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AN ASSESSMENT OF BUILDING ELEMENTS' PRONENESS TO VARIATION IN NIGERIA

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Abstract
Variations in construction had been studied by a number of researchers in the light of its causes and effects on project delivery, thereby taking for granted the susceptibility of building elements to variation. Thus, this paper becomes imperative to fill the gap with a view to examining the proneness of building elements to variation and assessing the control measures of proneness of building elements to variation before and during construction process. Data were collected using structured questionnaires administered on construction professionals in Lagos metropolis. Systematic sampling technique was employed in the administration of the questionnaire to consulting firms, contracting firms and client organizations within the built environment in the study area. The data were analyzed using statistical methods of average, percentage, relative significant index (RSI) and Spearman rank-order correlation coefficient. The results of the analysis revealed that excavation and fillings, concrete work at substructure, block work at substructure, roof and wall finishes were ranked highest of the building elements that were highly susceptible to variation. While internal doors, disposal installation, water installation, ventilation system, windows and external doors respectively were less susceptible to variation during construction processes of educational building projects in Nigeria. The paper further identified involvement of professionals at initial stage of project, client's involvement at planning and design phase, clear and thorough project brief and thorough detailing of design respectively as control measures of proneness of building elements to variation. The study recommended that the identified building elements which have been known to have a high degree of susceptibility to variation are to be given utmost consideration during the design and construction process in order to minimize their effects and contributions to variation with overall aim to improving construction project delivery.

Keywords: Building elements', Construction, Nigeria, Project delivery, Proneness, Variation

INTRODUCTION

It is a common practice to described items of work provisional while preparing the bill of quantities for building projects. Reason for this is that completion without alteration or modification to building elements resulting in some re-measurement during the progress of the project are rarely impossible. Designing and constructing a building project is a collaborative effort of professionals from independent disciplines, such as architecture, quantity surveying and engineers to mention a few. The complexity of construction works means that it is hardly possible to complete a project without changes to the plans or construction process itself. Construction plans exist in the forms of designs, drawings, quantities and specification earmarked for a specific construction site. Changes to the plans are effected by means of a variation order initiated by a consultant on behalf of the client or as raised by the contractor (Ssegawa, Mfolwe, Makuke and Kutua, 2002). Ssegawa et al., (2002) further stated that any building project is liable to variations due to changes of mind on the part of the clients, the consultants, or unforeseen problems raised by the main contractor or sub-contractor. Therefore from the sides of client, consultant and contractor on a building project, variations will therefore occur for a number of reasons ranging from finance, design, aesthetic, geotechnical, geological, weather conditions to feasibility of construction.

Variations are inevitable in any construction project (Mokhtar, Bedard and Fazio, 2000). Needs of the client may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer (Arain, Assaf and Low, 2004). The engineer's or architect's review of the design may bring about changes to improve or optimize the design and hence the operations of the project. Furthermore, errors and omissions in construction may force a change (Arain, 2005). All these factors and many others necessitate changes that are costly and generally unwelcome by all parties. Variations are common in all types of construction projects (Construction Industry Institute (CII), (1994a), Fisk, (1997), Ibb, Wong and Kwak, 2001). The nature and frequency of variations occurrence vary from one project to another depending on various factors (Construction Industry Institute (CII), (1986), Kaming, Olomolaiye, Holt and Harris, 1997).

However, within the framework of the time lag between contract award and practical completion of the project, unanticipated conditions arise. These conditions warrant decision so as to obtain optimum juxtaposition of the elements of architecture in terms of its economy, quality and aesthetic in relation to fairness (Seeley, 1997). These unanticipated conditions can be as a result of the underground nature of the construction work whose extent were not fully known during the design and tendering phase or an opportunity to make amendment by the designers that may have errors in their designs. On the other hand, the client might want to add or modify the design to fit the project requirements or status symbol. All these result in variation of various functional elements that make the building. A building element is a component of the building that fulfils specific function(s) irrespective of its design, construction or specification. Therefore, the aim of this study is to determine the relative degree of proneness of building elements to variation and the control measures of variation at design and construction stages with a view to enhancing construction projects delivery.

