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Empirical Study of the Origins and Causes of Variation Orders in Building Projects

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ABSTRACT
Variations or changes to construction plans have been identified as a major problem in construction projects. Variations have adverse impact on project delivery. Effective management of variations, therefore, is critical to accomplishing project objectives; and this commences with identifying the sources and causes of variations. This paper presents the results of a study of the origins and causes of variation orders in building projects within the Federal Government of Nigeria (FGN): Ministries, Departments, and Agencies (MDGs). Extensive review of relevant literature has been provided. The methodology adopted involved the use of structured questionnaires administered on the MDGs ensuring a fair representation of the geo-political zones of the country. Use was made of field assistants to facilitate the administration of questionnaires. An ex-post facto research design was also employed in the data gathering. Analysis of data was done using descriptive and inferential statistics. The results reveal that variation orders are common in building projects. The client was shown to be the most frequently involved origin agent of variation orders as a result of inadequate or unclear brief, and change in plan or scope. The study concludes with recommendations that project planning; and engagement of project officers are effective means of formulating clear project briefs in order to minimize variation orders and enhance project performance.

Keywords: Construction plans, FGN, MDGs, origin agents, project performance, variation orders

I. INTRODUCTION

1.1 Background of the study

The construction of buildings is a piece of work in human multitasking. Building construction comprises of a multitude of professions, occupations and organisations. The processes embrace design and production information documentation, financial and legal considerations, interaction of expertise, contracts procurement, and site operations. Building construction works are often subject to variability of soil, site and weather conditions. These phenomena make building projects prone to changes or variations to the construction plans: designs, drawings, quantities and specifications for a project earmarked for a specific site. These changes occur after the award of the initial contract or after work might have commenced at the construction sites (Ismail, Pourrostam, Soleymanzadeh & Ghouyounchizad, 2012). According to Variations in Construction (2016), construction projects will inevitably depart from the original tender design, specifications and drawings prepared by the design team. 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.

Contracts for building projects within the FGN are based on Standard Forms of Building Contract (SFBC). The Federal Ministry of Works (FMW) and the Bureau of Public Procurement (BPP) published SFBC are commonly used for projects within the FGN. The Forms authorize the architect/supervising officer/engineer to issue instructions requiring a variation to the works. Variation means the alteration or modification of the designs, quality or quantity of the Works as shown upon the Contract Drawings and described by or referred to in the Contract Bills, and includes the addition, omission or substitution of any work shown in or described by the construction plans. According to Keane, Sertyesilisik and Ross (2010), variation is the deviation experienced in any project from base contract or work scope mutually agreed at contracting time. Variations or changes to construction plans during site operations are effected through variation orders. Variation orders are instructions that permit changes to be made to the works as originally defined in the contract. Variations and variation orders are invariably encountered in construction projects. In the absence of variation clauses in building contracts, the client could be in a difficulty should variation to the works be required. However, variations have adverse impact on projects' objectives. Ibbs (2012) asserted that change on construction projects impedes project success for both the owner and the contractor. Waldron's study (as cited in Love, Sai on Cheung & Irani, 2011) pinpointed variations as a significant contributor to disputes in construction

projects. According to Pourrostam and Ismail (2011), variation orders are the reasons why most contractors don't meet up with the time specified for completion of most contract works. Variations affect project total cost and time for completion; it might instill conflicts, claims, and disputes between all associated parties (El-adaway, Fawzy, Allard & Runnels, 2016).

From the foregoing, therefore, it is pertinent to ask the following questions that are germane to the objectives of this study:

i) How common are variation orders in building projects?
ii) Who are the origin agents of variation orders?
iii) What is the frequency of involvement of the origin agents of variation orders?
iv) What are the reasons or causes of variation orders?
v) How do building participants perceive the relative importance of the causes of variation orders?

Effective management of variations is important in order to mitigate their adverse effects on building projects. Bottari (2014) noted that effective change or variation management is critical to mitigating project risk. According to Construction (2011), management of change or variation orders easily boost operational efficiency of construction. A critical step in the management of variations is to identify and understand their sources, causes and effects. According to Construction Engineering and Infrastructure Management, CEIM, (2011), identifying the nature or type of variations will assist in formulating a procedure suitable for the management of variations. This study, therefore, investigates the origin and causes of variation orders in public sector building projects within the Federal Government of Nigeria. Public sector projects are selected for the study because projects of varying scope impacted by variations in this sector reach undesirable outcome. The study evaluated the causes of variations in building projects; and investigated the origins of variation orders. The causes of variation orders identified will be of help to practitioners in assessing variation orders. The evaluation of the causes of variation will assist professionals in adopting proactive measures to control the important causes of variations. This will be helpful in minimizing the adverse effect of variations on building projects in the sector.

