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Variations in Civil Engineering Construction Projects in Kenya: Causes and Effects

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***Abstract* -The purpose of thispaper is to investigatethe factors contributing to variation orders in civil engineering construction projects in Kenya.A survey of12 clients,32 consultants and 51 contractors, based in Nairobi, Kenya was conducted. Simple random sampling was carried outto select the respondents. The data was analysed using percentages and the Relative Importance Index. The study revealed that additional work is the most predominant aspect of variation with a score of 58%. In addition, the five most important causes of variations were revealed to be:delay in land acquisition/compensation (0.859), differing site conditions (0.832), change of plans or scope by client (0.762), change of schedule by the client (0.751), and lack of coordination between overseas and local designers (0.741). The five most important impacts of variations were found to be; cost overruns (0.903), contractual claims and disputes (0.814), and time overruns (0.811).To minimize the occurrence of variations, the study recommends:prompt acquisition of way-leave, thorough feasibility study, and provision clear project brief.**

Keywords:Civil Engineering Construction, Kenya, Variations, Variation Order

I. INTRODUCTION

According to Ashworth (2001), variation is a combination of any or all of the following: addition, omission or substitution of any work; the alteration of the kind or standard of materials or goods; the removal from site of work, material or goods that were formerly in accordance with the contract, but which have now been changed and change in the circumstances in which the work is carried out such as: access and use of site; limitation of working space; limitation of working hours and changes made to the sequencing of work.

Globally, variation orders are the main cause of cost and time overruns in construction contracts. Various studies on variations attribute 6-17% cost overruns in construction projects to variations (Hsieh *et al.* 2004; Mohamed, 2001; Randa*et al.* 2009), even as time overruns due to variation orders are in the magnitude of 10-50% (Kumaraswamy et al, 1998).

Recently,Ndihokubwayo (2008) observed that construction projects have a prevalence of variation orders of

85% of the total site instructions with clients being the origin of 49%, consultants 47% and contractors 4% of the variations.

In Kenya, variation orders in construction projects have been associated with cost and time overruns in the magnitude of 70 - 151% and 32 - 179% respectively,(Andrew, 2013; KRB, 2002). On their part, KACC (2007) reported thatthe rampant occurrence of variations has been revealed as an avenue through which unscrupulous contractors, engineers and government officials collude to escalate project cost resulting into wastage of public funds.

Attempts have been made to solve the problem of variations by restricting their magnitude. FIDIC (1999) allows for up to 10% while FIDIC (2006)stipulates 25% of the contract sum. In Kenya,PPOA (2006)imposes a ceiling of 15% of the original contract quantity. Despite of these attempts, civil engineering construction projects in Kenya are still overwhelmed by variation orders which are not only *incessant*,but also *excessive in magnitude*, thus negatively impacting on the performance of these projects. Moreover, KACC (2007) cautioned that unwarranted variations present loopholes that could be exploited by unscrupulous personnel to embezzle public funds. This paper therefore aims to investigate the factors causing variationorders in civil engineering construction projects in Kenya with a view of making recommendations geared towards their minimization.

I. LITERATURE REVIEW

A. Variation under PPOA

In Kenya, variation to works in public projects is administered by the Public Procurement and Disposal Act of 2005. Under this legal dispensation,the Public Procurement Oversight Authority (PPOA) wascreated to oversee public procurement system with its principal function of ensuring that the public procurement law is complied with. According to PPOA (2006) clause 31, variations to work shall be effective provided; the quantity variation for works does not collectively exceed 15% of the original contract quantity; and quantity variation is to be executed within the period of the contract. Further, PPOA (2009) instructs that all variation must be approved by the tender committee within the procuring entity and instruction issued in writing in form of Variation Instruction or Variation Order.

B. Variation under FIDIC

FIDIC (1999)empowers the engineer to initiate variations either by instruction (sub-clause 3.3) or by a request for the contractor to submit a proposal (sub-clause13.1). An instruction can be issued at any time to the extent that it is necessary forthe execution of the works (sub-clause 3.3). However,FIDIC (1999) limits the power ofthe engineer to give an instruction which constitutes a variation until the engineerhas issued the Taking-Over Certificate (TOC). Any variation order instructed after the issuanceof the TOC to the contractor is therefore null and void.

Jaeger & Hok (2010) argue that the contractor is bound to execute each variation, unless he promptly givesreasons with supporting particulars stating the grounds for which he is not willing todo so. However,FIDIC (1999) gives little scope for excuses. The extent to whichvariations are admissible is covered in sub-clause 13.1.

