors and other causes of variation orders on construction projects have also been identified by many researchers [31-35].

3.0 Methodology

The study adopted documentary reports/archival records, this includes: the contract drawings; original bill of quantities; addendum; and reduction bill of quantities, minutes of site meetings among others of completed educational building projects attributed to variations on each building element in Lagos metropolis, Nigeria. Educational building projects were sampled because there is always proper contract documentations, and all the professionals within the built environment are involved which led to the award of contract to the contractor within a time frame, and also there were huge construction of educational building projects in the study area because the Lagos State Government initiated a plan tagged “Millennium Model Schools” an effort to build modern educational building projects across the study area. Thus, the educational building projects were limited to the one awarded and completed between year 2002 and 2012 because the periods experienced similar economic conditions in Nigeria. However, there was no official list stipulating the number of educational building projects completed in the study area. Therefore, as a result of researcher’s knowledge of the area and the help of Lagos State ministry of educational coupled with the assistance of colleagues working in the construction industry within the study area. Fifty (50) completed educational building projects were identified together with the names and addresses of consultancy firms involved on each project. It was on this premise, that the list of the consultancy firms, particularly architectural and quantity surveying firms were generated. However, the identified firms were visited. In view of this, archival records of Thirty Nine (39) out of Fifty (50) identified and completed educational projects were reviewed. This was due to the fact that few of the firms considered the information classified and confidential while others could not retrieve them due to poor data storage. Thus, in order to achieve the purpose of this study the information relating to initial cost, final construction cost, estimated period in week(s), and final completion period in week(s) on each building element attributed to variations were securitized to eliminate those that fail to provide adequate information. Therefore, Thirty (30) educational building projects were found suitable for the analysis. The data obtained were analyzed using statistical methods of average, percentage, regression analysis, and analysis of variance (ANOVA).

4.0 Results and Discussions

Table 2 reveals the cost implications of each building element to variation during construction process. The table shows the percentage of cost overruns due to variation on each building element and it classified as follows: cost overrun greater than ‘>’ 20% include the following building elements: earthwork and fillings; frame; windows and external doors; fittings and furnishings; water installation; and external services having the percentage of cost overruns of 20.08%; 28.84%; 39.09%; 31.71%; 21.55% and 20.69% respectively. The table also reveals the percentage range of cost overrun between 10 to 20%; this includes the following building elements: wall finishing; floor finishing; service equipment; disposal installation; electrical installation; and drainage with the percentage of cost overruns of 11.18%; 19.63%; 17.66%; 16.15%; 18.63%; and 10.05% respectively.

Table 2: Cost Implication of Variation on each Building Elements

Building elements	Average Initial Cost (Naira)	Average Final Cost (Naira)	Difference (Average Cost Overrun) (Naira)	Percentage of Cost Overrun
A. Substructure				
i. Earthwork and Fillings	5,948,594.96	7,442,828.79	1,494,233.83	20.08 %
ii. Concrete works	9,153,882.85	9,926,950.46	773,067.61	7.79%
iii. Block works (if any)	2,935,140.54	2,762,889.12	172,251.42	5.87%
B. Superstructure				
i. Frame	8,762,897.75	12,315,182.85	3,552,285.1	28.84 %
ii. Upper floors	14,174,208.14	14,929,252.3	755,044.16	5.06 %
iii. Roof	6,672,276.48	7,395,181.59	722,905.11	9.78 %
iv. Stairs	2,464,121.08	2,521,205.88	57,084.8	2.26%
v. External walls	4,524,693.47	4,737,670.41	212,976.94	4.50 %

vi. Windows and external doors	6,161,368.81	10,115,674.19	3,954,305.38	39.09 %
vii. Internal wall and internal partitions	4,695,491.02	5102386.73	406895.71	7.97%
viii. Internal doors	3,623,466.73	3,858,414.44	234,947.71	6.09%
C. Internal Finishes				
i. Wall finishing	5,191,418.05	5,844,816.12	653,398.07	11.18%
ii. Floor finishing	7,605,887.59	9,463,098.77	1,857,211.18	19.63 %
iii. Ceiling finishing	3,492,507.56	3,637,182.89	144,675.33	3.98%
D. Fittings and Furniture				
i. fittings and furnishings	3,742,969.9	5,480,876.17	1,737,906.27	31.71 %
E. Services				
i. Sanitary appliances	8,447,568.3	8,507,460.22	59,891.92	0.70%
ii. Service equipment	7,321,909.22	8,891,796.5	1,569,887.28	17.66%
iii. Disposal installation	4,742,581.65	5,655,982.89	913,401.24	16.15%
iv. Water installation	2,568,899.88	3,274,462.51	705,562.63	21.55 %
v. Ventilation system	3,228,467.28	3,279,998.48	51,531.209	1.57%
vi. Electrical installation	10,549,346.2	12,964,360.28	2,415,014.08	18.63%
F. External works				
i. Drainage	3,881,252.67	4,314,958.28	433,705.61	10.05%
ii. External services	3,472,856.12	4,378,978.43	906,122.31	20.69%

1US $ =150 Nigerian Naira; 1 £ =250 Nigerian Naira.