1.2 Aim and Objectives

The aim of this study is to evaluate the causes of variation orders in building projects. The study investigates the origins of variation orders. This is with a view to afford building practitioners the capacity for effective management of variations in building projects. The objectives of the study are to:

i) Investigate the occurrence of variation orders in building projects
ii) Examine the origins of variation orders, and identify the predominant origin agent.
iii) Identify, and evaluate the causes of variations.

1.3 Hypotheses of the Study.

The following hypotheses were formulated to further examine the objectives of the study:

i) Variation orders are not common in building projects.
ii) There is no agreement between project participants on the relative importance of clients-related causes of variation orders.

II. LITERATURE REVIEW

2.1 Frequency of variations in building projects

Several researchers (Ibbs, Wong & Kwak, 2001; Thomas, Horman, Souza & Zaviski, 2002; Oladapo, 2007) have reported that variations are common in all types of construction projects. Industry research indicated that approximately 40% of all construction projects undergo more than 10% change, as measured by the ratio of final project costs to estimated project costs (Ibbs, 2012). According to Memon, Rahman, and Hasan (2014), variation order is a common phenomenon in construction projects. It involves an amendment to the original scope of work as in the contract.

Numerous factors account for the prevalence of variations in building projects. Sunday (2010) asserted that the complexity of construction gives rise to situations like variations with their attached effects. According to Hanna, Calmic, Peterson, and Nordheim (2002), variations are frequent on construction projects given the uniqueness of each project. Building projects are each distinctively unique. No two building projects are identical. Even where the designs and form of construction are the same, variability in soil and site conditions; unpredictable market prices of building materials and goods would constitute a distinguishing feature of otherwise identical projects.

2.2 Origins of variation orders

The origin of variations refers to any of the project participants who directly initiates or suggests variations to the project, or by reason of whose failure or inability to fulfill the requirements for carrying out the project, causes a variation order to be issued. It also embraces factors or conditions which though not directly linked to the participants,

also cause an instruction requiring a variation to be issued. The report of a study on Minimizing Impact of Change Order to Projects Cost conducted by the Construction Engineering and Infrastructure Management, CEIM, (2011) indicated that change orders or variation orders are changes brought about by the owner or changes due to site conditions, damages (sic) or weather. According to Harbans (2003), variation orders may be initiated either by clients or by contractors. These postulations on the origins of variation orders are shallow. They tend to suggest the exclusion of project consultants as origin agents of variation orders. It is submitted that the intendment of the Standard Forms of Building Contracts is to enable the consultant architect initiate variation orders when he desires; and design consultants often initiate variations.

The origin agents of variation orders in building projects are well documented in the literature. Mainly the client, architect, contractor and other stakeholders are the originators of variation orders in building projects (Ssegawa, Mfolwe, Makuke, & Kutua, 2002). Several researchers (Jawad, Abdulkader, & Ali, 2009; Ndihokubwayo and Haupt, 2009; Mohammad, Chi Ani, Rakmat, & Yusof , 2010; Anees, Mohamed & Abdel Razek, 2013) have reported that the owner (client) is the main source of variation orders in building projects. A survey on Developers' Views of Potential Causes of Variation Orders conducted by Arain and Pheng (2006) however posited four main origin agents of variation orders. These agents included Clients, Consultants, Contractor and "Others". According to Mohammad et al. (2010), "Other" changes refer to variation orders brought about by factors not directly related to the participants.

2.3 Causes of variation orders

The causes of variations are the underlying reasons that precipitate variation orders in building projects. They are the incident for a variation order to be issued. Because these causes can affect construction projects adversely, Arain and Pheng (2006) suggested that it is important to investigate them.

Several researchers (Thomas and Napolitan, 1994; Mukhtar, Bedard & Fazio, 2000; Gray and Hughes, 2001; Arain, Assaf & Low, 2004) have identified the causes of variation orders. A study conducted by Alaryan, Emadelbeltagi, Elshahat and Dawood (2014) identified five most common causes of change or variation orders to include: change in plans by owner; change in project scope by owner; problem on site; error or omission in design (main element); poor design and poor working drawing details (secondary element). Alaryan et al (2014) submission finds support in the assertion of Ashworth, Hoggs and Higgs (2013) that the most common reason for variations is to amend the designs in some way. The needs of the owner 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 choice of the design consultants (Arain and Pheng, 2006). It is suggested that the consultants' review of the design may promote improvement changes and thus, the operations of the project. Most commonly, lack of timely and effective communication, lack of integration, uncertainty, a changing environment, and increasing project complexity are drivers of project variation (Arain et al., 2004).

