International Journal of Civil Engineering and Technology (IJCIET)
Volume 9, Issue 7, July 2018, pp. 412–421, Article ID: IJCIET_09_07_042
Available online at http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=9&IType=7
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

EMPIRICAL REVIEW OF VARIATION ORDERS' INFLUENCE IN CONSTRUCTION PROJECT DELIVERY

Afolabi Adedeji, Ojelabi Rapheal, Tunji-Olayeni Patience, Omuh Ignatius and Adedotun Akinola
Department of Building Technology, Covenant University, Ogun State, Nigeria

Afolabi Adesola
Department of Economics and Development Studies, Covenant University, Ogun State, Nigeria

ABSTRACT

Variations on construction projects are sometimes unavoidable but most times unnecessary. The resultant effects of allowing too much of variation orders issued on construction projects affect time, cost and quality. The study examined variation orders' influence in construction project delivery. Using a cross-sectional survey of construction businesses with completed projects, the study utilized a questionnaire instrument. The study showed that consultants contribute to the high variation orders issued during the building project lifecycle which ultimately results in the discrepancies between the initial and final cost of construction. The study suggested the early involvement of all construction professionals including the active participation of the client in preparing a comprehensive feasibility and maintainability analysis at the design stage of construction projects. Consultants should not work in isolation but rather collectively in producing an error-proof design.

Key words: Client, Construction industry, Delay, Project Delivery, Variation.

Cite this Article: Afolabi Adedeji, Ojelabi Rapheal, Tunji-Olayeni Patience, Omuh Ignatius and Adedotun Akinola, Empirical Review of Variation Orders' Influence In Construction Project Delivery, International Journal of Civil Engineering and Technology, 9(7), 2018, pp. 412–421.
http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=9&IType=7

1. INTRODUCTION

The intricacies involved in the production of construction products requires human input and in turn could result in complications such as variations (Sunday, 2010). This ideal factor makes it differ from other industries such as the manufacturing sector who work with prototypes. It is crucial that the factors such as time, cost and quality are attained in the highest standard for a

construction project to be termed successful (Frimpong et al., 2003; Aduwo et al., 2017). But, variations on construction projects makes it almost impossible to achieve the project goals. According to Fatoye (2012), these goals are usually not achieved on building projects thereby putting more strain on client satisfaction. As far back as 1994, only a quarter of 8000 completed projects could boast of achiving the desired goals of timely completion, within client's financial plan and desired quality (Ameh, Soyingbe and Odusami, 2010). Till now, the menace of time overrun and discrepancies between the initial cost and final cost still pervades the construction industry (Koushki, Al-Rashid and Kartam, 2005). In the final cost, the client is expected to pay more than expected. This defers from the initial bill of quanities that was used to approve the project for the successful contractor (Eshofonie, 2008). Mbachu and Nkado (2004) opined that construction stakeholders need to be aware of the undesirable repercussions it is having on the construction industry. Is it that there can be no variations specified by the client or client's representatives? The answer may be relative, however, what this study posits is the high frequency of issuing variation orders on construction projects can be avoided. One of the obvious problems created by high issuance of variation orders is construction delay. This problem may not be peculiar to Nigeria alone (Sambasivan and Soon, 2007) as there are other factors that can cause construction delay. The human aspect of errors, omission, alterations and so on that may have been corrected at the initial stage of design are issued that would not allow variation orders to become problematic to the lifecycle of the project. Improving the overall delivery of the construction industry should be the utmost concern of every stakeholder (Fatoye, 2012).