According to sub-clause 13.2 the contractor is also entitled to initiate variationson special grounds. This kind of variation has been named value engineering. Thetypes of variations which fall under sub-clause 13.2 are clearly defined in sub-clause 13.2. However, if the consultant approves a proposal of the contractor whichdid not meet the requirements of sub-clause 13.2 this will nevertheless constitute a variation order. But only if the requirements of sub-clause 13.2 are met, will the contractor be entitled to an additional fee pursuant to sub-clause 13.2.

C. Aspects of Variation Orders

According to FIDIC (2006),each variation may include:

1) Changes to the quality and other characteristics of any item of work,

2) Changes to the levels, positions and/or dimensions of any part of the Works,

3) Omission of any work unless it is to be carried out by others,

4) Any additional work, Plant, Materials or services necessary for the PermanentWorks, including any associated Tests on Completion, boreholes and other testing and exploratory work, or

5) Changes to the sequence or timing of the execution of the Works.

Ssegawa *et al.* (2002) investigated the opinion ofproject parties regarding the nature of variation orders in construction projects in Botswana. The studyfound that additions and omissions are the most common aspects of variations in projects, which represented about45.7% of all variation orders in building projects. Substitutionswere considered the third most important cause ofvariations. Elsewhere Ndihokubwayo (2008) analyzed the aspects of variations in building construction projects in Cape province of South Africa and revealed that additional work comprised 71% of all variation orders issued in the course of construction.

D. Factors Contributing to Variation Orders

The enormity of the various factors causing variations identified over the years by various author shows that variation has come tostay as part of the construction projects and it cut across all contracting parties. Wu *et al.* (2005) found that changes made in response to legislative orpolicy changes, changes in response to complaints ofcivilians and geological conditions were significant causesof variation ordersin a highway construction project in Taiwan. Elsewhere, Arain & Pheng (2006a)revealed that errors and omission in design,change in specification by owner, design discrepancies,change in specifications by consultant, and noncompliancedesign with governmental regulation considered werethe most significant causes of variation ordersinstitutional buildingsin Singapore. On their part, Amiruddin *et al.* (2012) disclosed that change of plans or scope by the owner,errors and omissions, differing siteconditions, contractor's financial difficulties, weather condition, conflict in the project site,owner's financial problems, value engineering and quality improvement are the top ten most important causes of variation orders in road construction projects in Iran.

E. Impacts of Variation Orders

Koushki *et al.* (2005)studied delays and cost increases in the construction of private residential projects in Kuwait and revealed that variation orders issued during the construction phase led to both delays and cost increases. In his study of causes, effects and control of variation orders in large building constructions projects in Malaysia, Randa *et al.* (2009) indicated that cost overruns due to variations were in the magnitude of 5-10% of the original contract sum and that the schedule slippage was less that 10% of the original contract duration. According to Hsieh *et al.* (2004), cost overruns in the magnitude of 10-17% occurred due to variations in metropolitan public works in Taiwan.

On their part, Assaf & Al-Hejji (2006) studied the causes of delayin large construction projects in Saudi Arabia, theresults of the study indicated that most common cause ofdelays identified by all three parties of the project wasvariation orders.

Zaneldin (2006) studied the types, causes,and frequency of construction claims in Dubai andAbu Dhabi in the UAE using data from 124 claims for avariety of projects. The study results indicated that the"variation order" claims were the most frequent type ofclaims with an important index of 60.5% and variationorder was the most frequent cause of claims with an importantindex of 55%.

II. RESEARCH DESIGN &METHODOLOGY

This study was conducted through a survey research design. The target population comprised 12 clients, 32 consultants registered with the Association of Consulting Engineers of Kenya under the civil infrastructure category, and 51 contractors registered with the Ministry of Public Works under categories A and B contractors working within the geographical area of Nairobi, Kenya.

Simple random sampling method was adopted. Using sample size from Mugenda & Mugenda (1999)a sample of 11 clients, 25 consultants, and 34contractors was established.

A five point Likert scaleranging from 1 (least frequent) to 5 (extremely frequent)was adopted to capture the frequency of occurrence of factors causing variation orders and their effects.The five point Likert scale was transformed into relative importance index (RII) using the formula below;

$$RII = \frac{\sum W}{AN}$$

Where: W=the weight given to each factor by the respondents, ranges from 1 to 5; A= the highestweight = 5; andN= the total number of respondents.