The causes of variations can be categorized according to the origin agent that initiates the variation (Thomas and Napolitan, 1994; Jawad et al., 2009; Mohammad et al., 2010). Thus, the causes of variations identified from literature review are as follows:

2.3.1 Client related changes.

The client may directly initiate variations or the variations are required because the client fails to fulfill certain requirements for carrying out the project. The following are the causes of variations initiated by the client: Change of plans or scope by client; Change of construction time by client; Client financial problem; Unclear brief (Inadequate project objectives); Change of materials or procedure; Impediments in prompt decision making; Obstinate nature of client; Change in specification by client

2.3.2 Consultant related changes.

Consultants may directly initiate variations or the variations may be required because the consultants fail to fulfill certain requirements for the carrying out of the project. The following are the causes of variations initiated by consultants: Change in design by consultant; Change in specification by consultant; Errors and omissions in design; Errors and omissions in contract bills; Discrepancies between contact documents; Inadequate scope of work for contractor; Technology change; Lack of coordination; Design complexity; Inadequate working drawings details; Consultant lack of judgment or experience; Consultant lack of knowledge of available materials and equipment; Honest wrong belief of consultant; Consultant lack of required data; Obstinate nature of consultant; Ambiguous design details; Design discrepancies;

Design non-compliance with statutory/government regulation; Design non-compliance with client requirements

2.3.3 Contractor related changes.

These are variations suggested by the contractor or required because the contractor fails to fulfill certain requirements for the carrying out of the project. The following are the causes of contractor related variation: Unavailability or lack of equipment; Shortage of skilled labour; Contractor's financial problem; Contractor's desired profitability; Unfamiliarity with local environment; Absence of specialized construction manager; Poor procurement process; Lack of communication; Contractor's lack of experience and judgment; Honest wrong belief of contractor; Lack of strategic planning; Contractor's lack of required data; Obstinate nature of contractor

2.3.4 Other changes. These are variations required by reason of the following causes not directly related to the participants:

Weather conditions; Safety conditions; Changes in government regulations; Changes in economic conditions; Socio-cultural factors; Unforeseen problems.

2.4 Summary of literature review

The review of the items for discussion commenced with exploring the prevalence of variation orders. The origins of variation orders were captured in the literature. The underlying causes of variation orders were identified in the literature and categorized according to their originators. It is reported in the literature that the client is the predominant origin agent of variation orders.

However, in spite of numerous articles on the origins and causes of variation orders, the significance of the number of variation orders in building projects was not investigated. The level of involvement of the origin agents; and the reason that might have been the incident for client-related variations have not been fully examined. The relative importance of the causes of variation orders were not much explored. Besides, it is yet to be established whether stakeholders hold the same view about the importance of clients-related causes of variation orders. This is imperative for effective management of variations. This study evaluated the causes of variation orders. It determined whether there is significant difference in the ranking of importance of clients-related causes of variation orders by stakeholders. It is hoped that the findings will assist practitioners in making timely and more informed decisions for effective management of variations in building projects.

It is pertinent to state here that the causes of variations and their categorization pattern documented in the literature were quite instructive. They formed the basis of the evaluation of causes of variations in this study.

III. METHODOLOGY

A questionnaire survey was conducted to gather data for the study following a comprehensive review of relevant literature. An ex-post facto research design was also employed whereby archival information from source documents of completed building projects was obtained and analyzed to further examine the objectives of the study. The source documents included Architects' Instructions, Variation Orders Documents, and Records of measured and valued variations.

The sample used for the study was drawn from the Federal Government of Nigeria MDGs projects spread across the zones of the country which comprised building projects completed between 2010 and 2015, and the project participants – clients, consultants and contractors – as subjects in the survey. A sample of two completed projects selected from each of the six geo-political zones was considered a fair representation. The MDGs used are a body corporate; they therefore are statutorily empowered to commission and manage own building and construction projects. Archival information was obtained from project completed by the MDGs. The survey participants were the client's project officers; and the professional consultants and contractors prequalified by the MDGs 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 frequency of variation orders in building projects based on their experience.

The questionnaire administration was carried out in two stages. In the first stage, the causes of variations established from literature review were listed. Respondents were requested to identify the common causes of variations from the list of root causes. The design of the final research instrument was informed by the literature review and the results of the first stage questionnaire set. The final questionnaire was divided into two parts. Part 'A' solicited information about respondents' demographics. Part 'B' focused on the origins, and

causes of variation orders and respondents were required to provide responses based on their experience on the projects. The study adopted the structured questionnaire method, employing typically 5 points Likert type scaled questions. The structured questionnaire used, however, incorporated a response opportunity of "other, please specify" in appropriate cases. This approach finds support in Fellows and Liu (2015) submission that rigidity of available responses may constrain responses artificially.

Cronbach's alpha coefficient of reliability was used to test the reliability of scaled responses. Ideally, Cronbach's alpha coefficient of scale should be greater than or equal to 0.7 (George and Mallery, 2003; Pallant, 2005; UCLA, 2010). Pallant (2005), however, further indicated that for scales with fewer than ten items, low Cronbach's alpha coefficient such as, for example, 0.5 was common. This study adopted a Cronbach's alpha coefficient of 0.5 for scaled questions with fewer than ten items.

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:

$MS = \sum (FX) / N.$ $(1 \leq MS \leq 5)$ …… (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.

The 'Weighted Average' (WA) was used in assessing project participants' ranking of importance of the common causes of variations. The weighted average for each of the common causes of variations was obtained from the sum of the product of the proportion of the responses received from each group compared to the total number of receipts (n/N) and the corresponding mean score(MS) of that group in respect of individual cause of variations. The Weighted Average is given as:

$WA = \sum [(n/N)*MS]$ $(1 \leq WA \leq 5)$…… (Eqtn.2)

The significance of the important causes of variation orders categorized according to their origin agents was tested using the SPSS Version 17.0 One-Sample t-test of significance at 5% level of significance.

To determine whether there is a significant difference between clients, consultants and contractors' ranking of importance of client-related causes of variation orders, the mean score of the ranking for each group was computed. Spearman's rank correlation coefficient was used to measure correlation between two sets of rankings of the means. According to Fellows and Liu (2015), the coefficient of correlation between the ranks is a measure of the association between the variables, which is determined from the observations of the variables; it is calculated using Spearman's coefficient of rank correlation, ρ, represented as:

$\rho = 1 - 6\sum D^2 / n(n^2 - 1)$…….. (Eqtn.3)

Where D^2 is the difference between the rank given by one party and the rank given by another party for an individual factor or cause and n is the number of paired values. To test whether there is any significant difference in the correlation coefficient; t-test was employed at 5% level of significance of the null hypothesis, H_o. The t-statistic as defined by Spiegel (1972) is given as:

$$t_{cal} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad \text{…….. (Eqtn. 4)}$$

The decision rule depends on whether the computed values of t were greater than or less than the critical values of t at (n-2) degree of freedom. Thus, the null hypothesis, Ho is rejected if $t_{cal} > t_{tab}$ at 5% level of significance.

Source documents – variation orders documents – of fourteen completed projects were scrutinized to further investigate the common occurrence of variation orders. Frequency count of data obtained from the source documents was carried out. One-sample t-test at 5% level of significance was then adopted to test the significance or common occurrence of variation orders in building projects. Going by Freund and Walpol (1987) assertion of inferential statistics, one-sample t-test for a sample less than thirty (30) is expressed as:

$$t = \frac{\bar{x} - \mu_o}{s/\sqrt{n}} \quad \text{……..... (Eqtn. 5)}$$

Where $\bar{x}$ is the mean of sample data, s is the standard deviation, n is the sample size; and H_o: $\mu = 0$ (empirically not significant), H_1: $\mu \neq 0$ (empirically significant). According to Freund and Walpol (1987), $\mu \neq$ may be ascribed to $\mu > 0$ or $\mu < 0$.

IV. RESULTS AND DISCUSSIONS

4.1 Survey Participation

Survey questionnaires were administered on ninety-eight building practitioners and participants, namely; architects, engineers, builders, quantity surveyors, clients and contractors. A total of fifty-two returns were received. However, there were inconsistencies in the responses of two of the respondents and as such, their questionnaires were invalidated. Fifty completed questionnaires were therefore used for the analysis. This represents a response rate of 51.02% as shown in table 1.

