

## CAUSES OF VARIATION ORDER IN BUILDING AND CIVIL ENGINEERING PROJECTS IN NIGERIA

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### Article history

Received

2 July 2015

Received in revised form

20 October 2015

Accepted

23 October 2015

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### Abstract

Variation does not only affect labour productivity but also leads to the dispute, time and cost overrun. Consequently, it affects projects performance. It is, therefore, imperative for construction professionals to eliminate unnecessary additional cost from a project so as to optimize the client's benefit against input resources. This paper identifies and examines the most significant causes that contribute to the variation orders. Also, Nigerian construction industry is used as a case study. Variation orders causing factors were assessed. Questionnaires were administered to clients, consultants and contractors to elicit information regarding variation causing factors. These factors were analyzed using frequency aggregation, mean score method and subsequently ranked according to their severity. The result revealed three most significant causes of variation which are: 'Change of plan' with the highest frequency of 58% then followed by 'Conflicting contract documents (50%)'. The next most frequent causing factors were the "substitution of materials" and "change in design" each with frequency of 43%. The least causing factor of variation was the "error and omission in design" with the frequency of 10%. Also differing site condition, new government regulation, weather condition were identified as other cause of variation with the frequency of 27%, 29% and 10% respectively. It has also shown that most critical source of variation order is the client due to change of plan then followed by consultant due to conflicting contract document.

Keywords: Variation, variation order, construction industry, Nigeria

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## 1.0 INTRODUCTION

Variation is any deviation from the original scope and schedule of work [1]. Construction process is associated with changes due to its complex nature which consequently, leads to a variation order [2]. Thus, variation order involves alteration, addition, omission and substitution in terms of quality, quantity and schedule of work. Demand of the owner, market forces and development in technology may impose changes in the design and other parameters for the project [3]. Many projects in Nigeria during the period immediately after independence in the 1960's were abandoned. Also others suffered failure due to multiple causes. One of the notable causes is variation [4]. This variation is primarily caused by managerial

problem, design errors and logistics problems due to constraint in the resources delivery. Consequently, it leads to high level of dissatisfaction arising from variation in contract sum. According to Ayodele and Alabi [5] variation is one of the major causes of abandonment of building and civil engineering projects in Nigeria. Variation is generally inevitable [6]. And it occurs to all type of projects ([3], [7-8]). Such changes can occur at either design or construction stages [9]. Many other researchers have confirmed this and thus, hardly can a project proceed from beginning to the completion stage without having some changes even at level of planning or construction phase [10]. Frequent change in the scope of work due to variation order ultimately affect the quality work [11]. Usually these changes are either

beneficial or detrimental [12]. Beneficial variations bring about the reduction in the cost and improved quality of work. However, detrimental variations were identified to be the major causes of conflict and dispute in the construction industry [13]. These changes in the work were also reported to affect the labour productivity [14]. The impact of variation order on labour productivity at construction site has been critically studied [15]. And it was found to negatively affect the labor productivity. This was supported by many researchers ([16-18]). Consequently, the entire construction process would be disrupted. Thus, extending the project duration thereby causing delay, though, the contractor would be compensated [19] However, it affects projects performance. Other notable impacts of variation order were reported by many researchers. And they are: Delayed payment [20] delay in completion [21], Additional overhead, Cost overrun, Disruption of progress of work, Employing ad hock professionals, Quality compromise, poor project performance, Rework, Delayed logistics, Affects integrity of the firm, Delayed procurement, safety compromise and Delay.

The Nigerian construction industry comprises both a highly disorganized informal and formal sector [22]. The formal sector is the mix of indigenous and foreign companies which are classified as small, medium or large depending on their capital, annual volume of executed projects and turnover respectively. Construction industry has contributed substantially to the growth domestic product (GDP) immediately from post-independence periods up to the 1980s [23]. Unfortunately, dwindling economy in the country has led to the low demand, poor performance with a consistent low productivity since the late 1980s ([24-26]). This has invariably affected the contribution of the industry to the national economy [27]. Consequently, projects owners are forced to impose changes in the scope of work due to financial difficulty. Thus, frequent variation in Nigeria has led poor project performance, time overrun and source of corruption and high incidence of building failure [22], [28-31].

Many researchers have critically studied the effects of variation order on project performance. It led to a delayed payment which generates dispute, additional overhead, time overrun, rework, low productivity, delayed logistics, corruption, and high incidence of building failure. These effects are summarized and presented in the Table 1.

