International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 9 Issue 7, July 2022

ISSN: 2394-4404

Causes And Effect Of Variation Orders On Construction Project Performance In Edo State Nigeria

Simon-Eigbe, B.O.

Department of Quantity Surveying, Auchi Polytechnic, Auchi. Edo State, Nigeria

Abstract:** Variations in building construction play a determining role in projects' final cost and completion time. Important project success indicators include projects that are completed predictably, within budget, and by the deadline. This study identified the causes of variation, assessed effect of variations on project performance and examined the control measures for effective management of variations to enhance project performance within the context of public building projects in Edo State, Nigeria. Data for the study was collected from source documents of completed building projects and ten selected projects were used. The sample used for the study was drawn from projects completed between 2014 and 2020. Survey questionnaire was employed to enhance data for the study. Using the simple random sampling technique, a total of one hundred (100) questionnaires were administered, a total of seventy-five (75) was retrieved. The returns represent a 75% response rate. Data obtained were analysed using frequency, percentiles and mean item score. The research results show that unclear project brief by clients, errors and omissions in designs by consultants, change of plan or scope by client, change in designs by consultants and change of materials or construction procedure by clients are the five most important causes of variations in educational building projects. Cost and time overruns are the dominant frequent outcomes of variations in construction building projects. Also revealed, was that the involvement of clients at planning and design phases, clear project brief, thorough detailing of designs, involvement of professional consultants at the initial stages, contingencies allowance provision for variations in project budget are the five top most effective potential controls for variations in educational building projects as perceived by project participants. The study therefore, recommends that greater effort such as site and soil studies, should be expended by clients in the early stages of a project development so as to properly articulate all aspects of the project requirements and thus enhance the quality of project brief. Project planning should be seen as important and encouraged as this will bring about the involvement of the client at planning and design phases, promote client/consultants' collaboration in project procurement and thus minimize variations.

***Keywords:** Construction plans, Building Projects, Project Performance, Variation Orders, Cost Overrun*

I. INTRODUCTION

Building construction processes embrace design and production information documentation, financial and legal considerations, interaction of expertise, contracts procurement, and site operations. Construction plans exist in the form of designs, drawings, quantities and specifications. Alsuliman, Bowles and Chen (2012) noted that every construction project is unique in many respects, but liability to change is an attribute that generally characterizes almost all projects. Changes to construction plans during site operations are achieved by means of variation orders. According to Baxendale and Schofield (1996), variation means any change to the basis on which the contract was signed. In building construction contracts, a definition of variation in terms of specific actions and activities is usually contained in the Standard Form of Building Contract. A Standard Form of Building Contract is a document that contains the express terms of a building contract set out in a form.

Turner (1984) gave a clarification of the meaning of variation as used in the Standard Forms. According to Turner (1984), variations are "changes within a contract" and not "changes of contract". He explained that "changes of contract" will require that the existing contract be rescinded and a fresh contract drawn up. He further explained that variations relate firstly to, changes to the work itself and secondly, to the means of getting the work done. Variations and variation orders are invariably encountered in the Nigerian building and construction industry as in other construction industries. Arain (2006) noted that in the course of design or construction, clients' needs may change; changes to the parameters of the project may be dictated by market conditions; the design and choice of the consultants may be altered by technological developments; errors and omission in production information (construction plans) or construction may force a change. All these factors and many others, Arain (2006) asserted make construction variation inevitable.

STATEMENT OF THE PROBLEM

Variations in building construction play a determining role in projects' final cost and completion time. According to Ndihokubwayo and Haupt (2009)," the more the variation orders, the more they affect the overall construction delivery cost". Nworah and Nwachukwu (2004) stressed that variations often lead to claim for extra cost. Arain and Pheng (2005) surveyed consultants' perception of the causes of variations and reported that variation orders contributed substantially to increase in project cost. Koushki, Al-Rashid and Kartam, (2005) found that variation orders issued during various phases of construction projects negatively affected the cost of projects and their completion time. Hanna, Calmics, Peterson and Nordheim, (2002), revealed that the more the variation orders occurrence the more significant productivity losses. Productivity losses imply loss of time and associated delays since productivity is the amount of output over a unit of time. Ndihokubwayo and Haupt (2009) asserted that if variation orders are frequent, they may affect the quality of works. They argued that quality may be compromised because contractors tend to compensate for losses incurred to variation orders. Variations promote the prospect of dispute in construction projects. Charoenngam, Coquinco and Hadikusumo (2003) posited that disputes between the client and the contractor could occur because of variation orders.

The outcome of variations on a project's original scope of work depends on the nature or type of variation. Several authors have documented the nature of variations. Major variations take the nature of additions, omissions, and substitution of any of the works shown on the contract drawings or described by the contract bills (Eigbe, 2014). However, variation orders during the construction phase constitute one of the major problems facing construction projects (Ibbs, wongi and kwak, 2001). Variations in construction projects cause anxiety for construction practitioners and project participants because of their impact on the successful delivery of projects (Ssegawa et al, 2002).

The management of contracts and change (variation) orders easily boost operational efficiency of construction ("Construction,"2011). To manage a variation means being able to anticipate its effect and to control, or at least monitor, the associated cost and schedule impacts (Hester, Kuprenas and Chang, 1991). Construction stakeholders must therefore develop the capacity to effectively manage construction and associated variations.