III. RESULTS &DISCUSSION

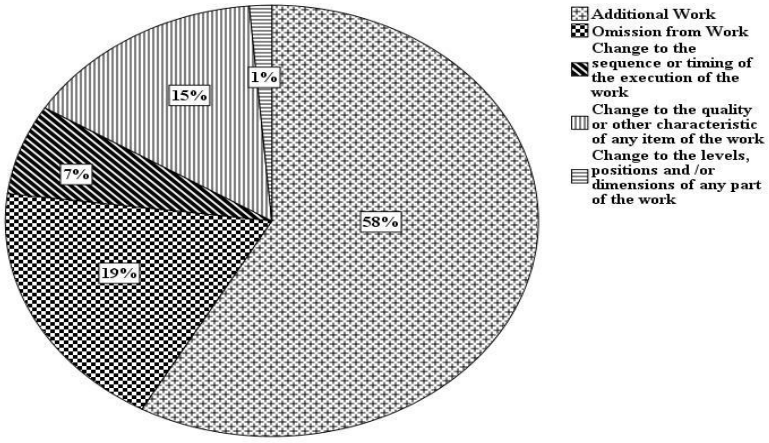

Figure 4-1: Types of Variation Orders in Kenya

Table 4-1: Top Ten Most Important Causes of Variation Orders in Civil Construction Kenya

Causes of Variation Orders	Overall		Client		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Delay in land Acquisition/ Compensation.	0.859	1	0.900	1	0.850	1	0.853	1
Differing Site Conditions.	0.832	2	0.767	2	0.842	2	0.847	2
Change of Plans or Scope by Client.	0.762	3	0.567	12	0.792	3	0.805	3
Change of Schedule by Client.	0.751	4	0.717	3	0.783	4	0.742	6
Lack of Coordination between Overseas and Local Designers.	0.741	5	0.667	6	0.758	5	0.753	4
Change in Design by Consultant.	0.735	6	0.650	8	0.750	6	0.753	4
Inclement Weather Conditions.	0.727	7	0.650	8	0.742	7	0.742	6
Errors and Omissions in Design.	0.711	8	0.717	3	0.708	8	0.711	8
Unavailability of Materials and Equipment.	0.651	9	0.417	21	0.700	9	0.695	9
Conflict between Contract Documents	0.651	9	0.717	3	0.633	11	0.642	10

Table 4-2: Top Five Most Important Impacts of Variation Orders in Kenya

Effects of Variation Orders	Overall		Client		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Cost Overruns	0.903	1	0.917	1	0.875	1	0.916	1
Contractual Disputes and Claims	0.814	2	0.733	3	0.842	2	0.821	2
Time Overruns	0.811	3	0.817	2	0.800	3	0.816	3
Increased Overhead Costs	0.786	4	0.717	5	0.792	4	0.805	4
Progress Degradation	0.724	5	0.733	3	0.758	5	0.700	5

A. Aspects of Variation Orders in Kenya

The respondents were asked to select the most common aspect of variation orders in their projects from a list of five, namely additional work; omission from work; change to the quality or other characteristic of any item of the work; change to the sequence or timing of execution of the work; and change to the levels, positions and/or dimensions of any part of the work.

The Figure 4-1 depicts the types of variation orders in civil construction projects in Kenya. The majority of the variation orders issued involved additional work with a score of 58%, even as change to the levels, positions and/or dimensions of any part of the work recorded only 1%.

Additional works are the result of the failure by client to provide a clear andcomprehensive brief with the result that client changes emerge during the construction stage. In addition, additional works are also the result of the failure by the consultant to produce complete design resulting in more details being required during the constructionstage.

This finding is in agreement with that of Ndihokubwayo (2008) who found that additional work is the major aspect of variation orders, contributing to 71% of all the variations. Compared to 58% for the case of additional work in civil construction projects in Kenya, it give the impression that though projects in Kenya experience scope creep, they do at slightly controlled environment than in South Africa.

B. Causes of Variation Orders

The respondents were asked to rate each potential cause based on his/her professionaljudgment and using the following scale, Least frequent = 1; Slightly frequent = 2; Moderately frequent = 3; Very frequent = 4; Extremely frequent = 5. As illustrated in Table 4-1, it was possible to rank the causes of variation orders by way of the Relative Importance Index (RII).