Sunday (2010) noted that variations should not become the 'new normal' if designs are well conceived and tested. For a success to be recorded in the industry, variation orders need to be questioned due to the consequences on the overall project goals. According to Mohammad et al. (2010), trying to define what constitutes as 'variation' is also complicated. Most building contracts align it with actions or activities. However, Ndihokubwayo and Haupt (2009) defined variation orders as the additions, omissions, alterations and substitutions in terms of quality, quantity and schedule of works. This definition is concise as it depicts that the construction process may have started based on approved details but new modifications becomes necessary. These modifications or substitution to the original designs may be due to financial factors, human errors, client needs, environmental factors and so on (Hanna et al., 2002; Ismail et al., 2012; Afolabi et al., 2017). Even though some of the modifications may be called for, it is necessary that they are carefully controlled so as not to negatively influence the project goals and objectives. Variation order raised on some construction projects are responsible for abandonment of project, litigation and the erroneous tagging of some contractors as 'slow' (Amu, Adeoye and Faluyi, 2005; Pourrostam and Ismail, 2011). Some client do not even want to pay for the variations issued by consultants. In addition, the issues of variation on construction projects ultimately leads to high waste generated on the construction project (Afolabi et al., 2017). The losses occurs in time wasted, depletion of limited funds, unaccounted human effort to break and rework to new modifications and building materials that are generated from the demolition. Ultimately, raising variation orders on construction projects have consequences, while clients and consultants may not be aware of the enormous effect on achieving the project delivery goals. Therefore, it is the intention of the researchers to review variation orders' influence in construction project delivery. The study is based on;

- Identifying the major variation orders issued on construction projects.
- Examining the reasons why variation order are raised.
- Reviewing the influence variation order has on project delivery.
- Measures to minimize the high rate of variation orders raised during the construction lifecycle.

2. RESEARCH METHOD

The empirical nature of the research required the use of a cross-sectional survey research design through a questionnaire data instrument (Afolabi and Oyeyipo, 2017). The study posits that most construction professionals have one time or the other dealt with variation orders on their projects, therefore, registered and unregistered construction professionals partook in the study. The study area being Lagos State considered construction businesses such as consulting and contracting construction organizations The target respondents included quantity surveyors, builders, engineers, project managers, contractors, site managers and other key professionals that are involved in consulting and contracting aspects in the industry. A non-probabilistic sampling technique which involved Quota -convenience sampling was used in selecting the sample size for the study. A total sample of fifty (50) was drawn from the consulting and contracting firms in Lagos State. A response rate of 72 percent was recorded in the 50 copies of research questionnaire distributed to contracting and consulting professionals in the construction industry. The study did not focus on the cost implication of the variation orders. The data was presented in tables and figures.

3. RESULT AND DISCUSSION OF FINDINGS

The first part identifies the project information data of previously completed projects in the last five (5) years. The second part identifies the different types of variation orders issued on construction projects and evaluates the causes of these variation orders in construction projects. The other part worthy of note is the variation order's influence on construction project delivery. In conclusion, the study evaluated channels by which variation order in construction projects can be minimized or controlled.

4. PROJECT INFORMATION

In order to sufficiently explore variation order, the respondents were asked to provide project information on a previously completed project, preferably within the last 5 years. Table 1 showed the summary of project information from a completed project from the respondent. From Table 1, the respondents that worked with Private Clients constituted the highest proportion with 28 (77.8%) while Public clients had 8 (22.2%). The project information on the selected project by the respondent showed that the project that lasted more than 12 months constituted the highest proportion with 32 (88.9%), while 7-12 months contract period for the projects had 3 (8.3%) and 1-6 months had 1 (2.8%). Most of the projects completed by the respondents lasted over a year. From Table 1, the selected project from the respondent showed that the contract sum of 51-100 million had the highest proportion with 16 (44.4%), while projects with contract sum less than 10 million had 12 (33.3%) and contract sum of 10-50 million had the least proportion with 8 (22.2%). This indicated that the projects been considered in this study were significantly important with the sum allocated to the projects. All the projects selected by the respondents for consideration in this study shows that they were all Building structures with 36 (100%). None of the projects selected by the respondents were civil engineering projects. The project use showed that commercial use had the highest proportion with 20 (55.6%), while residential use had 12 (33.3%) and educational use had 4 (11.1%). From the above the use was significantly from private client that initiated the project. From Table 1, all the project considered were building structures and the number of floors varied in that Medium rise (4-7 floors) had the highest proportion with 18 (50.0%), while Low rise (1-3 floors) had 17 (47.2%) and High rise Buildings (above 7 floors) had 1 (2.8%). In this study, it was important to consider the construction type, from the result it showed that new construction works had the highest proportion with 25 (69.4%) compared with renovation works which had 11 (30.6%).