According to Eigbe (2016), the construction of tertiary educational buildings is as liable to risks as the construction of any other large projects. He submitted that variations are to be expected during the design and construction processes of educational buildings. It is therefore helpful to investigate the causes and effects of variations on project performance in this sector in order to develop appropriate variations control steps to improve project performance and enhance construction efficiency. Various authors (Ibbs et al., 2001; Oladapo, 2007) have reported that variations are common in all types of construction projects. A number of factors including the distinct nature of each project; constraint of time; complex operations involved in construction projects; limited resources and money make variations in building projects a common occurrence (Wainwright and Wood, 1983; Hanna et al., 2002). Eigbe, (2016) reported that the management of variations continues to challenge stakeholders of building projects because of their effect on the successful delivery of projects in terms of cost, time, quality and utility.

The relative significance of the causes, effects, and variation control measures, as well as the scope of the cost deviation and time slippage caused by variations in educational buildings in Nigeria's Edo state, have not received much attention despite the fact that numerous research reports that variations significantly contribute to poor project performance. To improve the performance of construction projects, the study concentrated on the causes, effects, and the management of deviations with a view to enhancing construction project performance.

II. LITERATURE REVIEW

Standard Forms of Building Contract (SFBC) are the basis on which building contracts are executed in the Nigerian construction industry and these SFBC commonly in use are published by the Federal Ministry of Works (FMW) and the Bureau of Public Procurement (BPP). The forms contain clauses that empower the Architect/supervising officer/engineer to issue instructions necessitating a variation to the works.

CAUSES OF VARIATION IN CONSTRUCTION PROJECTS

Chini and Valdez (2003) declared that variations can be traced back to erroneous designs, poor contract administration or lax supervision by the client representatives. Oberlender (2000) argued that there is a tendency for some designers to make changes during design in order to please the client without regard to the impact of the changes on the project cost and schedule. Hanna et al., (2002) indicated that variations occur due to the uniqueness of each project and the limited resources, time and money available for planning. According to Finsen (2005), conditions that were unforeseen and therefore not captured in the project construction plans may arise and thus necessitate variation orders. It is submitted that soil and ground conditions adversely affecting foundations are some such unforeseen conditions. A study which focused on the classification of types of rework conducted by Love and Sohal (2003) revealed causes of variation orders. According to Love and Sohal (2003), the causes include design change, design error, design omission, construction change, construction error, construction omission, and damage which may be caused by accident or inclement weather. If the change affects the design, it will impact on the construction process and, quite possibly, operation and maintenance as well (Cameron, Duff and Hare, 2004).

The causes of variations can be categorized according to the source or origin agent that initiates the variation (CII, 1990; Thomas and Napolitan, 1994; Jawad, Abdulkader and Ali, 2009; Mohammad, Che Ani, Rakmat, and Yusof, 2010) Thus, the causes of variations identified from literature review are categorized into: Client related variations; Consultant related variations; Contractor related variations; and Other variations.

CLIENT RELATED VARIATIONS: Variations in construction projects may be initiated directly by the client. They may be required as a result of the client's inability to meet some project requirements. The following are the causes of variations initiated by the client: Problems of finance; Change of project duration by client; Change of plan or scope by client; Unclear brief; Change of materials or construction procedure; Change in specifications; Obstinacy of the Client and Impediments in prompt decision making.

CONSULTANTS RELATED VARIATIONS: Variations may be initiated by consultants. They may be introduced into a project because consultants are unable to meet the conditions necessary for carrying out the project. The causes of consultants'-initiated variations include the followings: Change in design; Change in specifications; Errors and omissions in design; Errors and omissions in contract bills; Discrepancy between contract documents; Inadequate scope of work for the contractor; Design complexity; Inadequacy of working drawing details; Technology change; Non-compliance of design with statutory requirement/government regulation; Consultant lack of knowledge of available materials or equipment; Ambiguity in design details by consultants; Consultant obstinacy and Inadequate working drawing details.

CONTRACTORS RELATED VARIATIONS: These are variations suggested by the contractor. They also include variations initiated as a result of the inability of the contractor to meet certain requirements for carrying out the project. The following are the causes of contractor related variations: Unavailability or lack of equipment; Non-involvement of contractor in design; Contractor's desired profitability; Obstinate nature of contractor; Complex design and Absence of specialized contract manager by contractor.

"OTHERS" RELATED VARIATIONS: These are variations required by reason of the following causes not directly related to the project participants: Weather condition; Change in government regulation; Safety considerations; Change in economic conditions and Socio-cultural factors.

EFFECTS OF VARIATIONS ON PROJECT PERFORMANCE

Several researchers have reported on the effects of variations on construction projects. Arain and Pheng (2006) asserted that changes in contract price or contract duration are brought about by variations. It needs be emphasized that changes in contract price or contract duration are not alternative outcome of variations on construction projects as suggested by Arain and Pheng (2006). According to Koushki, Al-Rashid, and Kartam, (2005), variations negatively affect the cost of projects and their completion time. Hanna et al., (2002) reported that variations may lead to disruptions and changes in work condition and eventually, loss of productivity. Oladapo (2007) remarked that variations have grave effect on project cost and time overruns. Variation or change orders are the reasons why most contractors do not meet up with the time specified for completion of most contract works (Amu, Adeoye and Faluyi, 2005; Pourrostam and Ismail, 2011). According to Ndihokubwayo and Haupt (2008), frequent variations may affect the quality of work. It is postulated that disputes deriving from variations can occur between the client and the contractor (Charoenngam, Coquinco, and Hadikusumo, 2003). Harbans (2003) indicated that the valuation of variations is a frequent cause of dispute in building contracts. The determination of the value of the variation itself is one of the challenges of variations identified by Trickey and Hackett (2001). Harbans (2003) warned that variations will remain at the forefront of disputes unless a solution acceptable to the parties on an ideal mode of valuation is agreed upon. Finsen (2005) revealed that a sizeable proportion of arbitration were claims for additional time and additional expense emanating from variations.