The following is a brief discussion of the five most important factors contributing to variation orders in civil engineering construction projects in Kenya:

1) Delay in acquisition of right of way is the most important cause of variation orders in civil construction projects in Kenya. It was ranked first, according to overall correspondents with RII of 0.859. According to Steven & Daniel (2008), at the outset of construction, the owner has an implied obligation to provide adequate and timely access to the construction site. This implied obligation requires both acquiring the property, whether by purchase or lease, and providing access to the property for the delivery of contractor's equipment and materials.

This finding shows that due to government bureaucracy, the clients who in the case of Kenya are mostly government parastatals and corporations, issue premature notice to proceed at the beginning of the contract and that the contractor commences work while the right of way is progressively resolved alongside the works. This is a common phenomenon in infrastructure projects in Kenya such as roads, water distribution and transmission lines. In most cases this causes delays and disruption of work which are responsible for variation in project schedule. In extreme cases, right of way problems could necessitate rerouting of projects so as to avoid contentious areas.

2) Differing site conditions was found to be the second most important cause of variation order in civil construction projects in Kenya. It was ranked second overall with RII of 0.832. Samantha (2002) contends that during the construction of a project, contractors often encounter subsurface or hidden conditions which were not anticipated and which may have a major impact on the time and cost of performing their work. However, Steven & Daniel (2008) argue that the owner has an implied obligation to provide the contractor with complete and accurate information regarding conditions at the construction site. If the owner has information in its possession regarding adverse conditions at the site, such as unanticipated geological conditions, water intrusion, underground pipe or cable, and other types of impediments to the clearing, grubbing and grading of the site, the owner has a duty to provide that information to the contractor. An owner can be liable for a "differing site condition" claim by the contractor even when the nondisclosure is unintentional.

This finding implies that in civil construction projects in Kenya, the owners do not learn as much about the site conditions as possible before entering into the contract (generally in the planning stages) by conducting adequate site or subsurface investigations through its geotechnical consultant. Moreover, this finding could be a pointer to the fact that the contractors do not conduct their own investigations if necessary to confirm the information provided by the owners and its consultants so as to ensure accuracy.

3) Change of plans or scope by client was ranked the third most important cause of variation orders in civil construction projects in Kenya with an RII of 0.762. Samantha (2002) noted that having adequate plans is a fundamental requirement for construction project. Insufficient plans result in uncertainties in the work which generally lead to remedial work prior to completion and an increase in the number of

variations in the work. Increased variations in a construction project generally reduce productivity and efficiency, and increase the chances of construction claims, especially delay claims.

According to Wally (2012), *Spearin* doctrine holds that a contractor will not be liable to an owner for loss or damage that results solely from defects in the plan, design, or specifications provided to the contractor. Effectively, *Spearin* created a doctrine whereby the owner impliedly warrants that the plans and specifications, if followed, will result in a functioning system. The *Spearin* doctrine holds that if a contractor is required to build according to plans and specifications prepared by the owner (or the owner's representative), then the contractor will not be responsible for the consequences of defects in the plan.

This finding suggests that in civil construction projects in Kenya, cases of insufficient plans and lack of scope control is the order of the day. This often leads to frequent change of plans and scope creep further resulting into additional work, disruptions or defective workmanship. This finding could also be a suggestion that contractors do not adequately review plans submitted by the client or his representative for obvious deficiencies so as to alert the owner and consultant in respect of any such defects.

4) Change of schedule by the client was revealed to be the fourth most important cause of variation orders in civil construction projects in Kenya, with an RII of 0.751. Improper scheduling and coordination of the works leads to a disorganized construction project prone to disputes, claims and considerable losses for all involved. Proper scheduling and coordination is thus required for a successful and profitable construction project Samantha (2002).

This finding is an indicator that in Kenya, the owners do not give much attention to scheduling during the planning phase of their projects and thus schedules issued for construction are always unrealistic leading to acceleration of work where a contractor must complete its work faster than it had originally planned in the construction schedule. This has the potential of precipitating claims for additional cost from the need to replay and re-sequence the work, hire additional workers, work overtime, accelerate material delivery, obtain additional supervision, or use additional equipment.

5) Lack of coordination between overseas and local designers was revealed to be the fifth most important cause of variation orders in civil construction projects in Kenya with an RII of 0.741. According to Alarcón & Mardones (1998), in construction projects clients requirements, constructive aspects and quality standards are defined during the design phase. However, this important phase is usually carried out with little interaction between the construction and design teams causing many problems during construction such us: incomplete designs, variation orders, rework, construction delays, etc.