THE CONCEPT OF VARIATION

Much of life is subject to change of mind's, rethinks, reappraisals and so on but variation in building contracts often produce division and conflicts between client, consultants and contractors. This has led to the revision of standard forms of contract in an attempt to maintain a balance of risk and remedy within construction contracts between client and contractors (Alan, 1997). Variation, in its literal sense, is an act of making some changes or alteration from an initial established agreement. This term is used in the Standard Form of Building Contract (SFBC)1990 clause 11(2) as "the alteration or modification of the design, quality, quantity of the work as shown upon the contract drawings and described by or referred to in the contract bills and include the addition, omission or substitution of any work, the alteration of the kind or standard of any of the materials or goods to be used in the works, and the removal from the site of any work, materials or goods executed or brought thereon by the contractor for the purposes of the works other than work materials or goods which are not in accordance with the contract. The Joint Contract Tribunal (JCT '80) edition clause 13 defined variation as follows:

1. The alteration or modification of the design, quality or quantity of work as shown upon the contract drawings as described by or referred to in the contract bills; including

- the addition, omission or substitution of any work
- the alteration of the kind or standard of any material or goods to be used in the work.
- the removal from the site of any work executed or materials or goods brought thereon by the contractor for the purposes of the work other work materials or goods which are not in accordance with the contract.

2. The addition, alteration or omission of any work obligation or restriction imposed by the employer in the contract bills in regard to:

- access to site or use of any specific parts of the site.
- limitation of working hours, and
- the execution or completion of the work in any specific order

BACKGROUND OF BUILDING ELEMENTS CLASSIFICATION

A building element is a component of the building that fulfils specific function(s) irrespective of its design, construction or specification. Robert and Harrold (1999) defined building elements as components common to most buildings that usually perform a given function, regardless of the design, specification, construction method, or materials used. Element classification ensures consistency in the economic evaluation of building projects over time and from project to project, and it enhances project management and reporting at all stages of the building life cycle planning, programming, design, construction, operations, and disposal (Robert and Harrold, 1999). Robert and Harrold (1999) asserted that the building community needs a classification framework to provide a consistent reference for the description, economic analysis, and management of buildings during all phases of their life cycle. This includes planning, programming, design, construction, operations, and disposal. The elemental building classification meets these objectives. Elements are major components, common to most buildings that usually perform a given function regardless of the design specification, construction method, or materials used. Examples of elements are foundations, exterior walls, sprinkler systems, and lighting. Robert and Harrold (1999) further stated that the need for an elemental classification is most apparent in the economic evaluation of building alternatives at the design stage. One way of obtaining an estimate of the lifecycle costs of design alternatives is to perform detailed quantity take-offs of all materials and tasks associated with the construction, operation, and maintenance of the buildings.

But a cost estimate prepared using a format based on a listing of products and materials is time consuming, costly, and inappropriate at the early design stages. Yet, it is in the early stages of design that economic analysis is most important in establishing the economically efficient choices among building alternatives. Only estimates based on an elemental classification provide the necessary cost information for the analyst to evaluate building alternatives in a cost-effective manner. However, there are various classifications of building elements by various schools of thought for easy identification and for the purpose of elemental cost analysis. Therefore, Figure 1 summarizes the four common elemental classifications. These include earlier UNIFORMAT, sponsored by American Institute of Architects (AIA) and General Services Administration (GSA) in the United States; the Canadian CIQS classification; the United Kingdom RICS classification, and the European CEEC classification for data exchange.

Figure 1: Building Elements Classification

UNIFORMAT General Services Administration (GSA)	**Canadian Institute of Quantity Surveyors (CIQS)**	**The Royal Institution of Chartered Surveyors (RICS-UK)**	**Construction Economics European Committee (CEEC)**
01 FOUNDATIONS 011 Standard foundations 012 Special foundations 02 SUBSTRUCTURE 021 Slab on grade 022 Basement excavation 023 Basement walls	A1 SUBSTRUCTURE A11 Foundations A12 Basement excavation	1.0 SUBSTRUCTURE	(1) SUBSTRUCTURE
03 SUPERSTRUCTURE 031 Floor construction 032 Roof construction 033 Stair construction	A2 STRUCTURE A21 Lowest floor construction A22 Upper floor construction A23 Roof construction	2.0 SUPERSTRUCTURE 2.1 Frame 2.2 Upper floors 2.3 Roof 2.4 Stairs 2.5 External walls 2.6 Windows and exterior doors 2.7 Interior walls & interior partitions 2.8 Interior doors	SUPERSTRUCTURE (2) Frame (3) External walls (4) Internal walls (5) Floors (6) Roofs (7) Stairs (8) Windows & external doors (9) Internal doors