Other effects of variations on construction projects were reported to include delay in payment, engagement of new professionals to take care of complex technological projects (CII,1995); quality degradation, logistic delays (Fisk,1997); rework and demolition (Clough and Sears,1994; Oyewobi, Ibironke, Ganiyu, and Ola-Awo, 2011); damage to reputation of firms (Kumaraswamy, Miller and Yogeswaran, 1998; Arain and Pheng, 2005).

The effects of variations on building projects identified from the literature are as follows: Increase in project cost; Disruption in work progress; Delay in project completion time; Quality degradation Demolition and rework; Hiring new professionals; Increase in overhead expenses; Delay in payment; Logistic delays; Procurement delays; Productivity degradation; Dispute among professionals; Poor professional relation; Poor safety conditions; Additional payments for contractor; Adverse impact on firm's reputation.

CONTROLS FOR VARIATIONS

The adverse effects of variations on construction projects could be minimized by limiting or reducing the number of variation orders. Several researchers (Mukhtar, Bedard, Fazio, 2000; Ibbs et al., 2001) have suggested controls for variations and variation orders as a means of reducing their occurrence and minimizing their adverse effects on construction projects. Potential controls for variations identified from literature, categorized into design phase controls and construction phase controls are discussed below.

DESIGN PHASE CONTROLS FOR VARIATIONS

Control measures initiated during a project's design phase would immensely minimize the adverse effects of variations on the project delivery. During this phase of the project implementation, variations in design would not require demolition and reworks in the construction site. The following are the identified design phase controls for variations: Involvement of professionals at the initial stages of projects; Clear project brief; Thorough detailing of designs; Review of contract documents; Involvement of contractor at planning and design; Value engineering at planning and design stage; Contingencies sum allowance for variations; Adapting contract clauses to control the potential for variation and Site studies and investigations prior to designs.

CONSTRUCTION PHASE CONTROLS FOR VARIATIONS

Variations initiated during the construction phase of a project could involve demolition and rework of works already completed with attendant adverse effects on project cost and completion time. Construction phase controls for variations listed below would assist in reducing variations and thus minimize their adverse impact on project delivery: Thorough definition of variation orders scope; Clarity of variation order procedures; Prompt variation orders approval procedures; Written approvals for variation orders; Comprehensive documentation of variation orders; Documentation of mode of valuation of indirect effects of variations; Involvement of client at construction stage; Appointment of project manager from independent firm; Variation logic and justification; Avoiding the use of open tendering; Variations negotiation ability; Team effort by client, consultants and contractor to control variations; Continuous coordination and direct communication and Experience of variation in past projects.

III. RESEARCH METHOD

This study was delimited to educational building projects in Edo State located in south-south region of Nigeria. Data for the study was collected from source documents of completed building projects and ten selected projects were used after a thorough preliminary investigation which shows that archival information was readily available. The sample used for the study was drawn from projects completed between 2014 and 2020. Tertiary educational institution building projects were selected for the study because of the need for expansion of building infrastructure in existing institutions, and of outright establishment of new educational institutions imposed on the education sector by new modes of teaching and learning, and the increasing army of higher education admission seekers increased construction activities and associated construction variations in this sector.

The study adopted the use of structured questionnaire, employing typically 5 points Likert type scaled questions. The structured questionnaire used, however, incorporated a response opportunity of "other" to enable flexible responses. This approach finds support in Fellows and Liu (2015) submission cited in Eigbe (2016), that rigidity of available responses may constrain responses artificially. The respondents for the questionnaire part were construction professionals and the project participants – clients, consultants and contractors - as subjects in the survey. The survey participants were the client's project officers; and the professional consultants and contractors that participated in the completed projects. The principal partner or an associate partner of consulting firms; the project or contract managers of contracting firms and the directors or project officers from the client's side were used in the survey. These individuals were expected to be able to identify the causes of variations, and report on the effects of variation orders in building projects based on their experience.

Using the simple random sampling technique, a total of one hundred (100) questionnaires were administered, a total of seventy-five (75) was retrieved. The returns represent a 75% response rate. Data obtained were analysed using frequency, percentiles and mean item score.