Table 1 Project Information

Details	Frequency	Percent (%)	Cumulative Percent
Project Client			
Private	28	77.8	77.8
Public	8	22.2	100.0
Contract Period			
Less than 6 months	1	2.8	2.8
Within a year	3	8.3	11.1
Above 1 year	32	88.9	100.0
Contract Sum			
Less than 10 million	12	33.3	33.3
10 – 50 million	8	22.2	55.5
51 – 100 million	16	44.4	100.0
Project Type			
Building	36	100.0	100.0
Civil Engineering	-	-	100.0
Project Use			
Residential	12	33.3	33.3
Commercial	20	55.6	88.9
Educational	4	11.1	100.0
Building Rise			
Low rise (1-3 floors)	17	47.2	47.2
Medium rise (4-7 floors)	18	50.0	97.2
High rise (above 7 floors)	1	2.8	100.0
Construction type			
New works	25	69.4	69.4
Renovation	11	30.6	100.0

5. TYPES OF VARIATION ORDER ISSUED ON CONSTRUCTION PROJECTS

In Figure 1, the different types of variation orders issued on construction projects were identified. The mean item scores of these various types of variation orders issued on construction projects are converted into a line figure as shown in Figure 1.

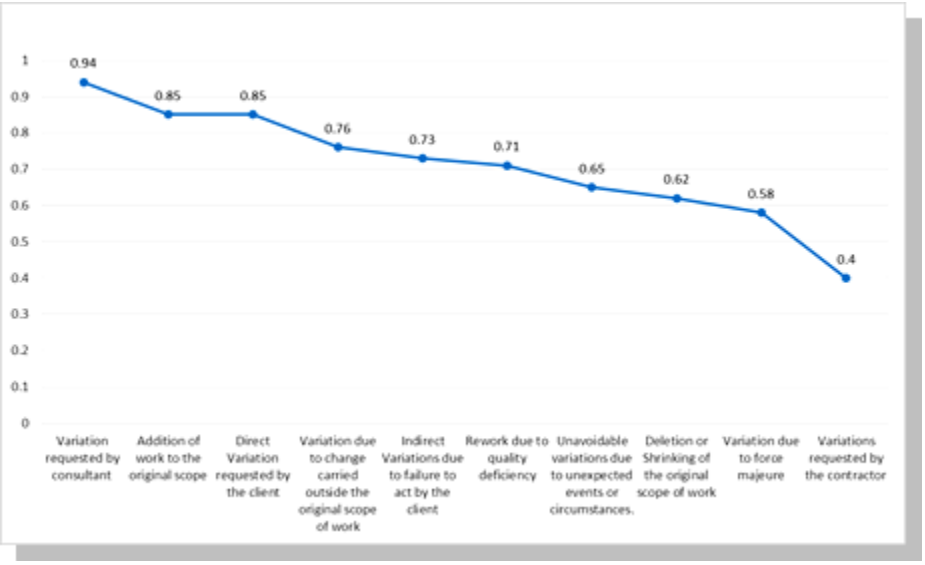

Figure 1 Types of variation order issued on construction projects

Figure 1 showed that Variation requested by consultant with a mean item score of 0.94 is the variation order that is highly issued on construction projects. Other variation orders that are highly issued on construction projects includes addition of work to the original scope and direct variation requested by client which both had 0.85 as its mean item score. Unavoidable variations due to unexpected events or circumstances (0.65), deletion or shrinking of the original scope of work (0.62) and variation due to force majeure (0.58) are identified in Figure 2 to be less issued variation orders, while Variations requested by the contractor with a mean item score of 0.40 was the least issued variation order on construction projects. Other variation orders issued on construction projects include Variation due to change carried outside the original scope of work (0.76), Indirect Variations due to failure to act by the client (0.73) and Rework due to quality deficiency (0.71).