Table 1. Response rate of respondents

Respondent	Questionnaire		Rate of response
	No. sent	No. returned	
Client	20	8	40
Contractors	15	10	66.67
Architects	20	12	60
Engineers	20	8	40
Builders	10	5	50
Quantity Surveyors	13	7	53.85
Total	**98**	**50**	**51.02**

The analysis of the data collected shows that 66% of the respondents have a working experience of over twenty years in the construction industry as shown in figure 1. The respondents had been involved in the administration of variation orders. Therefore, the information supplied by them is reasonably reliable.

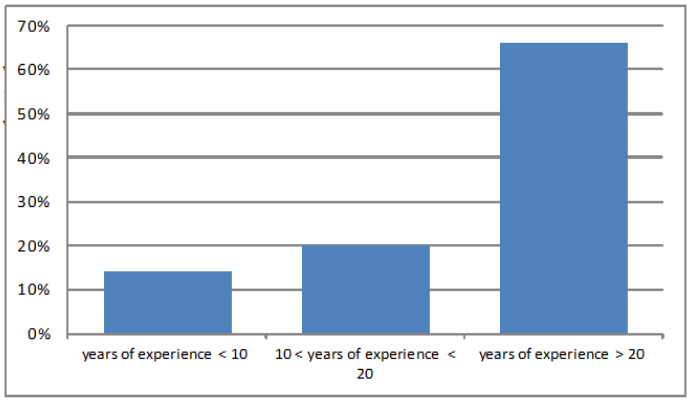

Fig. 1: Respondents working experience

4.2 Prevalence of variation

To investigate the prevalence of variation orders, a rating scale ranging from 1=rarely to 5=very often was used to obtain the opinions of respondents on the frequency of occurrence of variation orders in building projects. Table 2 shows the rating responses.

Table 2. Prevalence of variation orders

Frequency of occurrence	No. of responses
Rarely	0
Slightly often	0
Moderately often	6
Often	12
Very often	32
Total	**50**

1=Rarely, 2=Slightly often, 3=Moderately often, 4=Often, 5=Very often. (Mean Score=4.52)

As shown in table 2, the mean score is 4.52. This indicates that the respondents have been experiencing variations on most projects. This study further examined the occurrence of variation orders in building projects by scrutinizing source documents of fourteen completed projects. Table 3 shows the number of variation orders issued in the projects. The mean and standard deviation of the numbers were derived (see table 3).

Table 3. Frequency of variation orders

Project	No. of variation orders
1	75
2	30
3	11
4	16
5	70
6	62
7	33
8	22
9	31
10	54
11	71
12	57
13	50
14	83
Mean	**47.5**
Std. dev. (s)	**23.51**
n	**14**

t_{cal}=7.55; t_{tab}=1.77

The study hypothesized that "variation orders are not common in building project". To test this hypothesis, one-sample t-test at 5% level of significance was used to obtain the computed t-value with $|t| \geq t_{\alpha/2}$, n-1as shown in Table 3. From the computations, t-calculated is greater than t-tabulated; the study therefore rejects the null hypothesis and concludes that variations are common in building projects. The results as shown in tables 2 and 3 confirm reports of previous studies (Thomas et al., 2002; Oladapo, 2007; Ibbs, 2012; Memon et al, 2014) that variations are a common phenomenon and regular occurrence in construction projects.

4.3 Origin agents of variation orders

The origin agents of variation orders identified by the study are as shown in Table 4.

Table 4. Origin agents of variations

Origin agent	Description
Client	The owner or promoter of the project.
Consultants	Design and cost professionals; conceptualize and document project requirements. Include: architect, structural engineer, mechanical and electrical engineer and quantity surveyor.
Contractors	The only other party to the building contract with the client. Carries out the physical construction works
"Other factors"	Factors not directly related to the project participants. Include: weather conditions, safety conditions, change in government regulations, change in economic conditions, socio-cultural factors, and unforseen problems.

In order to determine the predominant origin agent, respondents were required to rank the involvement of the origin agents using 5=most frequently involved; 4=frequently involved; 3=moderately involved; 2=slightly involved; and 1=least frequently involved. Table 5 shows that

clients, with a mean score of 3.74 are the predominant originators of variation orders in building projects followed by consultants with a mean score of 3.62. Contractors and "others" are the least contributors to the generation of variation orders in building projects as revealed in table 5.

Table 5. Ranking of Origin Agents' involvement in variation orders

Origin Agent	Mean Score	Rank
Clients	3.74	1
Consultants	3.62	2
Contractors	2.00	3
'Others"	1.88	4

The involvement of origin agents in the generation of variation orders was further investigated by analyzing information from source documents. As shown in figure 2, of the 665 variation orders issued in the completed projects, 359 (translating to 54%) related to clients initiated variations. 273 of the variation orders, i.e. 41% were initiated by consultants while very few were from contractors and 'others' group with 24 (4%) and 9 (1%) respectively.

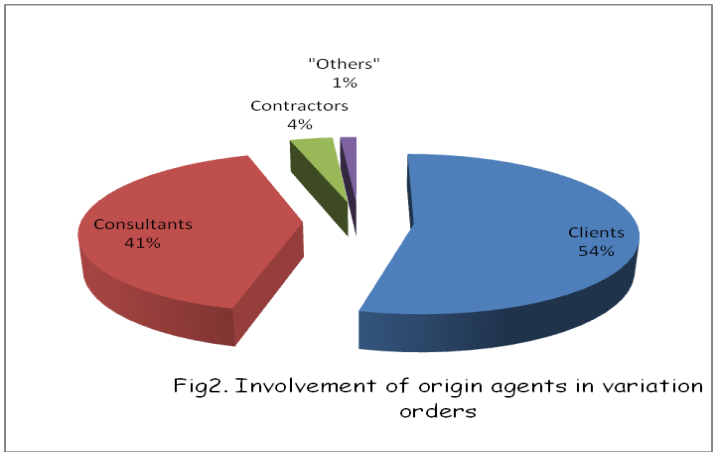

Fig2. Involvement of origin agents in variation orders

From table 5 and figure 2, it is revealed that the highest numbers of variation orders in building projects are initiated by clients. The results agree with the findings of other researchers (Jawad et al., 2009; Ndihokubwayo and Haupt, 2009; Anees et al, 2013) that the client is the most predominant originator of variation orders. For effective management of variation orders therefore, it is imperative to evaluate the causes that might have been the incident for clients to initiate variation orders. Findings also show that consultants are the next most important origin agent frequently involved in the generation of variation orders.

4.5 Evaluating causes of variation orders

The common causes of variation orders categorized according to their origin agents as identified by the study are shown in Table 6.

Table 6. Common causes of variations.

Causes of variations
Client related Causes:
Change of plan or scope
Change of construction duration
Financial problem
Unclear brief
Change of materials or procedure
Change in specification
Consultants related causes:
Change in design
Change in specification
Errors or omissions in designs

Errors or omissions in contract bills
Discrepancies between Contract documents.
Lack of coordination
Contractors related changes:
Unavailability or lack of equipment
Desired profitability
Lack of involvement in design
Absence of specialized contract manager
Poor procurement process
Lack of experience
"Other Causes":
Safety conditions
Change in economic conditions
Unforeseen problems

To evaluate the causes of variations, respondents were required to rank their importance on a scale of 1=least important, 2=slightly important, 3=moderately important, 4=important, and 5=most important. Table 7 shows the weighted average that represents the indices used in assessing the relative importance of the causes of variation orders. The results reveal that unclear project brief by the client is the most important cause of variation orders, followed by change of plan or scope by the client. Change of design by the consultants is ranked as the third most important cause of variation orders followed by errors or omissions in designs by consultants. This finding corroborates the assertion of Ashworth et al. (2013) that a common reason for variation is to amend the designs in some way. "Other causes" of variation such as unforeseen problems, change in economic condition, and safety conditions were ranked least in triggering variation orders.

Where clients do not state clearly and adequately what they need at the briefing stage, there would be request for variations during the construction stage. Shrinking time scales for project planning could produce unclear brief in consequence. Udeh (1991) observed that projects in Nigeria are hurriedly conceived. He contended that poor handling of project documentation, detailing and cost appraisal lead to variations subsequently. Insufficient planning as well as lack of client's involvement during the design stage could give rise to change of plan or scope by the client. Change in design by consultants may result from incompleteness of contract document. The results also indicate errors or omissions in design by consultants as a high ranking cause of variations. Architects tend not always to crystallize their intentions on paper before the contract is signed (Wainwright and Wood, 1979). This situation might have been encouraged by the contract provision that empowers the architect to vary the design.

The significance of each of the important causes of variations categorized according to their origin agents was carried out using the SPSS Version 17.0 one-sample t-test of significance at 5% level of significance as shown in Table 8. From Table 8, it is revealed that change of construction duration and change of materials and procedure are the most significant causes of client-related causes of variations along with unclear brief as indicated by the p-value associated with the t-calculated for these causes. Change in design, and discrepancies between contract documents are shown to be the most significant causes of consultants-related variations. The results also show that lack of experience on the part of the contractor is not a significant cause of variation order. This is unexpected as contractors ordinarily initiate variations as a result of inexperience in aspects of construction.

Previous studies (Jawad et al., 2009; Ndihokubwayo and Haupt, 2009; Mohammad et al., 2010; Anees et al., 2013) show that the owner (client) is the main source of variation orders in building projects. Based on this research findings, which corroborate previous works, it is submitted that any theoretical framework for the management of variations in building projects must emphasize a reduction in client-related variations by ensuring clarity of client's brief and detailed project planning in order to reduce the occurrence of variations and thus minimize their impact on project performance.

Table 7. Relative importance ranking of causes of variation orders

Causes of variations	n=8 Clients		n=32 Consultants		n=10 Contractors		Weighted average	
	(Mean score)	Rank	(Mean score)	Rank	(Mean score)	Rank	(Mean score)	Rank
Unclear brief by client	4.210	1	4.400	2	4.050	1	4.230	1
Change of plan or scope by client	4.010	2	4.500	1	3.800	2	4.281	2
Change in design by consultants	4.000	2	3.800	1	3.800	2	3.832	3
Errors or omissions in design by consultants	4.140	1	2.500	3	4.040	1	3.070	4
Change of materials or procedure by client	3.000	3	3.000	3	3.080	3	3.016	5
Change in specification by consultant	2.600	3	2.860	2	2.860	3	2.818	6
Contractor's desired profitability	2.080	5	3.200	1	1.800	4	2.741	7
Unavailability or lack of equipment on the part of the contractor	2.510	4	3.010	2	2.000	2	2.728	8
Absence of specialised contract manager in contractor's organisation	3.000	2	3.000	3	1.500	5	2.700	9
Contractor lack of experience	3.500	1	3.000	3	1.200	6	2.648	10
Change in specification by client	2.860	4	2.500	5	2.010	5	2.460	11
Client financial problem	2.460	5	2.750	4	2.800	4	2.714	12
Lack of contractor's involvement in design	2.900	3	1.860	6	3.500	1	2.354	13
Contractor poor procurement process	1.960	6	2.500	5	1.960	3	2.306	14
Discrepancies between contract documents by consultants	2.000	5	2.050	4	2.050	4	2.042	15
Lack of coordination by consultants	2.160	4	2.000	5	2.000	5	2.026	16
Change of construction time by client	1.960	6	2.010	6	2.000	6	2.000	17
Errors or omissions in contract bills by consultants	1.800	6	1.960	6	1.960	6	1.934	18
Unforeseen problems	1.820	2	1.800	1	1.500	1	1.743	19
Change in economic conditions	1.900	1	1.500	2	1.350	2	1.534	20
Safety conditions	1.200	3	1.450	3	1.100	3	1.340	21

Table 8. Test of Significance of Causes of Variations

Causes of variations	N=50 Clients (n=8)		Consultants (n=32)		Contractors (n=10)						
	Mean Score	Rank	Mean score	Rank	Mean score	Rank	Overall Mean	Overall Rank	t-cal	P-value <0.05	Conclusion
Client Related Causes:											
Change of plan or scope	4.010	2	4.500	1	3.800	2	4.103	2	19.785	0.003*	Sig.
Change of construction duration	1.960	6	2.010	6	2.000	6	1.990	6	130.276	0.000*	Sig.
Financial problem	2.460	5	2.750	4	2.800	4	2.670	4	25.192	0.002*	Sig.
Unclear brief	4.210	1	4.400	2	4.050	1	4.220	1	41.716	0.001*	Sig.
Change of materials or procedure	3.000	3	3.000	3	3.080	3	3.027	3	113.500	0.000*	Sig.
Change in specification	2.860	4	2.500	5	2.010	5	2.457	5	9.973	0.01**	Sig.
Consultants related causes:											
Change in design	4.000	2	3.800	1	3.800	2	3.867	1	58.000	0.000*	Sig.
change in specification	2.600	3	2.860	2	2.860	3	2.773	3	32.000	0.001*	Sig.
Errors or omissions in designs	4.140	1	2.500	3	4.040	1	3.560	2	6.707	0.022**	Sig.
Errors or omissions in contract bills	1.800	6	1.960	6	1.960	6	1.907	6	35.750	0.001*	Sig.
Descripances btw. contract documents.	2.000	5	2.050	4	2.050	4	2.033	5	122.000	0.000*	Sig.
Lack of coordination	2.160	4	2.000	5	2.000	5	2.053	4	38.500	0.001*	Sig.
Contractors related changes:											
Unavailability or lack of equipment	2.510	4	3.010	2	2.000	2	2.507	2	8.597	0.013**	Sig.
Desired profitability	2.080	5	3.200	1	1.800	4	2.360	5	5.518	0.031**	Sig.
Lack of involvement in design	2.900	3	1.860	6	3.500	1	2.753	1	5.747	0.029**	Sig.
Absence of specialised contract Manager	3.000	2	3.000	3	1.500	5	2.500	3	5.000	0.038**	Sig.
Poor procurement process	1.960	6	2.500	5	1.960	3	2.140	6	11.889	0.007*	Sig.
Lack of experience	3.050	1	3.000	3	1.200	6	2.417	4	3.971	0.058	Not Sig.
"Other Causes":											
Safety conditions	1.200	3	1.450	3	1.100	3	1.250	3	12.010	0.007*	Sig.
Change in economic conditions	1.900	1	1.500	2	1.350	2	1.583	2	9.646	0.011**	Sig.
Unforeseen problems	1.820	2	1.800	1	1.500	1	1.707	1	16.490	0.004*	Sig.

***Significant at 1%.**
****Significant at 5%.**

Source: SPSS Version 17.0 One-Sample Test of Significance Result Output

4.5.1 Agreement on the ranking of clients related causes of variations

The client is reported in the literature to be the most frequently involved origin agent of variation orders. A comprehensive understanding of the causes of client-related causes of variations therefore is imperative for effective management of variations in building projects.

It was hypothesized that there is no agreement between any two groups of participants - clients, consultants, and contractors - in the ranking of importance of clients-related causes of variation orders. The participants' perception of importance of client-relate variations is expected to be influenced by their different roles in the project delivery system as well as their professional background. Table 9 shows the results of the hypothesis.

Table 9. Test of agreement on the ranking of clients-related causes of variations.

Project Participant	ρ	t-cal	t-tab	Decision $t_{cal} < t_{tab}$	Conclusion
Clients and consultants	0.543	1.293	2.776	1.293 < 2.776	Accept Ho (not significant)
Clients and contractors	0.886	3.819	2.776	3.819 > 2.776	Do not reject H_1 (Significant)
Consultants and Contractors	0.886	3.819	2.776	3.819 > 2.776	Do not reject H_1 (Significant)

ρ =Spearman's rank correlation coefficient, t-cal=t-calculated, t-tab= t-tabulated,

Ho=Null hypothesis, H_1=Alternative hypothesis

From Table 9, it can be seen that the t-computed is greater than the critical value for the clients/contractors, and consultants/contractors groups. Thus, the null hypothesis is rejected for these groups. The study concludes that there is agreement in the ranking of importance of clients-related causes of variations by the clients/contractors and the consultants/contractors groups. This will assist in the management of variations as these participants appreciate the causes of client-related causes of variations.

The results however show that there is no agreement in the ranking of clients-related causes of variations by the clients/consultants group. This suggests the absence of synergy or collaboration between clients and consultants in the conceptualization and procurement of building projects. Collaboration between these participants, such as greater involvement of clients in the design process, will promote better understanding by consultants of client's project requirements and constraints and thus, minimize variations in projects.

V. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the sources of variation orders in building projects. It evaluated the causes of variations. Based on the extensive literature review and a careful analysis of relevant data, the study concludes as follows:

- Variation orders are common in building projects.
- Clients and consultants are the main sources or origins of variation orders in building projects, the client being the most predominant originator of variation orders.
- Unclear project briefs, change of plan or scope constitute the most important causes of variations initiated by clients.
- Consultants' originated variation orders derive mainly from change in design, and errors or omissions in design.
- There is a common agreement among clients/contractors and consultants/contractors groups on the ranking of importance of client-related causes of variations. The clients/consultants group does not, however, have such agreement. This implies lack of client/consultant close collaboration in project procurement.

In order to reduce the number of variations during detail design and site operations and thus, minimize their adverse impact on project performance, the study makes the following recommendations based on its findings and conclusions:

- Greater effort such as, for example, site 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 adequacy of project brief.

- Project planning should be seen as important and encouraged. Schedule project officers in relevant clients' department should be engaged for project planning. The project officers should be responsible for formulating project briefs and liaison with consultants in developing the brief. This will promote client/consultants collaboration in projects procurement and thus minimize variations.
- Consultants should spend adequate time on design detailing and documentation, including critical revisions, before site construction operations in order to reduce errors and omissions in design.
- Clear, well defined and adequate information on the scope of proposed work and materials specification should be disseminated amongst project participants to promote better understanding of the project.

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