MEAN ITEM SCORE

The Mean Score method was adopted for the analysis of scaled responses. Several researchers in construction management have employed this method of analysis (Akintoye, 2000; Ling et al, 2000; Kululanga et al., 2001; Wong et al, 2001). The Mean Score is mathematically represented as:

$$MS = \sum (FX) / N. \qquad (1 \leq MS \leq 5) \; \ldots\ldots\ldots\ldots \text{(Eqtn.1)}$$

Where 'X' is the score or weight given to each factor being rated or ranked by respondents and ranges from 1 to 5, 'F' is the frequency of responses to the respective ranking (1 – 5) for each factor, and 'N' is the total number of responses concerning that factor. The Mean Score is computed for each factor or cause of variation and is then used to compare other factors or causes of variation by ranking. A high mean score represented the factor most frequent or the cause of variation most important, as applicable. Thus, the formula can be written as;

$$\text{Mean Score} = \frac{5F_5 + 4F_4 + 3F_3 + 2F_2 + F_1}{N}$$

Scale of Measure	Cronbach – Value
Identified Causes of Variation Orders	0.755
Effect of Variation Orders	0.899
Control Measures for Variation Orders	0.901

Table 1: Test of Reliability for Measuring Scale

Table 1 shows Cronbach's reliability test that was used to test the reliability of the questionnaire. Creswell (2013) noted that for all the items of an instrument to be internally consistent and reliable, the result of the reliability must produce a minimum Cronbach's Alpha of 0.7. In this study all the items of the three variables were subjected to the reliability test. The results with reference to Creswell (2013) suggested that all the items are good and consistent internally because the Cronbach's Alpha coefficient for the items were 0.7 and above. The results are presented in the Table below:

IV. RESULTS AND DISCUSSION

Category	Classification	Frequency	Percent
Profession of Respondents	Quantity Surveyors	25	33
	Architects	12	16
	Builders	10	13
	Engineers	23	31
	Others Specify	5	7
	Total	**75**	**100**
Professional Body of Affiliation	NIQS	24	32
	NIA	10	13
	NIOB	9	12
	NSE	23	31
	Others	9	12
	Total	**75**	**100**
Professional Membership (Type)	Fellow	6	8
	Corporate	60	80
	Graduate/Probationer	9	12
	Total	**75**	**100**
Highest academic Qualification of Respondents	PhD	8	11
	M.Sc/M.Tech/M.Eng	25	33
	PGD	10	13
	B.Sc/B.Tch/HND	32	43
	Total	**75**	**100**
Years of working Experience	1-5 years	6	8
	6-10years	10	13
	11-15 years	25	25
	16-20 years	20	20
	20 years and above	14	14
	Total	**75**	**100**
		Average =15	

Table 2: Summary of Background Information of the Respondents

Results from Table 2 shows that majority of the respondents 33% and 31% were Quantity Surveyors and Engineers respectively. This was followed by Architects 16% and Builders 13% while others were 7%. The Table also shows that all respondents were affiliated to relevant professional bodies in their respective professions, out of which 80% of them were corporate members, 8% fellows and 12% were graduate/probationer members of their respective bodies. This shows that the respondents are capable of providing the relevant information on the objectives of the study. The further shows that 32%, 25% and 10% of the respondents had B.Sc/M.Tech/HND, M.Sc/ M.Tech/M.Eng, PGD degrees respectively. It was also shown that 8% were PhD holders. The average number of years of experience possessed by the respondents was 15 years. The study therefore considers the response rate successful and adequate enough to produce reliable results.

Causes of variations	n=10 Client (Mean score)	Rank	N=75 n =45 Consultants (Mean Score)	Rank	n = 20 Contractors (Mean Score)	Rank	Weighted Average (Mean Score)	Rank
Unclear brief by client	4.51	1	4.50	1	4.08	6	4.42	1
Errors or omissions in design by consultants	4.48	2	4.40	3	4.34	1	4.40	2
Change of plan or scope by client	4.27	4	4.41	2	4.31	2	4.37	3
Change in design by consultants	4.30	3	4.35	4	4.26	4	4.32	4
Change of materials or construction procedure by client	4.20	6	4.28	6	4.30	3	4.27	5
Change in specifications by consultants	4.19	7	4.30	5	4.05	7	4.23	6
Discrepancy between contract documents	4.22	5	4.17	7	4.20	5	4.18	7
Change in specification by client	4.15	10	4.15	8	4.03	9	4.13	8
Ambiguity in design details by consultants	4.17	8	4.13	9	4.04	8	4.12	9
Contractor's desired profitability	4.16	9	4.11	10	4.01	10	4.10	10
Unavailability or lack of equipment by contractor	4.09	13	4.09	11	4.00	11	4.07	11
Design complexity by consultants	4.12	11	4.07	12	3.89	12	4.04	12
Noninvolvement of contractor in design	4.11	12	4.02	14	3.85	13	4.00	13
Absence of specialized contract manger by contractor	4.04	15	4.04	13	3.80	15	3.99	14
Inadequate scope of work for contractor specified by consultants	4.07	14	4.01	15		14	3.98	15
Inadequate working drawings by consultants	4.05	16	3.95	18	3.80	17	3.93	16
Impediments in prompt decision taking by client	4.01	18	3.90	19	3.77	18	3.89	17
Change of project duration by client	3.93	20	3.88	20	3.70	20	3.85	18
Defective workmanship by contractor	3.79	25	3.78	23	3.53	25	3.74	19
Contractor's lack of strategic planning	3.82	22	3.72	25	3.61	23	3.71	20
Change in Economic conditions	3.50	30	3.65	28	3.50	30	3.60	21
Contractor's financial problem	3.72	27	3.60	29	3.53	27	3.56	22
Consultants' lack of knowledge of available materials or equipment	3.65	28	3.49	30	3.52	28	3.52	23
Complex design interpretation by contractor	2.93	36	2.81	39	2.87	37	2.84	24
Safety conditions	2.90	37	2.82	38	2.80	40	2.83	25

ISSN: 2394-4404

Non-compliance of Consultants' designs with statutory requirements/government regulations	2.60	44	2.66	41	2.75	42	2.67	26
Consultants' obstinacy	2.75	41	2.52	44	2.70	43	2.59	27
Obstinate nature of contractor	2.71	42	2.51	45	2.65	45	2.49	28
Change in government regulations	2.32	46	2.30	46	2.58	46	2.36	29
Obstinacy of client	2.00	47	2.10	47	1.98	48	2.06	30
Client's financial problem	1.88	50	1.94	49	1.90	49	1.92	31
Weather condition	1.85	51	1.80	52	1.70	52	1.79	32

Table 3: Relative importance ranking of causes of variations

Table 3 shows that thirteen causes of variations are considered important in instigating variations because their mean scores are above 4.0 which means "important" on the measurement scale used. Table 3 reveals that unclear project brief by client with a mean score of 4.42 is the most important cause of variations in educational building projects, followed by errors and omissions in design by consultants with a mean score of 4.40. Change of plan or scope by client with a mean score of 4.37 is ranked the third most important cause of variation followed by change in design by consultants with a mean score of 4.32.

	Effects of Variations	Mean Score	Rank
i	Cost Overun	4.78	1
ii	Time Overun	4.76	2
iii	Work progress adversely affected without delay to overall completion time	4.69	3
iv	Enhanced quality standards	4.60	4
v	Demolition and Reworks	4.50	5
vi	Dispute between parties	4.37	6
vii	Waste of resources	4.30	7
viii	Additional profit for Contractor	3.94	8
ix	Increase in Overhead expenses	3.93	9
x	Delay in materials procurement	3.81	10
xi	Productivity degradation	3.69	11
xii	Delay in payments to Contractor	3.65	12
xiii	Poor Sxafety conditons	3.60	13
xiv	Quality Standard degradation	2.68	14
xv	Request for additonal specialised equipment and Personnel	2.58	15
xvi	Reduction in Overall construction time	2.56	16
xvii	Optimal reduction in Cost	2.44	17

Table 4: Frequency of occurrence of Variations effects in Educational Building projects

From the result of the analysis presented in Table 4, seven (7) effects or outcomes of variations are perceived to occur often in educational building projects because their mean scores are above 4.0 which means "often,4.0" on the measurement scale used. The effects that often occur include: cost overrun (4.78), time overrun (4.76), work progress adversely affected without delay to overall completion time (4.69). Others are; enhanced quality standards (4.60), demolition and reworks (4.50), dispute between parties (4.37), and waste of resources (4.30). Reduction in overall construction (2.50) and optimal reduction in cost (2.44) are rarely outcomes of variations in educational building projects.

Control of variations	N=75							
	n=10 clients (Mean Score)	Rank	n =45 Consultants (Mean Score)	Rank	n = 20 Contractors (Mean Score)	Rank	Overall Mean Score)	Rank
Involvement of clients at planning and design phases	4.66	1	4.60	1	4.25	3	4.50	1
Clear Project brief	4.52	3	4.55	2	4.20	5	4.42	2
Thorough detailing of designs	4.58	2	4.50	3	4.13	7	4.40	3
Involvement of professional consultants at the initial stage	4.50	4	4.38	4	4.22	4	4.37	4
Making contingencies sum allowance for variations	4.30	5	4.35	5	4.26	2	4.30	5
Freezing designs	4.20	7	4.28	7	4.30	1	4.26	6
Team effort by clients, consultants and contractors to control variations	4.21	6	4.16	8	4.19	6	4.19	7
Review of contract documents	4.19	8	4.30	6	4.05	8	4.18	8
Continues coordination and direct communication	4.17	9	4.13	9	4.04	9	4.11	9
Comprehensive documentation of mode of valuation of indirect effects of variations	4.12	10	4.07	10	3.89	10	4.02	10
Prompt variation orders approval procedures	4.01	11	3.90	11	3.77	11	3.89	11
Written approvals for variation orders	3.82	12	3.72	12	3.61	12	3.72	12
Clarity of variation orders procedures	2.75	13	3.70	13	3.55	13	3.67	13
Adapt contract clauses to control potential for variation.	3.40	14	2.90	14	2.90	14	3.07	14
Site studies/investigations prior to design	2.86	16	2.88	15	2.86	16	2.87	15
Comprehensive documentation of variation orders	2.81	17	2.84	16	2.89	15	2.85	16
Thorough definition of variation order scope	2.88	15	2.80	17	2.81	17	2.83	17
Variations negation ability	2.65	18	2.61	18	2.28	18	2.68	18
Involvement of contractors at planning and design	2.57	19	2.58	19	2.68	19	2.61	19

phases								
Appointment of project manager from independent firm	2.35	20	2.30	20	2.58	20	2.41	20
Involvement of clients in construction	2.00	21	2.10	21	1.98	21	2.03	21
Value engineering at planning and design stages	1.98	22	1.92	23	1.97	22	1.99	22
Avoiding use of open tendering	1.83	25	2.01	22	1.73	24	1.88	23
Use of experience of variations in pat projects	1.95	23	1.81	24	1.75	23	1.84	24
Variation logic and justification	1.84	24	1.79	25	1.68	25	1.77	25

Table 5: Ranking of controls for variations

The results presented in Table 5 indicate that the top six most effective controls for variations - involvement of clients in planning and design, clear project brief, thorough detailing of designs, involvement of professional consultants at the initial stages of project, contingencies allowance provision for variations, and freezing designs - are design phase controls. Thus, the design phase is the most effective stage to implement controls for minimizing the adverse effects of variations on building projects performance.

Projects	Original Contract Period (weeks)	Final Contract Period (weeks)	Extension of Period (Deviation)	Percent (%)
1	28	32	4	14
2	36	48	12	33
3	30	38	8	27
4	32	45	13	41
5	24	30	6	25
6	26	40	14	54
7	26	30	4	15
8	36	48	12	33
9	24	29	5	21
10	28	36	8	29
Total	290	376	86	292
Mean	29.00	37.60	8.60	29.20

Table 6: Time Data from source document

Table 4 shows the analysis of secondary data collected on the original and final contract period of individual projects to assess completion time and time overrun experienced as a result of variation orders. From the table it can be seen that no project was completed within the time schedule. They all exceeded their estimated completion time with a percentage deviation of 12% to 54%. On the average, the projects exceeded their completion with a percentage deviation of 29.20%. This means that all the projects had extension of time which lead to time overrun.

DISCUSSION OF FINDINGS

The study findings on the importance of causes of variations corroborate numerous research reports. Giwa (1988) and Udeh (1991) in Ogunsemi (2006) pinpointed that inadequate project brief, design inconclusiveness, inadequate pre-contact planning, and indiscipline on the part consultants as major factors causing variations. Instructions requiring a variation would become necessary in circumstances where clients do not clearly and adequately articulate the project requirements at the briefing stage. Shrinking time scale for project planning could result in unclear or inadequate project brief. According to Udeh (1991), projects in Nigeria are hurriedly conceived. He contends that poor handling of project documentation, detailing and cost appraisal give rise to variations subsequently. The result on errors and omissions in designs by consultants agrees with frequent assertions in the literature that modifications to the designs are a common cause of variations in building projects. According to Ashworth, Hoggs and Higgs (2013), the most common reason for variations is to amend the designs in some way. And Wainwright and Wood (1983) suggested that architects tend not always to crystallize their intentions on paper before the contract is signed. Incentive might have existed for this situation because of the contract provision that empowers the architect to vary the designs. Errors and omissions in design could lead to loss of productivity and delay in project delivery time.

Change in plan or scope by clients with a mean score of 4.37 and change in specifications by clients with a mean score of 4.13 were ranked as important causes of variations in educational building projects. Majority of the respondents interviewed indicated that plans were often not finalised by clients before commencement of work on site. Such a situation, they submit, leads to frequent revision of plans during the construction phase of project implementation. Variation orders are thus initiated where plans are revised with attendant significant demolition and reworks where the revisions touch on aspects of work already carried out. Change in specifications by clients during the construction phase often requires extensive variations and adjustments in project planning in a multiplayer environment like construction.

Cost overrun is the most predominant adverse effect of variations on project performance. This corroborates reports of several authors (Hanna et al., 2002; Koushki et al., 2005; Arain and Pheng, 2006; Eigbe 2008) that projects' cost escalation is the most significant effect of variations. The result on cost, and time overruns as the dominant frequent outcomes of variations agrees with reports of previous other studies. Jawad et al (2009) report that increases in project cost and duration are the two main effects of variations in construction projects, According to Amu et al., (2005), and Pourrostand and Ismail (2011), variations or change orders are the reasons why most contractors do not meet up with the time specified for completion of most contract works.

The effective controls for variations corroborate with the findings from the literature (Fisk, 1997; O'Brien, 1998; Arain et al., 2004) 'According to Fisk (1997), clarification of project objectives is greatly enhanced with the involvement of the owner at the design phase. He added that this could aid the identification of non-compliance with project requirements at an early stage, thus eliminating variations during the construction phase. O'Brien (1998) asserted that a clear and thorough project brief is an important control for variations. With thorough and comprehensive design details, errors and omissions in designs are detected at the early stage and this facilitates corrective measures and eliminates variations deriving from ambiguous and erroneous designs. O'Brien (1998) confirmed this when he stated that project participants more readily appreciate clearer designs. Involving professionals in project briefs formulation assist in the development of better designs by incorporating their practical ideas (Eigbe, 2016). From the foregoing, it can be seen that control measures initiated during a project's design phase would immensely minimize the adverse effects of variations on the project delivery.

V. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the causes and impact of variation orders on building construction projects' performance. This is with a view to suggesting effective variations control measures to improve project performance within the context of building project in public tertiary educational buildings in Edo State, Nigeria. Based on extensive literature review and a careful analysis of relevant data, the study concludes that, unclear project brief by clients, errors and omissions in designs by consultants, change of plan or scope by client, change in designs by consultants and change of materials or construction procedure by clients are the five most important causes of variations in educational building projects. Cost and time overruns are the dominant frequent outcomes of variations in construction building projects. Furthermore, the study concludes that the involvement of clients at planning and design phases, clear project brief, thorough detailing of designs, involvement of professional consultants at the initial stages, contingencies allowance provision for variations in project budget are the five top most effective potential controls for variations in educational building projects as perceived by project participants.