Table 2 finally shows the percentage range of cost overruns between 0 to 10%; these include the following building elements: concrete works; block work (at substructure); upper floors; roof; stairs; external walls; internal wall and internal partitions; internal doors; ceiling finishing; sanitary appliances; and ventilation system having the percentage of cost overruns of 7.79%; 5.87%; 5.06%; 9.78%; 2.26%; 4.50%; 7.97%; 6.09%; 3.98%; 0.70%; and 1.57% respectively. Table 3 and 4 were derived from the table 2, thus, the following relationships were established.

Table 3 shows a strong linear correlation between Average Final Cost (AFC) and Average Initial Cost (AIC) of each building element. The value of R= 0.908 and coefficient of determination R^2=0.825 which implies that 82.5% of the variation in final cost of each building elements is explained by initial cost of each building elements during construction process. The P value of 0.000 indicates that the relationship is statistically significant. Also, Table 3 indicates the relationship between 'AIC' and 'AFC' illustrated using a model of this form: AFC= 981690 + 1.033AIC. This model can be used to predict Average Final Cost of each building element. Table 2 further reveals a strong linear correlation between Average Initial Cost (AIC) and Average Final Cost Overrun (AFCO) on each building element. The value of R= 0.962 and coefficient of determination R^2=0.926 implies that 92.6% of the variation in Average Final Cost Overrun of each building element is explained by Average Initial Cost (AIC) of each building element during construction process. The P value of 0.000 reveals that the relationship is statistically significant. Moreover, Table 3 further indicates the relationship between 'AIC' and 'AFCO' due to variation on each building element illustrated using a model of this form: AFCO= 608390.865 +1.310AIC. Therefore, the model is most appropriate in predicting Average Final Cost Overrun of each building element.

Table 3 also reveals a strong linear correlation between Average Initial Cost (AIC); Average Final Cost Overrun (AFCO) and Percentage of Cost Overrun (PCO) on each building element. The value of R= 0.966 and coefficient of determination R^2=0.933 which implies that 93.3% of the variation in Percentage of Cost Overrun of each building element is explained by initial cost of each building element during construction process.

Table 3: Model Summary of Cost Implication on Building Elements to Variation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.908[a]	.825	.818	1.69395E6	.825	113.266	1	24	.000
2	.962[b]	.926	.920	1.12319E6	.101	31.589	1	23	.000
3	.966[c]	.933	.924	1.09183E6	.007	2.340	1	22	.140

a. Predictors: (Constant), Average Initial Cost (Naira)
b. Predictors: (Constant), Average Initial Cost(Naira), Average Cost Overrun (Naira)
c. Predictors: (Constant), Average Initial Cost(Naira), Average Cost Overrun (Naira), Percentage of Cost Overrun

In Table 4, the relationship between 'AIC,' 'AFCO' and 'PCO' due to variation was illustrated using a model of this form: PCO= 1.482E6 + 2.59 - 58400AIC. Hence, introducing Percentage of Cost Overrun (PCO) into the model, although produces a significant model but its contribution to prediction of the Average Final Cost Overrun is not significant (t =-1.53, p>0.05).

Table 4: Coefficients of the Developed Model for Cost Implication on Building Elements to Variation

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	981690.454	579684.569		1.693	.103
	Average Initial Cost (Naira)	1.033	.097	.908	10.643	.000
2	(Constant)	608390.612	390060.833		1.560	.132
	Average Initial Cost (Naira)	.865	.071	.760	12.177	.000
	Average Cost Overrun Due to Variation Only (Naira)	1.310	.233	.351	5.620	.000
3	(Constant)	1.482E6	685765.124		2.162	.042
	Average Initial Cost(Naira)	.767	.094	.674	8.159	.000
	Average Cost Overrun Due to Variation Only (Naira)	1.823	.405	.489	4.501	.000
	Percentage of Cost Overrun Due to Variation Only	-58400.241	38176.423	-.153	-1.530	.140

a. Dependent Variable: Average Final Cost Overrun Due to Variation only (Naira)

Table 5 indicates the time implications of each building element to variation during construction process. The table shows the percentage of time overruns due to variation on each building element as follows: time overruns greater than '>'20% include the following building elements: earthwork and fillings; block work (at substructure); frame; upper floors; roof; stairs;

external walls; wall finishing; ceiling finishing; fittings and furnishings; sanitary appliances; service equipment; disposal installation; water installation; ventilation system; electrical installation; and drainage with the percentage of cost overruns of 40.65%; 37.48%; 29.31%; 25.74%; 22.80%; 21.64%; 29.94%; 30.04%; 20.63%; 26.82%; 23.11%; 23.79%; 25.82%; 25.91%; 26.89%; 23.48%; and 26.81%. It can be deduced from the finding that almost all the building elements experienced time overruns greater than 20%. The table also reveals the building elements suffered time overruns between 10 to 20%. The building elements are: external services; concrete works; internal wall and internal partitions; internal doors; and floor finishing having the percentage of cost overruns of 19.97%; 14.08%; 10.27%; 13.94%; and 14.98%. The table finally indicates percentage of time overruns between 0 to 10% the only building element in this category is windows and external doors with percentage time overrun of 9.32%.