This finding suggest that in large infrastructure projects in Kenya where the design consultants are foreign based, designs are often done on the basis of foreign standards and later reviewed locally to conform with the requirements of the local standards and site conditions. Poor or lack of proper coordination of this process could be responsible for design deficiencies/omissions and lack of constructability of the designs leading to high number of variations to suit the local clients requirements.

D. The Impacts of Variation Orders

The respondents were requested to rank the frequency of occurrence of effects of variation orders in civil construction projects in Kenya using a 5 point Likert scale where Never = 1; Seldom = 2; Sometimes = 3;Often = 4; and Always = 5.

From Table 4-2, it is evident that cost overruns, contractual claims and disputes and time overruns were the top three most important effects of variation orders in civil construction projects in Kenya. In contrast, delays in payment, procurement delays and quality degradation were the top three least important effects of variation orders. The discussions on the three most important impacts of variation orders in civil construction projects in Kenya are amplified as follows;

1) Cost overrunswasfound to be the first most important impact of variation orders in civil construction projects in Kenya, with RII of 0.903. It not entirely unexpectedfor the project cost to increase due to frequent variations in the project.According to Arain & Pheng (2006b), this isbecause variation orders may affect the project's total direct and indirectcosts. Therefore, any major addition or alteration in the design may eventuallyincrease the project cost. In every construction project, a contingency sum isusually allocated to cater for possible variations in the project, while keeping theoverall project cost intact. However, frequent major variations may lead to costoverrun in the contingency sum.

This finding is a submission that variations are incessant and indeed huge in magnitude contrary to the requirement of the public procurement and oversight authority stipulation of 15%. This is informed by the fact that most civil contracts have a contingency sum of 15% of the contract sum which is often exhausted by incessant and humongous variations.

2) Contractual disputes and claims was found to be the second most important effect of variation orders in civil construction projects in Kenya, scoring RII of 0.814 According to Harbans & Sri (2004) the common areas of contention involving variation that usually lead to claims and disputes can be narrowed down to the following stages of a typical variation cycle, namely:

1) Ordering of variations;
2) Measurement of variations undertaken;
3) Valuation of varied work; and
4) Payment for the variation ordered.

This revelation could signify the notion that there is lack of clear variation order protocol in most construction projects in Kenya. Such protocol would entail; the procedures for initiating variation; approval of variations; timing of the issuance of variation order; procedure for measuring varied works; method for valuation of the varied works; and time limits within which payments have to be made to the contractor.

3) Time overruns was revealed to be the third most important effect of variation orders in civil construction projects in Kenya with RII of 0.811. Arain & Pheng (2006b) noted that the contractors areusually compelled to accommodate the implementation time for variations byutilizing the free floats in the construction schedules.

Hence, minor variations affectthe progress but without any delay in the overall project completion. However, major variations may affect the project adversely, leading to delays in the project completion. Furthermore, frequent minor variationscan also affect the project adversely depending on the timing of the occurrence ofthe variations. This is because the impact of variations during theconstruction phase can be more severe than in the design phase.

Therefore, this finding is a demonstration that indeed variations orders in Kenya are incessant and large in magnitude to the extent that they cannot be accommodated within the floats in the construction schedules.

IV. CONCLUSIONS

The study finding suggested that additional work is rampant in civil construction projects in Kenya. This is a shortfallin scope management which falls under the responsibilities of the client since he is the originator of project brief that defines the project scope.Moreover, the client is responsible for four out of the five most important causes of variation orders, thus suggesting that the client is the most predominant origin agent of variation orders in civil engineering construction projects in Kenya.In the light of the foregoing observations, the clients need to be at the forefront of any interventions meant to manage variations in civil construction projectsif these interventions have to be successful.

V. RECOMMENDATIONS

Based on the findings of this study the following recommendations are proposed in order to minimize the occurrence of variation order in civil construction projects in Kenya:

1) As part of preconstruction planning, the client should acquire the right of way for the entire corridor before the contractor moves in to commence works.

2) A conclusive feasibility study that entails thorough geotechnical investigation that brings to the fore all subsurface conditions necessary for design.

3) Clients should provide a clear brief of the scope of works.

4) Proper coordination between the overseas and local designers so that the local design standards and requirements are adhered to and the actual site conditions are taken into consideration during design.

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