The study therefore, recommends that greater effort such as site and soil studies, should be expended by clients in the early stages of a project development so as to properly articulate all aspects of the project requirements and thus enhance the quality of project brief. Project planning should be seen as important and encouraged as this will bring about the involvement of the client at planning and design phases, promote client/consultants' collaboration in project procurement and thus minimize variations. Consultants should spend adequate time on design detailing and documentation, including critical revision, before site construction operations in order to reduce errors and omissions in designs. Variations should be accounted for during project planning by the provision of a realistic contingencies allowance for it in projects' budgets based on empirical or model estimate of the value of variations. This will be helpful in the management of variation as it will serve as baseline for their control. This will minimize cost overruns and improve project performance.

REFERENCES

[1] Akintoye, A. (2000) Analysis of factors affecting project estimating practice, Construction Management and Economics, 18(1), 77-89.

[2] Alsuliman, J., Bowles, G and Chen, Z. (2012) Current practice of variation order management in the Saudi construction industry in: Smith, S.D. (Ed) Procs 28th Annual ARCOM Conference, 3-5 September, 2012, Edinburgh, UK, Association of Researchers in Construction Management, 1003-1012.

[3] Ashworth, A., Hogg, K., and Higgs, C. (2013). Willis's practice and procedure for the quantity surveyor. West Sussex, U.K: John Wiley & sons, Ltd.

[4] Amu, J.O.O., Adeoye, O.A. and Faluyi, S. O. (2005). Effects of incidental factors on the completion time of projects in selected Nigerian cities. Journal of Applied Sciences, 5(1), 144-146.

[5] Arain, F.M. (2006). The Potential Effects of Variation Orders on Institutional Building Projects. The Emerald Research, FAC 23, 11/12, 496-510.

[6] Arain, F.M. and Pheng, L.S. (2005). How Design Consultants Perceive Causes of Variation Order for Institutional Buildings In Singapore. Architectural Engineering and Design Management, vol.1, no.3, 181-196

[7] Arain, F.M. and Pheng, L.S. (2006). Developers' view of potential causes of variation orders for Institutional buildings in Singapore, Architectural Science Review, vol. 49, no.1, 59 – 74.

[8] Baxendale, A.T. and Schofield,T.J. (1996), Planning and Progressing Project Variations in Langford,D.A. and Retik, A. (eds), The Organization and Management of Construction: Shaping theory and practice, vol. 2 E & FN, London: Spon Press

[9] Cameron, I., Duff, R. and Hare, B. (2004). Integrated gateways: Planning out health and safety risk. Research Report 263, Glasgow Caledonian University, U.K.

[10] Charoenngam, C., Coquinco, S.T., and Hadikusumo, B.H.W (2003). Web-Based application for managing change orders in construction projects, Construction Innovation. Vol. 3 197-215

[11] Chini, A. R. and Valdez, H.E. (2003). ISO 9000 and the U.S. construction industry, Journal of Management in Enginee

[12] +ring, ASCE 19(2), 78-82.

[13] Clough, R.H. and Sears, G.A. (1994) Construction contracting (6th edition), New York: John Wiley and Sons Inc.

[14] Construction (2011). Construction: Industry challenges. Retrieved January 18,2012 from http://www.com/industries/constuction/construction-industy-challenges-html

[15] Construction Industry Institute, CII (1990). The impact of changes on construction cost and schedule. Retrieved May 22, 2004 from http://www.construction-institute.org/source/security/site-logon.cfm?activesection=home&a=1

[16] Creswell, J.W. (2013). Research Design: Qualitative, Quantitative and mixed methods approaches. USA: Sag.

[17] Eigbe, S.I. (2008). Evaluating the impact of variations on the cost of building projects. International Journal of Environmental Sciences vol.4, no.2

[18] Eigbe, S. I. (2014) Empirical Study of The Origins and Causes of Variation Orders in Building Projects'

Performance in Edo State, Nigeria. Unpublish Thesis presented to the department of Building, faculty of Environmenal sciences, Nnamdi Azikiwe University, Awka in partial fulfillment of the requirement for the award the Degree of Doctor of Philosophy (PhD) in construction margineb

[19] Eigbe, S.I. (2016) Empirical Study of The Origins and Causes of Variation Orders in Building Projects. International Journal of Engineering Research and Application ISSN: 2248-9622, Vol 6, Issue 10, (Part-2) October 2016, pp. 34-48.

[20] Fellows, R. and Liu, A. (2015). Research methods for construction (4th ed.), West Sussex, United Kingdom, UK: John Wiley & Sons, Ltd.

[21] Finsen, E. (2005). The Building Contract – A Commentary on the JBCC Agreement, 2nd ed., Kenwyn: Juta and co Ltd.

[22] Fisk, E.R., (1997). Construction project administration, 5th edition. Englewood Cliffs, NJ: Prentice-Hall.

[23] Federal Ministry of Works, F.M.W (1990). Lump Sum Contract for use with Bills of Quantities. Abuja: Federal Ministry of Work printing office.

[24] Hanna, A.S.P.E., Calmics, R., Peterson, P.A., and Nordheim, E.V. (2002). Quantitative Definition of Projects Impacted by Change Orders. Journal of construction Engineering and Management, vol. 128, no. 1, 57-64.

[25] Harbans, S.K.S. (2003). Valuation of varied works: A Commentary, In Bulletin Ingenieur, The Board Engineers Malaysia, vol. 20, no. 3. 32-42.