6. REASONS FOR VARIATION ORDER IN THE CONSTRUCTION PROCESS

There are different sources from which variation orders can originate. Figure 2 showed the mean item score of reasons why variation orders are issued during the construction process. Design changes by consultant with a mean item score (MIS) of 0.95 is the major reason variation orders are issued during the construction process. Additionally, when changes are requested by clients in terms of scope, specification changes requested by clients, errors and omission in design and weather conditions with MIS of 0.90, 0.84, 0.81 and 0.80 respectively. It is observed that the most significant cause of variation order is a consultant related factor which means that if consultant practices are well coordinated and controlled it can lead to a decrease in the cases of variation orders issued during the construction process. Figure 2 revealed that consultant's related causes of variation order is led by change in design, while change of plan or scope of the project was identified as the most significant owner's related factor, Contractor's financial difficulties was identified as the most significant contractor's related factor while weather conditions ranked most significant outside of these three (3) main causes of variation orders in construction projects. According to Arain et al. (2004), design consultants believe it is within their powers to make changes to their design even during construction without recourse to the consequences. This has become a normal practice in developing countries. Based on Figure 1 and 2, consultants are mostly responsible for raising variation orders due to errors, omission or adjustment to their initial designs.

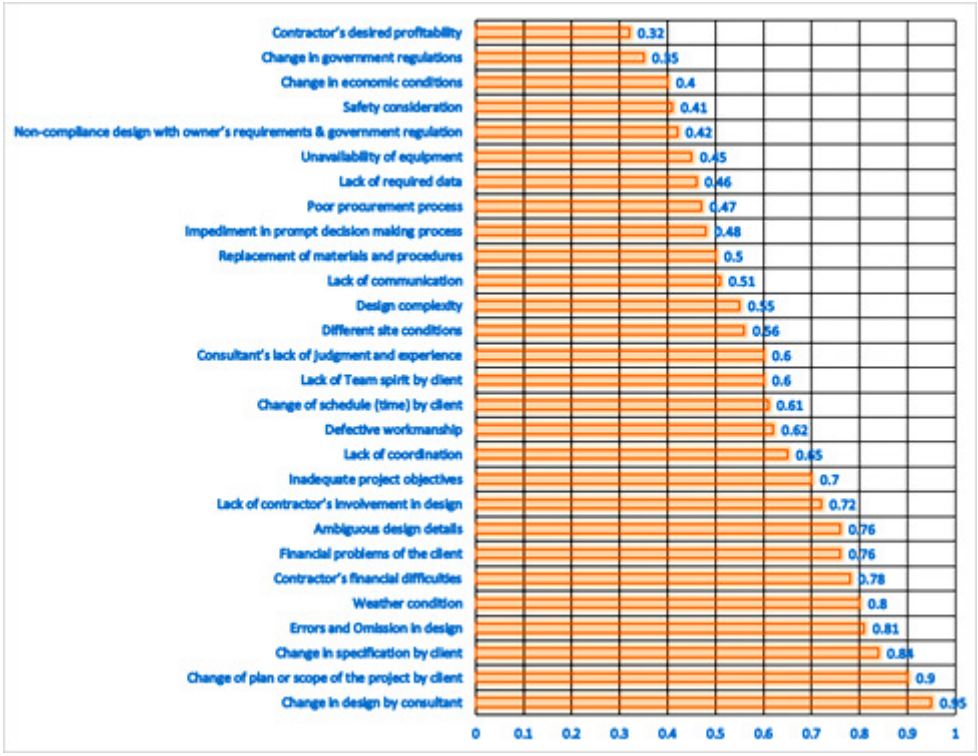

Figure 2 Causes of variation order in construction projects.

