FACTORS CONTRIBUTING TO VARIATION ORDERS: A SURVEY OF CIVIL ENGINEERING CONSTRUCTION PROJECTS IN KENYA

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ABSTRACT

The almost unavoidable situation in construction projects is variation. It is common in all types of construction projects and plays an important role in determining the closing cost and time of the projects. This study investigated factors causing variation orders in civil engineering construction projects in Kenya. To achieve this objective, a questionnaire survey of 12 clients, 32 consultants and 51 contractors, based in Nairobi, Kenya and are involved in civil engineering construction projects was carried out. The simple random sampling method was adopted in selecting the participant companies for the study. The data was analysed using the Relative Importance Index (RII) and correlation tested using Kendall's coefficient of concordance. The study revealed that the ten most important causes of variations are: delay in land acquisition/compensation, differing site conditions, change of plans or scope by client, change of schedule by the client, lack of coordination between overseas and local designers, change in design by consultant, inclement weather conditions, errors and omissions in design, unavailability of materials and equipment, and conflict between contract documents. The findings shall be useful to professionals and policy makers in the construction industry in identifying and managing construction risks that are related to variations, thereby improving construction project performance.

Key Words: *Variation Order, Civil Construction, Kenya*

Introduction

The complexity of construction works means that it is hardly possible to complete a project without changes to the plans or the construction process itself. Construction plans exists in form of designs, drawings, quantities and specifications earmarked for a specific construction site. According to Ssegawa *et al.* (2002), changes to the plans are often effected by means of a variation order initiated by a consultant on behalf of the client or as raised by the contractor.

Worldwide, variation orders are the main cause of cost and time overruns in construction contracts. CII (1990); Hsieh *et al.* (2004); Mohamed (2001); Randa *et al.* (2009); Zeitoun & Oberlender (1993) concur that variation orders contribute to 6-17% cost overruns in construction projects. CII (1990); Kumaraswamy *et al.* (1998); Zeitoun & Oberlender (1993) reported that time overruns due to variation orders are in the magnitude of 10-50%. Moreover, Assaf *et al.* (1995) reckoned that variation orders are the major cause of contractual claims, with a staggering 60% of all claims being attributed to variation orders.

Regionally, 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. Further, Oladapo (2007); Sunday (2010) believed that variation orders have been blamed for cost overruns of between 25-78% and time overruns of between 27- 68%.

In Kenya, ADB (1998); Andrew (2013); KRB (2002) noted that variation orders in construction projects have been associated with cost and time overruns in the magnitude of 70 - 151% and 32 - 179% respectively. In addition, KACC (2007) reported that the 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. Whereas in Kenya, PPOA (2006) imposes a ceiling of fifteen percent (15%) of the original contract quantity. Despite of these attempts, civil engineering construction projects in Kenya are still dogged 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 variation orders in civil engineering construction projects in Kenya.

Literature Review

Definition

Fisk (1988); Yu (1996), define variation as any modification to the contractual guidance provided to the contractor by the owner or owner's representative. This includes changes to plans/drawings, specifications or any other contract document. Whereas Clough & Sears

(1994) stated that a variation order is written instruction issued to the contractor after execution of the contract by the owner, which authorize a change in the work or an adjustment in the contract sum or even the contract time.

Legal Framework

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) was created to oversee public procurement system with its principal function of ensuring that the public procurement law is complied with. According to PPOA (2006), variations to work shall be effective provided; the quantity variation for works does not collectively exceed fifteen percent (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.

Factors Causing Variation Orders

Various authors had identified different causes of variation orders in construction projects as illustrated in Table 1. The causes of variation orders were categorized into consultant related, owner related, contractor related variation order and the "other" changes that are not attributable to the three contracting parties.

Table 1: Factors Causing Variation Orders

Category of variation	Cause of Variation	Identified Author (s)
Consultant related variations	Change in design by consultant; Errors and omissions in design; Conflicts between contract documents; Inadequate scope of work for contractor; Technology change; Lack of coordination; Design complexity; Inadequate working drawing details; Inadequate shop drawing details; Consultant's lack of judgment and experience; Lack of consultant's knowledge of available materials and equipment; Consultant's lack of required data; Obstinate nature of consultant; Ambiguous design details;	Al-Hammad & Assaf (1992); Assaf *et al.* (1995); Chappel & Willis (1996); CII (1994); Fisk (1997); O'Brien (1998); Wang (2000)
Client related variations	Change of plans or scope by owner; Change of schedule by owner; Owner's financial problems; Inadequate project objectives; Replacement of materials or procedures; Impediment in prompt decision making process; Obstinate nature of owner; Change in specifications by owner.	Arain & Pheng (2005); Fisk (1997); Gray & Hughes (2001); O'Brien (1998); Wang (2000)

Category of variation	Cause of Variation	Identified Author (s)
Contractor related variations	Complex design and technology; Lack of strategic planning; Contractor's lack of required data; Lack of contractor's involvement in design; Lack of modern equipment; Unfamiliarity with local conditions; Lack of a specialized construction manager; Fast track construction; Poor procurement process; Lack of communication; Contractor's lack of judgment and experience; Shortage of skilled manpower; Contractor's financial difficulties; Contractor's desired profitability; Differing site conditions; Defective workmanship; Long lead procurement	Al-Hammad & Assaf (1992); Arain & Pheng (2005); Assaf *et al.* (1995); Clough & Sears (1994); Fisk (1997); O'Brien (1998); Thomas & Napolitan (1994); Wang (2000)
'Other' variations	Weather conditions; Safety considerations; Change in government regulations; Change in economic conditions; Socio-cultural factors; Unforeseen problems.	Arain & Pheng (2005); Fisk (1997); Kumaraswamy *et al.* (1998); O'Brien (1998); Wang (2000)

Source: Sunday (2010)

Wu *et al.* (2005) analyzed the causes and effects of 1038 variation orders authorized by project management in a highway construction project in Taiwan. The study found that changes made in response to legislative or policy changes were significant in embankment roads on northern section. It was also revealed through this research that design changes in response to complaints of civilians and geological conditions were significant causes of variation orders.

Arain & Pheng (2006) studied 53 factors that caused variation orders in institutional buildings in Singapore. The study divided these factors into four categories based on the origin of variation orders; i) owner related factors; ii) consultant related factors; iii) contractor related factors; and iv) other factors. The study results indicated that errors and omission in design, change in specification by owner, design discrepancies, change in specifications by consultant, and noncompliance design with governmental regulation considered were the most significant causes of variation orders.

Amiruddin *et al.* (2012) examined the 26 factors that cause variation orders in road construction projects in Iran. Using the mean score method to rank the causes on a 5 point Likert scale of 1-Strongly disagree to 5-Strongly agree, the results of the study disclosed that change of plans or scope by the owner was identified as the greatest cause of variation orders from all the viewpoints. Errors and omissions comes second under the ranking while both differing site conditions and contractor's financial difficulties jointly take the third position in the order of the causes of variation orders. Jointly following this on the same ranking scale are weather condition and conflict in the project site, these two occupy the fourth ranked cause of variation order. