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CAUSES OF VARIATION ORDERS IN CIVIL ENGINEERING PROJECTS IN SOME SELECTED STATES IN NIGERIA

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ABSTRACT
One of the most important problems in the construction industry is variation. They occur in every construction project, and the magnitude of these variations varies considerably from project to project. Hence, the variation orders bear great importance right from inception to completion of a construction industry project. Most of the civil engineering projects in Nigeria have experienced a large number of variation orders. The client had to spend more than what was initially estimated in most cases. Sometimes, disputes and unnecessary delays occur due to variations. This study assesses the possible causes of variation orders in civil engineering projects in Nigeria. Data were collected through a literature review and a questionnaire survey administered to professionals engaged in civil engineering construction projects in Nigeria. The study results revealed that 'Client-initiated variations' and 'Poor estimation' are among the four (4) most occurring causes of variations orders in civil engineering projects in Nigeria.

Keywords: Variation, Variation Orders, Civil engineering, Construction, Projects.

1.0 INTRODUCTION
Halwatura and Ranasinghe (2013) stated that a construction project's cost is one of the most important factors in the construction industry. For many reasons, the total cost of a project can significantly vary from the initial estimated cost. Fisk (1997) defines variation as "any deviation from an agreed well-defined scope and schedule." Love (2002) noted that a degree of change should always be expected as it is difficult for clients to visualize the end product they procure. Arain and Low (2006) investigated the developer's views on potential causes of variation order on institutional buildings in Singapore. The authors established that errors and omissions in design; change in client and consultants specifications are the most significant causes of variations in institutional buildings. In Nigeria, Babatunde, Olubola, Onajite, and Akintayo (2012) assessed building elements' proneness to variation and found that the correlation coefficients of building elements' proneness to variation during the construction process from the perspectives of contractor, clients, and consultants were significant. Hence, the research concluded that statistical relationships exist between consultants, clients, and contractors on the control measures of building elements' proneness to variation at design and construction stages.
Similarly, Babatunde (2013) further investigated each building element's impact and susceptibility to such variations. The study (Babatunde, 2013) determined each element's percentage impact on

the overall time and cost overruns of projects. They highlighted the possible degree of variance likely to occur in each element of a building.

Variations in construction have been studied by so many researchers, with quite a significant number of them focusing on their potential causes and effects on building projects (Ssegawa, Mfolwe, Makuke and Kutua, 2002; Arain, Assaf and Low, 2004; Oladapo, 2007; Cantarelli, Flyvbjerg, and Buhl, 2012). In Nigeria, most studies focused on building projects with specific emphasis on the causes and effects of the variation orders (Ahmadu, 2010; Ahmad, 2011; Babatunde *et al.*, 2012) and didn't assess the causes of variation orders in civil engineering projects in Nigeria. This is despite the complexity of such projects, especially in terms of design and construction and the high need for technical expertise and capital funding. Therefore, the study assessed the causes of variation orders in civil engineering projects in Nigeria. To achieve the aim, the following objectives were formulated;

1) To identify the causes of variation orders in civil engineering projects.
2) To assess the level of occurrence of each of the causes of variation orders in civil engineering projects.
3) To compare the ranked causes of variation in Nigeria with the Sri Lankan and international ranking causes of variation orders.

2.0 LITERATURE REVIEW

Variation orders involve additions, omissions, alterations and substitutions in terms of quality, quantity, and work schedules. Any minor change that the client or his/her architect wished to make later would mean that the contract had to be canceled and a new one drawn up (Wainwright & Wood, 1983). Once a contract has been concluded, its terms cannot be changed unless the contract contains provisions for variation. Then the only permitted variations fall clearly within the contractual terms (Willis & Willis, 1980). Uff (2005) indicated that a clause permitting variation of works is an essential feature of any construction contract. Without it, the contractor is not bound to execute additional work or make omissions or changes. Under contractual provisions, the client has the right to vary the extent and nature of the performance to be rendered by the contractor (Wainwright & Wood, 1983).

The nature of variation orders can be determined by referring to both the reasons for their occurrence and subsequent effects. (Arain & Pheng, 2005) distinguished two types of variation orders, namely: beneficial and detrimental variation orders.

A beneficial variation order is issued to improve the quality standard and reduce cost, schedule, or degree of difficulty in a project (Arain & Pheng, 2005). It is a variation order initiated for value analysis purposes to realize a balance between the cost, functionality, and durability aspects of a project to clients' satisfaction. A beneficial variation eliminates unnecessary costs from a project. According to Zimmerman & Hart (1982), all designs have unnecessary costs regardless of how excellent the design team may be. Therefore, a beneficial variation order seeks to optimize the client's benefits against the resource input by eliminating unnecessary costs. These benefits are understood to be the satisfaction of perceived needs for the development project, including social,

economic and commercial aspects. Impliedly, a beneficial variation is initiated in the spirit of adding value to the project. However, it should be noted that regardless of how beneficial a variation order might be, non-value-adding costs are likely to accrue as a result.

A detrimental variation order negatively impacts the client's value or project performance (Arain & Pheng, 2005). Arguably, a detrimental variation order compromises the client's value system. A client experiencing financial problems may require the substitution of quality standard expensive materials to sub-standard cheap materials. For example, on a construction project situated in a salty environment, steel window frames result in steel oxidation if selected instead of timber or aluminum frames. A variation involves changes to the work or matters relating to the work in accordance with the conditions of the contract and changes to the working conditions.

The causes of variation orders as listed by Halwatura and Ranasinghe (2013) include the following; Poor estimation, Unforeseen site conditions, Political pressure, Poor investigation, Client-initiated variations, Natural disasters, the scope of work for the contractor is not well defined, Unrealistic contract durations imposed by client, New government regulations/change in economic condition, Change in design by consultant/design changes, Errors and omissions in design Weather condition, Poor performance of subcontractors Inadequate planning, Delay in approval, Shortage of materials, Other organization, Consultant's Lack of judgment and experience, Workmanship or material not meeting requirement of specifications, the contractor's financial difficulties, Additional preliminaries due to time extension, Lack of coordination between Consultant and contractor, Defective workmanship, the required tools and equipment are not available, Substitution of material and procedure, Unavailability of skills (Shortage of skilled manpower, Conflict between project documents, Value engineering, Safety considerations, Technology change, Weather conditions, Inadequate Planning, Local residents, Delay in approval, Contractors desire to improve his financial situation.

3.0 METHODOLOGY

The study adopted a quantitative research approach. The sample frame was obtained from an online directory V-connect (2018). According to V-connect (2018), there are 62 civil engineering construction firms in the study area (Kaduna 51, Sokoto 11). The sampling technique adopted was purposive sampling. A total of 50 well-structured questionnaires were purposively administered to respondents (Civil Engineers, Quantity Surveyors, and Land Surveyors) engaged in Civil engineering construction firms only, 33 were returned and 17 not returned. The questionnaire's distribution was carried out within the period of 3 months from November 2019 to January 2020. The fifty-number sample size was determined using the Cochran (1963) formula for determining the sample size of infinite population shown in equation one below with a 90% confidence level (z-score of 1.645), the margin of error of ±9% and standard deviation $p = 0.5$ and q represented by $(1-p)$.

$$N_0 = \frac{z2p(1-q)}{e2} \qquad (1)$$

The questionnaire comprises two sections, sections A and B. The former is meant to collect the respondents' background information, while the latter requires the respondents' perception

concerning the causes of variation orders in civil engineering projects in Nigeria. The questionnaire listed 32 causes of variation orders in civil engineering from a review of the literature. Respondents were then asked to provide their opinion on the level of occurrence of each of the causes of variation orders in civil engineering projects in Nigeria. The secondary sources of data were drawn from journals and textbooks, which were accordingly cited and referenced. The 5-point Likert scale of 1-very Low, 2-low, 3-medium, 4-high & 5-very high. And all data were analyzed using descriptive statistical analysis.

4.0 RESULTS AND DISCUSSION

This section details the characteristics of respondents and analyzes the respondents' perception on the level of occurrence of the causes of variation orders in Civil engineering projects in Nigeria in other to achieve the objectives of the study.

Table 1.0 Disciplines of Respondent

	Frequency	Percentage
Quantity surveyors	6	18.2
Land Surveyors	8	24.2
Civil Engineers	19	57.6
Total	33	100

Source: Field survey, 2020

In table 1.0 above, Quantity Surveying had 6 respondents representing 18.2%, followed by Land Surveyors with 8 respondents representing 24.2%, and 19 respondents, representing 57.6%, were Civil Engineers. The data received seems reliable because of a high percentage of Civil engineers followed by Land surveyors and then Quantity Surveyors.

Table 1.1 Designation of Respondent

	Frequency	Percentage
Top Level Management	20	60.6
Middle-Level Management	10	30.3
Low-Level Management	3	9.1
Total	33	100

Source: Field survey, 2020

The respondents' designation was classified according to the level of respondents in the firm from top to middle and then finally low-level management, as shown in Table 1.1 above. Top-level management has 60.6%, followed by Middle-level management with a percentage of 30.3% and then finally Low-level management with a percentage of 9.1%, which is the least. This implies that the data retrieved is from the highest authority of the various organizations.

Table 1.2: Level of occurrence of the causes of variation orders in Civil engineering projects in Nigeria

Categories	Causes	Mean	Nigeria ranking	Sri Lankan ranking	International ranking
CLIENT RELATED CAUSES	Client-Initiated Variation	4.70	1st	6th	1st
	Delay in approval	2.64	15th	-	-
	Clients financial difficulties	3.48	7th	-	11th
	unrealistic contract conditions imposed by the client	3.36	9th	19th	-
	Change in specification	3.30	10th	12th	2rd
	The Scope of Work not clearly defined by the client	2.22	19th	9th	9th
	Inadequate Planning by client	3.06	11th	10th	5th
CONSULTANT RELATED CAUSES	Consultants lack of Judgment	1.67	24th	-	-
	Errors and Omissions in design	2.94	13th	8th	3rd
	Poor investigation	3.72	4th	2nd	-
	The Conflict between project documents	2.34	16th	14th	6th
	Poor estimating	4.10	2nd	1st	-
	Changes in design and scope of work by Consultant	3.67	5th	4th	5th
	Value Engineering	1.72	23rd	-	12th
	Lack of communication between consultants	2.28	18th	21th	7th

CONTRACTOR RELATED CAUSES	Workmanship or material not meeting the requirement of the specification	1.90	22nd	-	15th
	Defective workmanship	2.93	14th	18th	18th
	Safety considerations	2.10	20th	16th	12th
	Contractors desire to improve the financial situation	1.90	21st	-	10th
	Lack of contractor/subcontractor experience	3.42	8th	20th	7th
	Unavailable skills(Shortage of manpower)	3.00	12th	17th	16th
	Additional preliminaries by the contractor	3.78	3rd	5th	-
	The required tools and equipment are not available	2.33	17th	-	18th
OTHER CAUSES	Political Pressure	2.94	13th	23rd	-
	New Government regulations/change in economic conditions	1.90	22nd	22nd	19th
	Natural Disaster	2.28	18th	-	-
	Weather Conditions	1.67	24th	-	17th
	Residents	2.22	19th	11th	-
	Other Organization	3.06	11th	7th	10th
	Unforeseen site conditions	3.67	6th	3rd	8th
	Technology Change	2.34	16th	15th	13th
	shortage of material	1.65	25th	13th	-

Source: Field survey, 2020

The respondents' opinion was sought on the level of occurrence of the causes of variation orders, which is shown in table 1.2 above. The result shows that client-initiated variation, which has a mean value of 4.70, is the most occurring among the causes of variation orders in civil engineering projects in Nigeria and the international ranking, followed by poor estimating with a mean value of 4.10, additional preliminaries with the mean value of 3.78 and poor investigation having a mean 3.72 as 2nd, 3rd, and 4th occurring causes respectively which are not even recognized in the international ranking. Halwatura and Ranasinghe (2013) studied causes of variation orders in Road construction in Sri Lanka; the research results show that poor estimating was the most occurring cause, followed by poor investigation, which was the second. Furthermore, the rank of unforeseen site conditions, change in design by Consultant and Additional preliminaries are ranked 3rd, 4th, and 5th. This shows that some causes occur more frequently in Nigeria and Sri Lanka, though not in the same ranking position; this may be attributed to the fact that both Nigeria and Sri Lanka are developing countries. As understood by the professionals in the two countries. Client initiated variation is the most occurring cause of variation orders in Nigeria, which those not even fall amongst the 1st five in Sri Lanka. Similarly, value engineering, Consultants' Lack of judgment, weather condition and Shortage of material with a mean score of 1.72, 1.67, 1.67, and 1.65, respectively, are the causes with the least level of occurrence.

5.0 CONCLUSION

Based on the study's findings, the following conclusions were drawn: Some causes of variation orders occur more frequently in civil engineering projects in Nigeria, which are client-initiated variation, poor estimating, additional preliminaries, poor investigation, change in design by consultants. This shows that Clients do not have capable professional staff to carry out estimates and investigations prepared by consultants and are not accurate in most cases. Therefore, several unnecessary variations occur during the construction stage; the consultants do not carry out adequate investigations at the initial investigation and design stage. Therefore, several site conditions arise in the construction stage. Finally, there are causes of variation orders common in Nigeria, Sri Lanka, and International ranking, including client-initiated variation, poor estimation, poor investigation, and additional preliminaries.

6.0 RECOMMENDATION

1. Nigeria should pay attention to several causes to minimize the occurrence of variation orders.
2. Client faults should be noted and properly documented.
3. The estimates have to be prepared properly by experienced professionals, and clients should provide a clear brief of the scope of work.
4. Extension of time should be avoided to prevent additional preliminaries.

7.0 REFERENCES

Ahmad, A. (2011). An appraisal on variation in the cost of finishes in building projects in Nigeria. Unpublished BSc Thesis. Department of Quantity Surveying, Ahmadu Bello University Zaria.

Ahmadu, M. (2010). An investigation into variation caused by consultants in the construction industry. Unpublished BSc Thesis. Department of Quantity Surveying, Ahmadu Bello University Zaria

Arain, F. M Assaf S. A. and Low S. P. (2004). "Causes of Discrepancies between Design and Construction," Architectural Science Review, vol.47, pp. 237-249

Arain, F.M. & Pheng, L.S. (2005), 'How Design Consultants Perceive Causes of Variation Orders for Institutional Buildings in Singapore,' Architectural Engineering and Design Management, vol. 1, no. 3, pp 181- 196

Arain, F.M. and Pheng, L.S. (2006). Developers' views of potential causes of variation orders for institutional buildings in Singapore, vol. 49(1), 59-74

Babatunde, S. O., Olubola, B., Onajite, J.G., & Akintayo, O. (2012), 'An assessment of building element's proneness to variation in Nigeria', Journal of Construction Project Management and Innovation, Vol.2, No.2, pp.403-447

Babatunde, S. O. (2013), 'A quantitative assessment of cost and time implication of susceptibility of building element to variation in Nigeria,' Journal of Sustainable Construction Engineering and Technology, vol. 4, no. 2.

Cantarelli, C. C. and Flyvbjerg B. and S. L. Buhl, (2012). "Geographical Variation in Project Cost Performance: The Netherlands versus Worldwide," Journal of Transport Geography, vol.24, pp. 324–331.

Cochran W.G. (1963). Sampling technique. 2nd Ed. New York (N.Y.): Wiley.

Fisk E. R. (1997). "Construction Project Administration," Prentice-Hall, New Jersey.

Halwatura R. U and Ranasinghe N. P. N. P (2013). Causes of variations orders in a road construction project in Sri Lanka.

Http://www.vconnect.com

Love, P.E.D. (2002), 'Influence of Project Type and Procurement Method on Rework Cost in Building Construction Projects', Journal of Construction Engineering and Management, vol. 128, no. 1, pp 1-29.

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(1), pp. 35-48.

Ssegawa, J.K., Mfolwe, K.M., Makuke, B. & Kutua, B. (2002), 'Construction Variations: A Scourge or a Necessity?', Proceedings of the First International Conference of CIB W107, 11- 13 Nov. 2002, Cape Town, South Africa, pp 87-96

Uff, J., 2005, 'Commentary on the I.C.E. Conditions of Contract,' In Furst, S. & Ramsey, V. (eds) 2005, Keating on Building Contracts, 9th ed. London: Sweet & Maxwel

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

Willis, A.J. & Willis, C.J. (1980), 'Practice and Procedure of the Quantity Surveyor,' 8th ed. London: Granada

Zimmerman, W.L. & Hart, D.G. (1982), 'Value Engineering - A practical approach for Owners, Designers and Contractors', New York: Van Nostrand Reinhold Company