7. VARIATION ORDER'S INFLUENCE IN CONSTRUCTION PROJECT DELIVERY

When variation orders are issued on construction projects it has an influence on the overall construction project delivery. Figure 3 indicated that Cost overrun with MIS of 0.89 has a very high influence in the construction project delivery process. This is closely followed by Time overrun and Rework and demolition with MIS of 0.88 and 0.81 respectively. The least effects of variation order on construction project outcome include Tarnish contractor firm's reputation, Need to hire new professionals and Poor Safety conditions with mean item score of 0.45, 0.40 and 0.36 respectively. From Figure 3, it is observed that variation order's influence is mainly felt in the discrepancy between the initial contract sum and the final cost of construction which is referred to as cost overrun. Other effects identified in Figure 3 include Disputes among professionals (0.8), payment deferment to contractors (0.75), high overhead expenses incurred by contractor (0.72), Reduction in productivity of works (0.62), Logistics delays (0.59) and Reduction in the quality of work (0.5). From the result, the client is the main person that bears the brunt of high variation order issued during the construction process. Clients end up paying more for changes in design due to consultant's errors or negligence. The influence of variation orders leading to cost overruns are very common in developing countries in different types of projects (Koushki, Al-Rashid and Kartam, 2005). Clough and Sears (1994) noted that consultants need to be aware of their activities as any major modification to the initial design is bound to skyrocket the final sum of construction. Although, this may bring some financial benefit to the contractor that documents the variation order. Some consultants that do not want to may for the alterations lead the contract into dispute, litigation and ultimately abandonment at the detriment of the client.