**Table 1** Effects of variation on Project performance

S/No	Effects	Reference
1	Delayed payment	[20]
2	Delay in completion	[21]
3	Additional overhead	[7]
4	Cost overrun	[35]
5	Rework	[35]
6	Low productivity	[14],[15],
7	Additional payment to contractor	[7],[22]
8	Delayed logistics, Disruption of progress of work	[15]
9	Affects integrity of the firm	[8],[21]
10	Time overrun	[22]
11	Incidence of building failure	[4], [31]
12	Source of corruption	[30]
13	Affect project performance	[28],[29]
14	Abandonment of projects	[5]

Mass construction of infrastructure by Kano State Government in Nigeria between the period 2003-2011 prompted this research with a view to identifying the likely more contributing factors of variation during this period. And also whether they are consistent with such prevailing factors and sources in other parts of the country as reported earlier. This forms the basis for which, this research is being conducted.

Therefore, it becomes crucial to examine factors that cause variation order in construction projects. This will assist the construction professionals in elimination of unnecessary additional cost from a project so as to optimize the client's benefit against input resources. It will also get rid of incessant dispute that characterized the construction industry.

The objective of this study is to identify and assess factors that contribute to the causes of variation orders in the construction of building and civil engineering projects. It is part of the objective also to rank these factors based on their severity on project quality. Accordingly, the research allocates the responsibility of such variation based on the sources.

## 2.0 CAUSES OF VARIATION

Changes in the construction projects have been classified according to sources and factors responsible for these causes by many researchers [32-34]. According to them the three major sources are the clients due to design errors and omission which account for 65% variation, design changes contribute to 30% variation and other conditions which also account for only 5% variation. Many other research have shown that changing variables and unpredictable factors arising from different sources usually influence the construction process which

ultimately led to variation order. These sources include environmental condition, availability of resources, performance of construction parties and contractual relation [35].

Therefore, construction stake holders, resources and environmental influence were the major sources of variation [35] Variation causing factors due to different sources were identified by many researchers [36]. It could be Client related cause, Consultant related. This was supported by Dadzie [29]. However, the project participants in the project usually initiate variation due to geotechnical, geological, financial, weather, technological requirement and other conditions [37-38]. Most significant and frequently reported contributing factors of variation from literature have been adopted for use in this research. Client and consultant related causes were known to contribute 30% and 65% variation respectively [32-34]. However, other factors which contribute to 5% variation have not yet been investigated as potential contributing factors of variation in Nigerian situation. They are therefore, incorporated in to the questionnaire. They are the; new government regulation, weather and differing site condition are also likely contributing causing factors of variation in the Nigerian situation.

The client related causes were the change of project scope and schedule, financial predicament, insufficient project objectives, change of specification and substitution of material.. Consultant related factors are the change in design, errors and omission, conflicting contract document, design complexity, insufficient shop drawing details and scope of work for contractor. Other factors include weather fluctuations, nation's economic conditions and government regulations, unforeseen problems. Many researches were conducted on the variation causing factors [2-4, 39-45]. And they were found to largely influence the final cost of project [46-47]. It led to dispute though arbitration and litigation were the adopted solutions. However, alternative dispute resolution was also used and worked favourably [48]. Therefore, it is pertinent to get all the necessary information regarding variation causing factors in the course of executing the projects to enable construction stakeholders to take effective control measures [49]. Most significant causes of variation based on the available literature were summarized and presented in Table 2 below

The Figure 1 has shown the client related factors, consultant related factors and other factors that lead to variation order. major causing factors. Previously, it has always been reported on the implications of consultants and clients related factors. However, the effects of other factors leading to variation order have not been emphasized. Most notably, new government policy.

**Table 2** Factors of variation

S/No	Most significant causes of variation Effects	Citation
1	Plan error, change in design, mistakes, unclear specification,	[20]
2	Change in scope, errors and omission, adjustment of provisional sum, discrepancies in contract document, geological condition	[39]
3	Non compliance of design with government regulation, change of scope, change in design, design discrepancies, change in specification	[40]
4	Managerial problem, Design errors, constraint in resource delivery	[3]
5	Design variation, Inadequate working detail, change of plan	[2], [41],[42]
6	Aesthetic, Cost, Substitution of material, change of plan	[43]
7	Technological requirement, geotechnical, geological, other conditions	[37],[38]
8	Inadequate project objectives	[44]
9	External factors	[45]
10	Additional work and Inflation	[46]
11	Differing site condition I	[47]

### 3.0 METHODOLOGY

In this research a descriptive survey method is adopted via qualitative data gathering through a literature review. Thus, a questionnaire survey was used to seek the perception of the respondents. Stratified method of sampling was used. Consequently, these respondents were randomly selected from group of contractors. Hence, this group is used as a unit of analysis. Accordingly, the responses were subsequently analyzed.