Table 5: Time Implication on each Building Element to Variation

Building Elements	Average Estimated Period (week)	Average Actual Completion Period (week)	Difference (Period Overrun) (Week)	Percentage of Period Overrun
A. Substructure				
i. Earthwork and Fillings	6.25	10.53	4.28	40.65%
ii. Concrete works	6.53	7.60	1.07	14.08 %
iii. Block works (if any)	3.87	6.19	2.32	37.48%
B. Superstructure				
i. Frame	9.31	13.17	3.86	29.31%
ii. Upper floors	8.77	11.81	3.04	25.74%
iii. Roof	3.42	4.43	1.01	22.80%
iv. Stairs	4.20	5.36	1.16	21.64%
v. External walls	5.43	7.75	2.32	29.94 %
vi. Windows and external doors	5.84	6.44	0.60	9.32 %
vii. Internal wall and internal partitions	5.33	5.94	0.61	10.27%
viii. Internal doors	3.52	4.09	0.57	13.94%
C. Internal Finishes				
i. Wall finishing	3.75	5.36	1.61	30.04 %
ii. Floor finishing	5.11	6.01	0.90	14.98 %
iii. Ceiling finishing	3.27	4.12	0.85	20.63%
D. Fittings and Furniture				
i. fittings and furnishings	3.22	4.40	1.18	26.82%
E. Services				
i. Sanitary appliances	3.16	4.11	0.95	23.11%
ii. Service equipment	2.98	3.91	0.93	23.79%
iii. Disposal installation	2.73	3.68	0.95	25.82 %
iv. Water installation	3.46	4.67	1.21	25.91 %
v. Ventilation system	3.29	4.50	1.21	26.89 %
vi. Electrical installation	5.15	6.73	1.58	23.48%
F. External works				

i. Drainage	5.05	6.90	1.85	26.81 %
ii. External services	4.65	5.81	1.16	19.97%

Table 6 and 7 were derived from the table 5. The result from table 6 shows a strong linear relationship between average estimated period and average actual completion period due to variation on each building element. The value of R= 0.955 and coefficient of determination R^2=0.912 which implies that 91.2% of the variation in actual completion period of each building element is explained by average estimated period of each building element during construction process. The P value of 0.000 reveals that the relationship is statistically significant. Moreover, table 7 indicates the model as Average Actual Completion Period (Y) = 1.379(X) – 0.251. The model is statistically significant, hence the model can be adopted in predicting the average actual completion period of each building element in building projects.

Table 6: Model Summary of Time Implication of Variation on Building Elements

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.955[a]	.912	908	.77065	.912	218.042	1	21	.000

a. Predictors: (Constant), Average estimated period (week)

Table 7: Coefficients of the Developed Model for Time Implication of Variation on Building Elements

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.251	.468		-.537	.597
	Average estimated period (week)	1.379	.093	.955	14.766	.000

a. Dependent Variable: Average actual completion period (week)

Y = ax +b
If Y =Average Actual Completion Period
X = Average Estimated Period (week)
b = Slope or Relationship between X and Y

5.0 Conclusions

The study concluded that variation on each building element had a significant impact on educational building projects delivery in terms of cost and time. The building elements to variations have varying percentage of cost overruns and time overruns with earthwork and fillings; frame; windows and external doors; fittings and furnishings; water installation; and external services have higher percentage of cost overruns greater 20%. On the other hand concrete works; block work (at substructure); upper floors; stairs; external walls; internal wall and internal partitions; internal doors; ceiling finishing; sanitary appliances; and ventilation system have the least cost overruns ranges between 0 to 10%. The study further revealed time overruns on each building element to variation with earthwork and fillings; block work (at substructure); frame; upper floors; roof; stairs; external walls; wall finishing; ceiling finishing; fittings and furnishings; sanitary appliances; service equipment; disposal installation; water installation; ventilation system; electrical installation; drainage; and external services have higher percentage of time overruns greater than 20%. While windows and external doors only have the least time overruns ranges between 0 to 10%. The study established the models: AFC= 981690 + 1.033AIC and AFCO= 608390.865 +1.310AIC to predict the average final cost of each building element and the average final cost overrun of each building element respectively, where AFC= Average Final Cost; AIC= Average Initial Cost; and AFCO= Average Final Cost Overrun. The model for predicting the average actual completion period of each building element due to variation was established as average actual completion period(Y) = 1.379(X) – 0.251, where X= Average Estimated Period (week). The study recommends identified building elements that have higher percentage of cost and time overruns due to variations are to be given outmost consideration during the design and construction processes in order to minimize its effects and contribution to variations. Also, the clients should be encouraged by the various professionals to be to be more comprehensive and firm in their briefs to facilitate adequate planning and reduce variations.

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