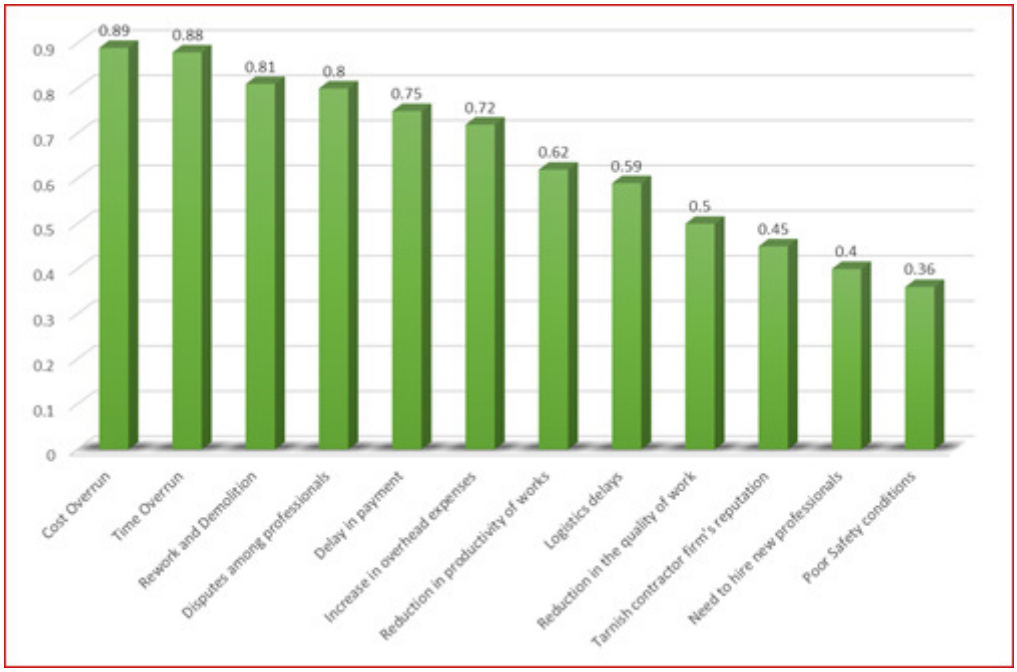

Figure 3 Variation order's influence in construction project delivery

8. MINIMIZING VARIATION ORDER IN CONSTRUCTION PROJECTS

Essentially, the high spate of unnecessary variation orders issued during the construction process needs to be controlled. Since Figure 3 indicated that variation order leads to the client paying more for the final product, it is therefore important to find ways to minimize or control the issuance of variation order on construction projects so as to reduce the burden on the client and thereby improving the image of the construction industry. Figure 4 showed the channels or means by which variation order in construction projects can be minimized or controlled. From Figure 4, it is observed that Early & active participation of all stakeholders from the design stage and Preparing in-depth & Comprehensive designs with MIS of 0.86. These two controls were the most significant measures that can minimize or control the emergence of variation orders in construction project delivery. From Figure 4, the most significant controls are followed by Review of contract documents and use of capable contractors with mean item score of 0.80 and 0.75 respectively. The least significant controls or measures include written approvals (0.43), Use of project scheduling/management techniques (0.42), Valuation of indirect effects (0.40), Ability to negotiate variation (0.35) and Reducing contingency sum (0.31). These measures were observed to be less influential to the reduction of variations on construction projects. Other channels by which increase in the variation orders issued on construction projects can be minimized or controlled include Comprehensive site investigation (0.72), Continuous coordination & direct communication (0.68), Team effort to control variation orders (0.63), A clear and well-defined scope of work (0.63), Active participation of clients at planning and design phase (0.61), Using knowledge of previous similar projects (0.59), Contractual clause in project contracts (0.57), Clear variation order procedure (0.54), Value engineering at conceptual phase (0.52), Prompt approval procedures (0.48) and Freezing design after design is completed (0.46). According to Gambatese and McManus (1999), design consultants need to be practical with their ideas at the initial stage. Such ideas need to be concrete as possible so as to avoid changes during the construction stage. Design consultants need to be stable in their design thoughts so as to avoid unnecessary modifications and alterations that have dire consequences on the time and cost factors of the project. Therefore,

all stakeholder should be involved early to contribute ideas to produce a more feasible design (Arain et al., 2004). One of the construction professional; a professional Builder is usually assigned the role of preparing the feasibility and maintainability plan of the initial design. By troubleshooting the design, errors, omission and other inconsistencies are fished out for an improved final design before construction begins. But, unfortunately, most professional Builders are not involved at the design stage of construction project delivery.