The research made use of the 48 returned questionnaire out of the 50 administered representing 98% response. These questionnaires were used to source the required data. It consists of three parts, first part deals with the personal information regarding the respondents' characteristics such as academic qualifications, construction industry work experience and membership with professional organization as the case may be. Part two deals with such information as area of specialization, ages, and type of projects executed by each of the companies. The last part of the questionnaire deals with such information on those factors that contribute to the evolving of variation as perceived by the respondents.

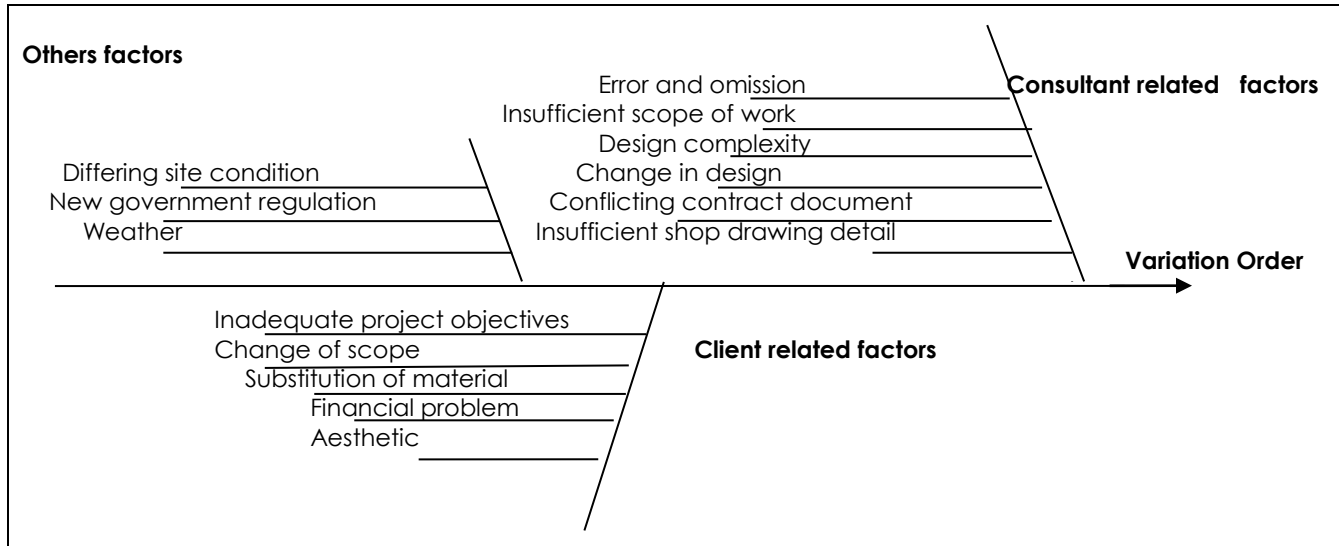


Figure 1 Factors contributing to cause of variation order

## 4.0 RESULTS AND DISCUSSION

Here, the findings based on the information from the administered questionnaires regarding the respondents' professional background and most significant and frequently reported factors of variation causing order were presented and discussed

### 4.1 Results

The results have shown that most of the respondents (65%) are civil engineers, and (35%) are builders while only (2%) are architects. The average construction industry work experience for all the respondents is twelve (12) years. Also all of them (100%) are corporate members of their professional societies. The respondents rated the variables which they perceived to be the likely contributing factors to the cause of variation in building and civil engineering projects by responding on a scale from 1 (insignificant) to 5 (extremely significant). The five-points rating scale was 1 insignificant, 2 slightly significant, 3 moderately significant, 4 very significant and 5 extremely significant. This five point scale is used to calculate the mean score for each factor and element, which is then used to determine the relative ranking of each factor by assigning ranking to the mean score, such mean score with low magnitude is assigned low rank while those with the highest score is allocated the highest rank, accordingly. The mean score (MS) for each factor is computed by using the following formula;

$$MS = \frac{\sum(f \times s)}{N} \quad (1)$$

Where  $s$  is the score given to each factor by respondents and ranges from 1 to 5

$f$  is frequency of responses to each rating (1 - 5), for each factor; and  $N$  is the total number of responses concerning that factor

Percentage Response with respect to a particular factor is computed as  $(\frac{n}{N}) \times 100\%$

Where  $n$  = number of responses with respect to each score,  $N$  = Total number of responses concerning that factor.

Factors that lead to variation as presented in Table 2 were adopted in the questionnaire prepared and sent to the respondents. The factors used include:

#### 4.1.1 Owner Related Factors:

- Change of plan
- Owner's financial problem
- Substitution of materials

#### 4.1.2 Consultant Related Factors

- Change in design
- Errors and omissions in design
- Conflicting contract documents

#### 4.1.3 Other Causes

- New government regulation
- Differing site conditions
- Weather condition

The result of these factors of variation as returned by the respondents and their overall ratings was prepared and presented in Table 3. Also the mean scores values and ranking with regard to each factor as perceived by the respondents is also presented in the Table 4.