04 EXTERIOR CLOSURE 041 Exterior walls 042 Exterior doors & windows	A3 EXTERIOR ENCLOSURE A31 Walls below grade A32 Walls above grade A33 Windows & entrances A34 Roof covering A35 Projections	3.0 INTERNAL FINISHES 3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes	FINISHES (10) Internal wall finishes (11) External wall finishes (12) Floor finishes (13) Ceiling finishes
05 ROOFING	B1 PARTITIONS & DOORS B11 Partitions B12 Doors	4.0 FITTINGS AND FURNITURE 4.1 Fittings and furnishings	(14) EQUIPMENT AND FURNISHINGS SERVICES (15) Plumbing (16) Heating (17) Ventilating & air-conditioning (18) Internal drainage (19) Electrics (20) Communication (21) Lifts, escalators, etc. (22) Protective installations (23) Miscellaneous services inst.
06 INTERIOR CONSTRUCTION 061 Partitions 062 Interior finishes 063 Specialties	B2 FINISHES B21 Floor finishes B22 Ceiling finishes B23 Wall finishes	5.0 SERVICES 5.1 Sanitary appliances 5.2 Services equipment 5.3 Disposal installations 5.4 Water installations 5.5 Heat source 5.6 Space heating & air treatment 5.7 Ventilation systems 5.8 Electrical installation 5.9 Gas installation 5.10 Life & conveyor installation 5.11 Protective installations 5.12 Communication installations 5.13 Special installations 5.14 Builders work in connection with services 5.15 Builders profit & attendance on services	EXTERNAL SITE WORKS (24) Site preparation (25) Site enclosure (26) Site fittings (27) Site services 28) Site Buildings (29) Hard and soft landscaping
07 CONVEYING SYSTEMS	B3 FITTINGS & E QUIPMENT B31 Fittings & equi	6.0 EXTERNAL WORK S 6.1 Site works	30) PRELIMINARIES

	pment B32 Equipment B33 Conveying syst ems	6.2 Drainage 6.3 External services 6.4 Minor building work	
08 MECHANICAL 081 Plumbing 082 HVAC 083 Fire Protection 084 Special mechanical systems	C1 MECHANICAL C11 Plumbing & dra inage C12 Fire protection C13 HVAC C14 Controls		
09 ELECTRICAL 091 Distribution 092 Lighting & power 093 Special electrical systems	C2 ELECTRICAL C21 Services & dist ribution C22 Lighting, devic es & heating C23 Systems & anci llaries		
10 GENERAL CONDITIONS & PROFIT 11 EQUIPMENT 111 Fixed & moveable equipment 112 Furnishings 113 Special construction	D1 SITE WORK D11 Site developme nt D12 Mechanical site services D13 Electrical site s ervices		
12 SITE WORK 121 Site preparation 122 Sit improvements 123 Site utilities 124 Off-Site work	D2 ANCILLARY W ORK D21 Demolition D22 Alterations		

Source: Bowen, B. and Charette, R.P., "Elemental Cost Classification Standard for Building Design,"1991 American Association of Cost Engineers (AACE) Transactions, Seattle, Washington, 1991, p. H2-1 to H2-5. (Cited in Robert and Harrold, 1999).

Royal Institute of Chartered Surveyors (RICS) classification

The British quantity surveyors first developed an elemental format after World War II while helping the Department of Education to develop a cost planning and cost control approach in rebuilding and expanding the British school system (Nisbet (1989), cited in Robert and Harrold, 1999). This led to the Royal Institution of Chartered Surveyors (RICS) publishing a standard list of elements in 1969 that the building community uses routinely in the United Kingdom (Royal Institution of Chartered Surveyors (RICS), (1987), cited in Robert and Harrold, 1999). As quantity surveyors who were trained in Britain performed their jobs around the globe, they took the elemental format with them (Robert and Harrold, 1999).

The Canadian Institute of Quantity Surveyors (CIQS) Classification

The Canadian Institute of Quantity Surveyors promulgated its own standard classification of elements for buildings in 1972, which was subsequently adopted by the Royal Architectural Institute of Canada (RAIC) (Robert and Harrold, 1999).

UNIFORMAT II Classification

Hanscomb Associates in the United States developed for the American Institute of Architects (AIA) in 1973 an elemental format called MASTERCOST (American Institute of Architects (1974), cited in Robert and Harrold, 1999). The General Services Administration (GSA) was also developing an elemental format, which was called UNIFORMAT. American Institute of Architects (AIA) and General Services Administration (GSA) ultimately agreed on a common format which became known officially as UNIFORMAT (American Institute of Architects (1992), cited in Robert and Harrold, 1999). It was incorporated into AIA's practice on construction cost management and GSA's project estimating requirements (General Services Administration (1981), cited in Robert and Harrold, 1999).