[26] Hester, W., Kuprenas, J.A., and Chang, T.C. (1991). Construction change and change orders: Their magnitude and impact, The University of California – Berkeley, CII Source Document No. 66.

[27] Ismail, A., Pourrostam, T., Soleymanzadeh, A. & Ghouyounchizad, M. (2012). Factors causing variation orders and their effects in roadway construction projects. Research Journal of Applied Sciences, Engineering and Technology, 4(23), 4969-4972.

[28] Ibbs, C.W., Wong C.K., Kwak, Y.H. (2001). Project change management system, Journal of Management in Engineering, ASCE, Vol.17 No.3.pp. 159-65.

[29] Jawad,R.S.M., Abdulkader, M.R B., and Ali, A.A.A. (2009). Variation orders in construction projects. Journal of Engineering and Applied Sciences. Vol.4,issue 3, 170-176. Retrieved December 24, 2011, from http://wwwmedwelljournals.com/fulltext/?doi=jeasci.2009.170.176

[30] Koushki, P.A., Al-Rashid, K. and Kartam, N. (2005). Delays and Cost increases in the Construction of Private Residential Projects in Kuwait. Construction Management and Economics, vol. 23,285-294.

[31] Kululanga, G.K., Kuotcha, W., McCaffer, R.,and Edum-Fotwe, F. (2001). Construction contractors' claim process framework, Journal of Construction Engineering and Management, 127(4), 303-314.

[32] Kumaraswamy, M.M., Miller, D.R.A. and Yogeswaran, K. (1998) Claims for extension of time in civil engineering projects, Construction Management and Economics, 16(3), 283-294.

[33] Ling, Y. Y., Khee, H.Y., and Lim,K.S.G (2000). The reasons why clients prefer to procure more projects based on Design-Bid-Build than Design-and Build. Journal of Construction Procurement, 6(2), 135-146.

[34] Love, P.E.D. and Sohal, A.S. (2003). Capturing rework in projects, Managerial Auditing Journal 18(4). Pp.329-339.

[35] Mohammad, N., Che Ani, A.I., Rakmat, R.A.O.K. and Yusof, M.A. (2010) Investigation of the causes of variation orders in the construction of building project – A study in the state of Selangor, Malaysia, Journal of Building Performance, vol. 1 issue 1. Retrieved July 24, 2011 from http://pkukmweb.ukm.my/~jsb/jbp/index.html.

[36] Mukhtar, A., Bedard, C., Fazio, P. (2000). Collaborative planning and scheduling of interrelated design changes, Journal of Architectural Engineering, Vol.6 No.2, pp. 66-75.

[37] Ndihokubwayo, R. and Haupt, T. (2009). Variation Orders On Construction Projects: Value Adding or Waste? International Journal of Construction Project .Management, vol.1, issue 2.

[38] Nworuh,G. E., and Nwachukwu, G.O.C. (2004). Risk management approach to claims in construction contracts administration. The Quantity Surveyor, Journal of the Nigerian Institute of Quantity Surveyors, Vol.46.

[39] Oberlender, G.D. (2000). Project management for engineering and construction, 2nd edition. Boston: McGraw-Hill.

[40] O'Brien, J.J. (1998). Construction change orders. New York: McGraw Hill

[41] Odeh, A. M. and Battaineh, H.T. (2002) Causes of construction delay: traditional contracts. International Journal of Project Management 20, 67-73.

[42] Ogunsemi, D. R. (2006). Predicting the final cost of construction projects in Nigeria. The Quantity Surveyor, Journal of the Nigerian Institute of Quantity Surveyors, vol.51, 3-6.

[43] Oladapo, A.A. (2007). A Quantitative Assessment of the Cost and Time Impact of Variation Orders on Construction Projects. Journal of Engineering, Design and Technology, vol.5, no.1, 35-48

[44] Oyewobi, I.O., Ibironke, O.T., Ganiyu, B.O. and Ola-Awo, A.W. (2011) Evaluating rework cost – A study of selected building projects in Niger State, Nigeria, Journal of Geography and Regional Planning, vol.4(3) 147-151.

[45] Pourrostam, T. and Ismail, I. (2011). Significant factors causing, and effects of delay in Iranian construction projects. Australian Journal of Basic Applied Sciences, 5(7), 450-456.

[46] Ssegawa,J.K., Mfolwe,K.M., Makuke,B.,and Kutua,B.(2002). Construction Variation: A Scourge or a Necessity? Proceedings of the First International Conference of CIBW 107, 11-13, Nov., 2002, Cape Town, South Africa, 87-96.

[47] Thomas, H. R. and Napolitan, C. L. (1994). The effects of changes on labour productivity: Why and how much. CII document 99, The Pennsylvania State University, USA.

[48] Trickey, G. and Hackett, M. (2001). The presentation and settlement of contractor's claims, London: Spon Press

[49] Turner, D.F. (1984). Standard contracts for building. London: George Godwin.

[50] Udeh, B. C. (1991). Contract Administration in Nigeria. Zaria, Proceedings of the International Conference on Quantity Surveying in Developing World.

[51] Wainwright,W.H. and Wood, A.A.B. (1983). Variation and Final Account Procedure, 4th ed., London: Hutchinson.

[52] Wong, C. H., Holt, G.D., and Harris, P. (2001). MultiCriteria selection or lowest price? Investigation of UK Construction Clients' Tender Evaluation Preferences, Engineering and Architectural Management, 4(8), 257-271.