**Table 3** Respondents' Rating of factors causing variation (least to most critical) in construction projects (Respondents (N = 48))

S/N	Factors of Variation	Frequency Aggregation (Rating of factors)				
		1	2	3	4	5
1	Change of plan	0	7 (14.6%)	1 (2.1%)	12 (15%)	28 (58.3%)
2	Conflicting contract documents	2 (4.2%)	16 (33.3%)	3 (6.25%)	3 (6.23%)	24 (50%)
3	Substitution of materials	5 (10.4%)	10 (20.8%)	7 (14.6%)	5 (10.4%)	21 (43.7%)
4	Change in design	5 (10.4%)	11 (22.9%)	7 (14.6%)	4 (8.3%)	21 (43.7%)
5	New government regulation	13 (27.1%)	5 (10.4%)	10 (20.8%)	6 (12.5%)	14 (29.2%)
6	Differing site condition	5 (10.4%)	10 (20.1%)	5(10.4%)	6(10.4%)	14(29.2%)
7	Owner's financial problem	13 (27.1%)	10 (20.1%)	5 (10.4%)	6 (10.4%)	14 (29.2%)
8	Weather conditions	4 (8.3%)	15 (31.3%)	19 (39.6%)	5 (10.4%)	5 (10.4%)
9	Errors and omissions in design	27 (56.3%)	13 (27.1%)	3 (6.25%)	1 (2.1%)	4 (8.3%)

**Table 4** Respondents' Ranking of factors causing variation (Most to least critical) in construction projects (Respondents (N = 48))

S/N	Factors	Source	∑ Mean score (MS)	Rank
1	Change of plan	Client	4.27	1
2	Conflicting contract documents	Consultant	3.65	2
3	Substitution of materials	Client	3.56	3
4	Change in design	Consultant	3.52	4
5	New government regulation	Others	3.06	5
6	Differing site condition	Others	3.04	6
7	Owner's financial problem	Client	2.956	7
8	Weather conditions	others	2.833	8
9	Errors and omissions in design	Consultant	1.79	9

## 5.0 DISCUSSION

It can be seen from Table 1 that the most frequent (58%) cause of variation orders was the change of the original plan. These changes could probably be due to inadequate planning and also lack of involvement of client during design stage. The second most frequent (50%) cause is the conflicting contract documents. The third most frequent causes were the substitution of material and change in design both with same frequency of 43 %.

Other subsequent causes which seem to be neglected by previous researches were; the, owner financial problem (29.2%), new government regulation (29.2%), differing site condition (27.1%), weather (10%) and error and omission in design (8.3%). The frequency aggregation has clearly shown the causes cannot be ignored since they can negatively affect project performance, consequently this will lead to dispute. This however can be resolved selecting best method of dispute resolutions but still will result in an explicable delay [50, 51].

Further analysis of the factors and ranking was done according to their mean score values. It is thus, clear that from Table 2 change of plan was ranked the first causing factor with highest mean score value of 4.27. The second ranked causing factor was the conflicting contract document with mean score value of 3.65 followed by substitution of material with the MS value of 3.56. The fourth ranked factor was the change in design with the mean score value of 3.52. The next factors were the new government regulation and differing site condition each with mean score values of 3.06 and 3.04 respectively. It can also be seen from the Table that owner financial problem and weather condition were ranked as the seventh and eighth factors each with mean score value of 2.956 and 2.833. The Table has also shown that the least causing factor was the errors and omissions in design with mean score value of 1.79. It can also be seen from the Table that based on the top five (5) causing factors, client is the major source of variation followed by consultant and then other source.

## 6.0 CONCLUSION

Based on the analysis and discussion of the results above it shows that 9 factors were identified and examined. Thus, most frequent causes of variation orders were the changes imposed in the original plan by the owner (58%) with the mean score value of 4.27, conflicting contract documents in the construction projects as second most frequent cause (50%) with the mean score value of 3.65 followed by substitution of material which were ranked the first (1), second (2) and the third (3) respectively. Based on the top five ranked factors, variations were mostly initiated by the clients, then consultants followed by other factors. Therefore, such changes initiated by the clients were the most significant causes of variation order besides design errors, management problem and lack of total and effective control over the resource delivery.

## Acknowledgment

The authors would like to thank the PAS grants vote no. Q.J130000.2709.01K40 and Q.J130000.2709.01K41. Also, the authors appreciate for their supports and contributions, TNCPI, and Research Management Center at Universiti Teknologi Malaysia under GUP grants vote no. Q.J130000.2609.10J83 and Q.J130000.2609.11J04.

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