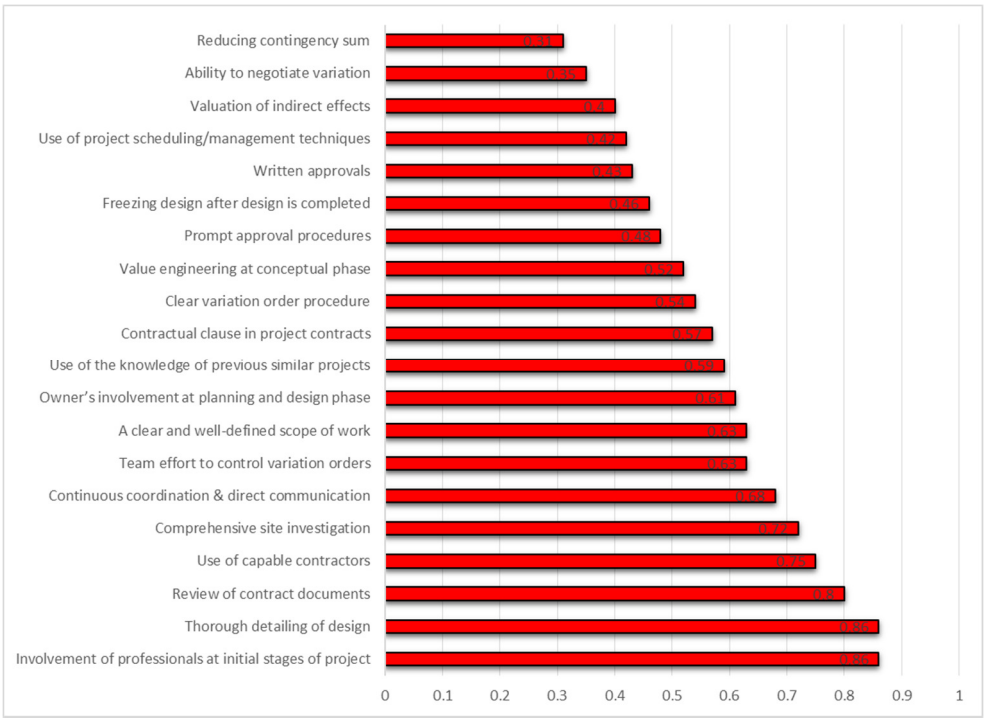

Figure 4 Minimizing variation orders issued on construction projects

9. CONCLUSION AND RECOMMENDATION

The study examined variation orders' influence in construction project delivery. Findings revealed that variation requested by consultant is the variation order that is highly issued on construction projects. This type of variation emerges from consultants through conflicting design documents, change in design after award of contract, errors and omission in design. Among the related factors highlighted in the study, consultant related factor is the major reason variation orders are issued on construction project. The consultant related factor means that alterations and modifications are requested based on errors, omissions or new ideas to the initial design. The study posits that the variation orders may be 'unwanted', unnecessary and uncalled for, therefore they can be avoided at the construction phase. Cost overrun has a very high effect on construction project outcome arising from variation order issued. Early & active participation of all stakeholders from the design stage and Preparing in-depth & Comprehensive designs were identified as the two (2) most significant measures in controlling or minimising variation orders on construction projects. Against the usual practice, a professional Builder and the Client should be involved at the planning and design stage of the construction project.

On the premise of the findings from this study, it is ideal that:

- Managing variations should be the priority of the design consultants due to its financial implication. Variations needs to be identified, documented and classified accordingly. Some variations may not be needed and therefore can be discarded. The information gathered during this stage would be relevant till the end of the project and during its maintenance period.

- The frequency of changes to design needs to reduce drastically. This can be achieved by team work amongst construction professionals and client, right from the planning stage to the handover of the construction project. By allowing contributions from contractors, consultants, manufactures and client in the finalising of the project design would ensure there are little or no changes when actual construction begins. The professional Builder is also very important at this stage to prepare a feasibility and maintainability plan for the design. The experience of the consultants is also called to question. Therefore, clients should endeavour to use consultants that have adequate experience in the construction industry to carry out their design works for construction projects. Use of new graduates or inexperienced designers in producing final designs for construction should be discouraged.
- The study pointed out the discrepancies that result from the design developed by the consultant. It is therefore pertinent to address the fault that arises from the design. Any design can have an error or omission but a design that undergoes thorough screening and trouble-shooting would go a long way to solving the need for adjustments when the project commences.
- It should be a strict adherence that no construction activities should be allowed to commence until proper approvals are in place for construction works to begin. Copies of the design should be submitted to the appropriate authorities in the Local planning authorities and a third party vetting to authenticate designs before their actual construction.

ACKNOWLEDGEMENT

The researchers are deeply grateful to the open access support policy sponsored by Covenant University.

REFERENCES

[1] Aduwo, E. B., Ibem, E.O., Uwakonye, O., Tunji-Olayeni, P., Ayo-Vuaghan, E. K. (2016). Barriers to the uptake of E-procurement in the Nigerian building industry. *Journal of Theoretical and Applied Information Technology,* 89 (1), 115-129.

[2] Aduwo, E. B., Ibem, E. O., Ayo-Vaughan, E. A., Uwakonye, U. O. & Owolabi, J. D. (2017). E-procurement use in the Nigerian building industry. *International Journal of Electronic Commerce Studies*, 8 (2), 219-254.

[3] Afolabi, A., Owolabi, D., Ojelabi, R., Oyeyipo, O. and Aina, D. (2017). Development of A Web-Based Tendering Protocol For Procurement Of Construction Works In A Tertiary Institution. *Journal of Theoretical and Applied Information Technology*, 95 (8), 1595 – 1606.

[4] Afolabi, A. and Oyeyipo, O. (2017). The Perception of Future Decision Makers on the Building Profession. *Malaysian Construction Research Journal*, 21 (1), 55 - 73.

[5] Afolabi, A. O., Oyeyipo, O., Ojelabi, R. A. and Tunji-Olayeni, P. F. (2017). E-Maturity of Construction Stakeholders for a Web-Based e-Procurement Platform in the Construction Industry. *International Journal of Civil Engineering and Technology (IJCIET),* 8 (12), 465-482.

[6] Afolabi, A., Fagbenle, I., Tunji-Olayeni, P. and Abimbola, M. (2017). Development of an on-site Builder's Estimating App for Construction Waste Reduction. *International Conference on Computing Networking and Informatics (ICCNI), IEEE*, Lagos, Nigeria, 1-9.

[7] Afolabi, A., Fagbenle, O. I. and Mosaku, T. O. (2017). Characteristics of a Web-Based Integrated Material Planning and Control System for Construction Project Delivery. In: Á. Rocha et al. (eds.), *Recent Advances in Information Systems and Technologies, Advances in Intelligent Systems and Computing, 570*, Chapter 3, Springer, Cham, 20 – 30.

[8] Ameh, O. J., Soyingbe, A. A. & Odusami, K. T. (2010). Significant factors causing cost overruns in telecommunication projects in Nigeria. *Journal of Construction in Developing Countries*, 15 (2), 49 – 67.

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

[10] Arian, F. M., Assaf, S. & Low, S. P. (2004). Causes of discrepancies between design and construction. *Architectural Science Review*, 47 (3), 237 - 249.

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

[12] Eshofonie, F. P. (2008). *Factors affecting cost of construction in Nigeria*. Unpublished Thesis submitted to the Faculty of Environmental Science, University of Lagos, Nigeria.

[13] Fatoye, E.O. (2012). Contributing factors of delay in the Nigerian construction industry: A comparative analysis with other selected countries. *In:* Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) *Procs 4th West Africa Built Environment Research (WABER) Conference,* 24-26 July 2012, Abuja, Nigeria, 575-587.

[14] Frimpong, Y., Oluwoye, J. & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in developing countries: Ghana as a case study. *International Journal of Project Management*, 21, 321-326.

[15] Gambatese, J. A. & McManus, J. F. (1999). The constructability review process: A constructor's perspective. *Journal of Management in Engineering*, 15 (1), 93 – 94.

[16] Hanna, R. S., Camlic, R., Petreson, P. A. & Nordheim, E. V. (2002). Quantitative definition of projects impacted by change orders. *Journal of Construction, Engineering and Management*, 128(1), 57-64.

[17] Ismail, A., Pourrostam, T., Soleymanzadeh, A. & Ghouyounchizad, M. (2012). Factors Causing Variation Orders and their Effects in Roadway Construction Projects. *Research Journal of Applied Sciences, Engineering and Technology*, 4(23), 4969-4972

[18] Koushki, P. A., Al-Rashid, K. & Kartam, N. (2005). Delays and cost increases in the construction of private residential projects in Kuwait. *Construction Management and Economics*, 23, 285-294.

[19] Mbachu J. I. C. & Nkado, R. N. (2004). Reducing Building Construction Costs; the Views of Consultants and Contractors. *Proceeding of the International Construction Research Conference of the Royal Institution of Chartered Surveyors, COBRA*.

[20] Mohammad, N., Ani, A. I. C., Rakmat, R. A. O. K. & Yusof, M. A. (2010). Investigation on the Causes of Variation Orders in the Construction of Building Project – A Study in the State of Selangor, Malaysia. *Journal of Building Performance*, 1 (1), 73 – 82.

[21] Ndihokubwayo, R. & Haupt, T. C. (2009). Uncovering the origins of variation orders. *International Journal of Construction Project Management*, 1, 1-17.

[22] Pourrostan, T. and Ismail, I. (2011). Significant factors causing and effects of delay in Iranian construction project. *Aust. J. Basic Appl. Sci.,* 5 (7), 450 - 456.

[23] Sambasivan, M. & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, 25, 517-526.

[24] Sunday, O. A. (2010). Impact of variation orders on public construction projects. *In:* Egbu, C. (Ed) *Proceedings of the 26th Annual ARCOM Conference,* 6-8 September 2010, Leeds, UK, Association of Researchers in Construction Management, 101-110.

[25] M. Karthikeyan, Impact Of V-Model On Project Delivery – Case Study, Volume 3, Issue 2, July- September (2012), pp. 571-578, International Journal of Computer Engineering and Technology (IJCET)

[26] Afolabi, Adedeji; Ojelabi, Rapheal; Fagbenle, Olabosipo and Mosaku, Timothy, The Economics of Cloud-based Computing Technologies in Construction Project Delivery. International Journal of Civil Engineering and Technology, 8(12), 2017, pp. 233–242