UNIFORMAT never gained "standard" status or Federal recognition as an official elemental classification. Yet, it is the basis of most elemental formats used in the United States. In 1989, the ASTM Subcommittee on Building Economics, representing a wide spectrum of the construction industry, initiated the development of an ASTM Standard Classification for Building Elements based in part on the original UNIFORMAT. The new classification was called UNIFORMAT II to emphasize its ties to the original UNIFORMAT (Robert and Harrold, 1999).

Construction Economics European Committee (CEEC) Classification

The need for a universal elemental system has encouraged the International Council for Building Research Studies and Documentation (CIB) and the Construction Economics European Committee (CEEC) to establish an elemental format to collect costs for international exchange. A major objective of the CEEC format is to make it compatible with the existing formats of as many European countries as possible. However, the CEEC format has not been widely adopted (Robert and Harold, 1999). Proneness of Building Elements to Variation.

The fact that Building and Engineering Standard Method of Measurement 3rd Edition (BESMM 3) opined that sub structural elements should be described as 'provisional' indicates that sub structural elements are highly prone to variations, that is , its items are subject to re-measurement. However, the Building and Engineering Standard Method of Measurement 3rd Edition (BESMM 3) does not identify the particular building elements at substructure that have higher degrees of proneness to variation. Akinsiku (2006) asserted that among building elements with high degree of susceptibility to variation are excavation and earthwork, concrete work, blockwork and mechanical service installations. While the building elements with "low" susceptibility to variation are electrical service installation, ceiling finishings, external works, external wall, fittings and furnishings. Akinsiku (2006) assessed only residential buildings. Moreover, most private individual clients do not engage the services of professionals in the built environment, that is, Architect to prepare the detailed working drawings; Quantity Surveyor to prepare the bill of quantities and Engineers to prepare engineering services drawings. Hence, the constructions of most residential buildings are not properly documented in Nigeria because of scanty contract documents. Also, the most common method of executing residential buildings in Nigeria is through direct labour. Therefore it would be difficult to ascertain the basis of degree of proneness of building elements to variations in residential buildings.

This research work becomes imperative to study proneness of building elements to variation on educational buildings project. Educational buildings are chosen because there is always proper contract documentations, all the professionals within the built environment are involved which led to the award of contract to the contractor within a time frame.

Controls of proneness of building elements to variation

Controls of variations have been suggested by many researchers such as, (Mokhtar, Bedard and Fazio, (2000), Ibbs, Wong and Kwak, 2001). The controls can be primarily grouped into two categories: Design stage and Construction stage.

Design Stage Controls for Variation Orders

Mendelsohn (1997) stated that 75% of the problems encountered on site were generated at the design stage.

This implies that the control of variations at the design stage has significant impact in overall reduction of the variation. The steps to achieve this reduction of variation at design stage include review of contract documents, involvement of professionals at initial stages of project, owner's involvement at planning and design phase, involvement of contractor at planning and scheduling process, thorough detailing of design, clear and thorough project brief and comprehensive site investigation among others (Construction Industry Institute (CII), (1994a) , Arain, Assaf and Low,(2004), O'Brien, (1998), Fisk, (1997), Assaf, Al-Khalil and Al-Hazmi,1995).

Construction Stage Controls of Variation Orders

The activities that are involved in control of variations at the construction stage include clarity of variation order procedures, owner's involvement during construction phase, use of project scheduling/management techniques, use of collected and organized project data compiled by owner, consultant and contractor, and Knowledge-base of previous similar projects among others (Mokhtar et al, 2000, Ibbs et al, 2001, Hester, Kuprenas and Chang, (1991), Fisk, (1997), Clough and Sears, (1994), CII (1994b), Miresco and Pomerol, 1995).

DATA AND METHODOLOGY

The data for the study were collected through structured questionnaires administered to consulting firms, contracting firms and client organizations within the built environment in Lagos metropolis. The study area was restricted to Lagos metropolis in South-western Nigeria because the region has the largest concentration of building projects (Ogunsemi and Jagboro, 2006) and a high concentration of construction activities in Nigeria (Odeyinka, Oladapo and Akindele, 2006). The data were limited to educational building projects awarded and completed within a ten-year period from 2000 to 2009, in order to have a vast number of educational building projects for assessment and this period is considered to have experienced the same economic climate in Nigeria. Also, educational buildings are chosen because there is always proper contract documentations, all the professionals within the built environment are involved which led to the award of contract to the contractor within a time. The Royal Institute of Chattered Surveyors (RICS) Classification of building elements provides the comprehensive list of building elements typical of any building projects. Thus, the study adopted the RICS classification.

The study made use of the percentage selection from the target population. According to Trochim (2000), for a small population of interest, sample of about 10-30% of that population is adequate; for a large population of interest (over 150,000), a sample as low as 1% is adequate. Thus, for objectivity the study adopted equal percentage selections from target population as follows: 30% each of Architectural firms, Builder's firms, Civil engineering firms, Quantity Surveying firms and registered contractors. These comprise 48 architectural firms, 75 builder's firms, 63 civil engineering firms, 50 quantity surveying firms, 24 contractors, and 50 client organizations were purposively selected. This gives a total sample size of 310. These percentage selections are adjudged adequate according to Trochim (2000) who specified a percentage range of not less than 10% for a small study population. A total of 310 copies of questionnaire were distributed to the target respondents through systematic sampling technique to the consulting firms and registered contractors in the study area. Non-probabilistic sampling method known as 'purposive sampling' technique was adopted in the administration of questionnaire to client organizations within the built environment because the actual number of the clients that have undertaken educational building projects within the study area cannot be ascertained but was generated through the consulting firms that were involved in executing educational building projects in the study area. Out of the 310 copies of questionnaire administered, 186 were retrieved but after checking through the completed questionnaires, 174 (56.13%) questionnaires were found to be suitable for data analysis. The response rate was considered adequate enough considering Moser and Kalton's (1971, cited in Aladegbaiye, 2002) assertion that the result of a survey is biased and of little value if the return rate was lower than 30-40%.

The questionnaires designed for this research paper were structured and multiple-choice type. Two sections of questionnaire were designed and administered to consulting firms, contracting firms and client organizations in the study area. section "A" encompasses the general characteristics of the respondents which includes; type of organization of respondents, years of working experience, academic and professional qualifications, number of institutional building projects handled and other matters relating to degree of variation that occurs among building elements during construction process, and control measures of proneness of the building elements to variation at design and construction stage. These questions were asked on a 5-point likert scale rating with 5 being the highest of the rating.

For example "Please rate the following building elements in terms of their susceptibility to variation, on a point scale of 1 – 5, where 5- Most Frequent, 4 – More Frequent, 3 – Frequent, 2 – Less Frequent, 1 - Not Frequent". And "Please rate the following identified control measures of proneness of the building elements to variation at design and construction stage , on a point scale of 1 – 5, where 5– Most Necessary, 4 – More Necessary, 3 – Necessary 2 – Less Necessary, 1 – Not Necessary.

Data were analyzed through descriptive and inferential statistics. These include percentage, frequency distribution, relative significance index (RSI) and spearman rank-order correlation coefficient. Also, the results are presented in tables.

Hypothesis testing 1

H0: There is no statistically significant relationship between consultants', contractors' and clients' ranking of the occurrence of building elements' proneness to variation during construction process.

H1: There is statistically significant relationship between consultants', contractors' and clients' ranking of the occurrence of building elements' proneness to variation during construction process.

Hypothesis testing 2

H0: There is no statistically significant relationship between consultants, contractors and clients regarding the ranking of control measures of proneness of building elements to variation.

H1: There is statistically significant relationship between consultants, contractors and clients regarding the ranking of control measures of proneness of building element

The Relative Significance Index (RSI)

The five-point scale (5 to 1) mentioned earlier was transformed into relative significance index for each factor used by using the numerical scores.

Relative significance index (RSI) was employed for two purposes i.e. ranking and determination of significance of different factors of the collected data. The relative significance index was determined using the following expression:

Relative significance Index (RSI) = A / (B x C)

Where:

A = total Score;

B = highest response option (5 in this study);

C = total number of responses; and

$0 \leq RSI \leq 1$

Spearman Rank-Order Correlation Coefficient

Spearman rank-order correlation coefficient was employed for the purpose of improving the reliability and validity of the research findings, the opinions of clients, consultants, and contractors were compared with a view to establishing multiple sources of evidence or measuring internal consistency. Cooper and Emory, (1995), and Zikmund, (1997), cited in Mbachu and Folose, 2005) recommend the use of spearman rank-order correlation as the appropriate statistical technique in situations involving ordinal measurement level and two related sample cases. Naoum (2003), cited in Mbachu and Folose, 2005) also supports the use of Spearman correlation test where “the problem is to measure the amount and significance of a correlation between people’s rank on a number of issues.”

Spearman’s rank correlation analysis was also employed to test the hypotheses. Spearman’s rank correlation coefficient (rs) measures the correlation between two sets of rankings and was determined using the expression:

$$rs = \frac{1 - 6\Sigma D^2}{N(N^2 - 1)}$$

Where:

D is the difference between the rank given by one group and that given by the second group.

N is the numbers of items being evaluated (24 building elements and 14 identified control measures in this study)

The rank correlation coefficients rs is from -1 to +1. A correlation of coefficient of +1 suggests a perfect linear correlation while a value of -1 means a negative correlation implying that a high ranking by one group is associated with low ranking by the other group. A zero value indicates that no linear association exists.

DATA ANALYSIS AND DISCUSSIONS

Table 1: Type of Organization of Respondents

Firms	**Questionnaires sent**	**Valid responses received**	**Percentage (%)**
Contracting	24	17	70.83
Consulting	236	122	51.70
Clients	50	35	70.00
Total	**310**	**174**	**56.13**

Table 1 shows that out of 24 contracting firms 17 responded representing 70.83% of contracting firms responded, out of 236 consulting firms 122 responded representing 51.70% of consulting firms responded and out of 50 client organizations 35 responded representing 70.00% of client organizations responded.

Table 2: Designation of Respondents

Designation	**Frequency**	**Percentage (%)**
Architect	36	20.69
Builder	43	24.71
Engineer	40	22.99
Quantity Surveyor	55	31.61
Total	174	100

Table 2 indicates the designations of respondents, the table reveals that out of 174 respondents, 36 are architects representing 20.69%, 43 are builders representing 24.71%, 40 are engineers representing 22.99% and 55 are quantity surveyors representing 31.61%.

Table 3: Highest Academic Qualifications of Respondents

Academic Qualification	**Frequency**	**Percentage (%)**
OND	12	6.90
HND	44	25.29
PGD	29	16.67
B.Sc	71	40.80
M.Sc	18	10.34
PhD	0	0.00
Total	174	100

Table 3 reveals the academic qualifications of respondents, the highest percentage of respondents academic qualifications are BSc holders (40.80%), followed by HND holders (25.29%), PGD holders (16.67%), M.Sc holders (10.37%) and OND holders (6.90%) respectively while none of the respondents bagged PhD.

Table 4: Professional Qualifications of Respondents

Professional Qualification	**Frequency**	**Percentage (%)**
MNIA	17	15.18
MNIOB	29	25.89
MNSE	21	18.75
MNIQS	30	26.79
FNIA	6	5.36
FNIQS	4	3.57
FNSE	5	4.46
Total	112	100

Table 4 indicates the professional qualifications of respondents, the table reveals that 26.79% of respondents are Member of Nigerian Institute of Quantity Surveyors (MNIQS), 25.89% of respondents are Member of Nigerian Institute of Building (MNIOB), 15.18% are Member of Nigerian Institute of Architects (MNIA), 18.75% are Member of Nigerian Society of

Engineers (MNSE), 5.36% of respondents are Fellow of Nigerian Institute of Architects (FNIA), 4.46% are Fellow of Nigerian Society of Engineers (FNSE) and 3.57% are Fellow of Nigerian Institute of Quantity Surveyors (FNIQS). The table further reveals that 112 respondents representing 64.38% are professionally registered.

Table 5: Years of Professional Experience of Respondents

No of Years	**Frequency**	**Mid-Point**	**(Fx)**	**Percentage (%)**
0-5	51	2.5	127.5	29.30
6-10	38	8	304	21.84
11-15	40	13	520	23.00
16-20	23	18	414	13.22
21 and above	22	21	462	12.64
Total	174	62.5	1,827.5	100

Mean = 10.50 (10 ½ Years)

The average years of professional experience of respondents as shown in table 5 is approximately 11 years. It can be deduced that the respondents are suitable and have acquired adequate experience in construction industry, based on this premise, the information supplied by these respondents are reliable and dependable.

Table 6: Educational Building Projects Handled by Respondents

No of Projects	**Frequency**	**Mid-Point**	**(Fx)**	**Percentage (%)**
0-5	75	2.5	187.5	43.10
6-10	49	8	392	28.16
11-15	30	13	390	17.24
16-20	16	18	288	9.20
21 and above	4	21	84	2.30
Total	174	62.5	1,341.5	100

Mean = 8

Table 6 shows the average number of educational building projects handled by respondents from 2001 to 2010. The table reveals the average of 8 projects are handled by respondents. Hence, the information provided is considered reasonably reliable and realistic.

Table 7: RSI of Frequency of Occurrence of Building Elements' Proneness to Variation

Building elements	**Contractors**		**Clients**		**Consultants**		**Overall Score**	**Rank**
	RSI	Rank	RSI	Rank	RSI	Rank		
A Substructure								
i Excavating and Filling	0.88	1	0.85	1	0.74	1	0.82	1
ii. Concrete works	0.68	3	0.71	2	0.68	2	0.69	2
iii. Block works (if any)	0.65	5	0.58	3	0.62	4	0.62	3
B Superstructure								
i. Frame	0.52	11	0.41	16	0.50	14	0.48	15
ii. Upper floors	0.48	14	0.43	14	0.44	22	0.45	17
iii. Roof	0.69	2	0.49	5	0.62	4	0.60	4
iv. Stairs	0.47	15	0.40	18	0.49	15	0.45	17
v. External walls	0.47	15	0.42	15	0.47	20	0.45	17
vi. Windows and External doors	0.46	17	0.41	16	0.45	21	0.44	20
vii Internal walls and partitions	0.54	9	0.45	11	0.48	17	0.49	14
viii. Internal doors	0.39	20	0.38	19	0.39	23	0.39	24
C Internal Finishes								
i. Wall finishes	0.66	4	0.49	5	0.58	9	0.58	5
ii. Floor finishes	0.53	10	0.48	7	0.59	8	0.53	8
iii. Ceiling finishes	0.61	6	0.38	19	0.57	13	0.52	9
D Fittings and Furniture								
i. Fittings and furnishings	0.59	7	0.47	8	0.65	3	0.57	6

E Services								
i. Sanitary appliances	0.38	21	0.44	13	0.58	9	0.47	16
ii. Service equipment	0.45	18	0.46	10	0.58	9	0.50	11
iii. Disposal installation	0.36	22	0.34	23	0.49	15	0.40	22
iv. Water installation	0.40	19	0.31	24	0.48	17	0.40	22
v. Ventilation system	0.34	23	0.35	22	0.58	9	0.42	21
vi. Electrical installation	0.52	11	0.45	11	0.60	7	0.52	9
vii. Lift and Conveyor	0.28	24	0.38	19	0.39	23	0.50	11
F External works								
i. Drainage	0.51	13	0.50	4	0.48	17	0.50	11
ii. External services	0.56	8	0.47	8	0.62	4	0.55	7

Table 7 reveals the occurrence of each building element to variation during construction process, from the table, the followings are the five (5) top most building elements that are highly susceptible to variation with their overall relative significant index; excavation and filling with relative significant index (RSI) of 0.82, concrete work with relative significant index (RSI) of 0.69, blockwork at substructure with relative significant index (RSI) of 0.62, roof with relative significant index (RSI) of 0.60 and wall finishes with relative significant index (RSI) 0.58. While the following Five (5) building elements are less susceptible to variation; internal doors with the overall relative significant index (RSI) of 0.39, disposal installation with overall relative significant index (RSI) of 0.40, water installation with overall relative significant index (RSI) of 0.40, ventilation system with overall relative significant index (RSI) of 0.42 and windows and external doors with overall relative significant index (RSI) of 0.44.

Test of Agreement between Respondents

Hypothesis 1

H0: There is no statistically significant relationship between consultants', contractors' and clients' ranking of the occurrence of building elements' proneness to variation during construction process.

H1: There is statistically significant relationship between consultants', contractors' and clients' ranking of the occurrence of building elements' proneness to variation during construction process.

Table 8: Correlation Coefficient of Occurrence of Building Elements' Proneness to Variation during Construction Process

Spearman's rho		**consultants**	**Contractors**	**clients**
Consultants	Correlation Coefficient	1.000	.775**	.676**
	Sig. (2-tailed)	.	.000	.000
	N	24	24	24
Contractors	Correlation Coefficient	.775**	1.000	.669**
	Sig. (2-tailed)	.000	.	.000
	N	24	24	24
Clients	Correlation Coefficient	.676**	.669**	1.000
	Sig. (2-tailed)	.000	.000	.
	N	24	24	24

***. Correlation is significant at the 0.01 level (2- tailed)*

The Spearman's rank correlation results of the ranking of building elements that most frequent to variation during construction process indicated that the ranking by all respondents (consultants, contractors and clients) are correlated as shown in Table 8. From the table R values are 0.775, 0.676 and 0.669 respectively. And P values were 0.000, 0.000 and 0.000 respectively. Therefore H1 is accepted, that is, there is statistically significant relationship between consultants, contractors and clients regarding the ranking of the frequency of occurrence of 24 building elements' proneness to variation during construction process.

Table 9: RSI of Control Measures of Proneness of Building Elements to Variation

	Contractors		**Clients**		**Consultants**		**Overall RSI**	**Rank**
CONTROL MEASURES	**RSI**	**Rank**	**RSI**	**Rank**	**RSI**	**Rank**		
Involvement of professionals at initial stage of project	0.89	1	0.85	1	0.82	2	0.85	1
Owner's involvement at planning and design phase	0.86	3	0.82	5	0.82	3	0.83	2
Strict compliance with statutory regulations	0.80	7	0.84	2	0.79	4	0.81	3
Clear and thorough project brief	0.88	2	0.83	4	0.73	7	0.81	3
Thorough detailing of design	0.85	6	0.79	6	0.77	5	0.80	5
Value engineering at initial stage of project	0.74	10	0.84	2	0.67	10	0.75	6
Comprehensive site investigation	0.86	3	0.55	10	0.84	1	0.75	6
Review of contract documents	0.86	3	0.64	7	0.69	8	0.73	8
Use of collected and organized project data compiled by owner, consultant and contractor	0.75	9	0.56	9	0.74	6	0.68	9
Knowledge-base of previous projects	0.78	8	0.54	11	0.68	9	0.67	10
Involvement of contractor at planning and scheduling stage	0.74	10	0.39	13	0.65	11	0.59	11
Use of project scheduling/management techniques	0.61	12	0.49	12	0.60	12	0.57	12
Restricted pre-	0.54	13	0.58	8	0.51	13	0.54	13

qualification system for awarding projects								
Avoidance of the use of open tendering	0.53	14	0.31	14	0.45	14	0.43	14

Table 9 indicates the control measures of proneness of building elements to variation before and during construction process, from contractors, consultants and clients perspective with overall relative significant index (RSI). From the table the followings are identified as top Six (6) control measures: involvement of professionals at initial stage of project, owner's involvement at planning and design phase, strict compliance with statutory regulations, clear and thorough project brief , thorough detailing of design and comprehensive site investigation.

Test of Agreement between Respondents

Hypothesis 2

H0: There is no statistically significant relationship between consultants, contractors and clients regarding the ranking of the 14 control measures of proneness of building elements to variation.

H1: There is statistically significant relationship between consultants, contractors and clients regarding the ranking of the14 control measures of proneness of building element.

Table 10: Correlation Coefficient of Control Measures of Proneness of Building Elements to Variation

Spearman's rho		**Consultants**	**Contractors**	**Clients**
Consultants	Correlation Coefficient	1.000	.614*	.840**
	Sig. (2-tailed)	.	.020	.000
	N	14	14	14
Contractors	Correlation Coefficient	.614*	1.000	.565*
	Sig. (2-tailed)	.020	.	.035
	N	14	14	14
Clients	Correlation Coefficient	.840**	.565*	1.000

	Sig. (2-tailed)	.000	.035	.
	N	14	14	14

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

The Spearman's rank correlation results of the ranking of the 14 control measures of proneness of building elements to variation. The table 10 indicates that the ranking by all respondents (contractors, clients and consultants) are strongly correlated. The table summarizes the results as follows; (r = 0.614, p = 0.020), (r = 0.840, p = 0.000) and (r = 0.565, p = 0.035). Thus, the P values of 0.020, 0.000 and 0.035 respectively indicate that the relationship is statistically significant. Therefore, H1 is accepted, that is, there is statistically significant relationship between consultants, contractors and clients regarding the ranking of the 14 control measures of proneness of building elements to variation.

CONCLUSION

The study concluded that the correlation coefficients of the occurrence of building elements' proneness to variation during construction process from the perspectives of contractors (R=0.676, P=0.000), clients (R=0.669, P=0.000) and consultants (R=0.775, P=0.000) were significant. Therefore, there is statistically significant relationship between consultants, contractors and clients on frequency of occurrence of building elements' proneness to variation during construction process. The study also found that the correlation coefficients of the control measures of proneness of building elements to variation at both design and construction processes from the perspectives of contractors (R=0.614, P=0.020), clients (R=0.840, P=0.000) and consultants (R=0.565, P=0.035) were also significant. Thus, there is statistically significant relationship between consultants, contractors and clients on the control measures of proneness of building elements to variation at design and construction stages.

The study recommended that the identified building elements which have been known to have a high degree of susceptibility to variation are to be given utmost consideration during the design and construction processes in order to minimize their effects and contributions to variation.

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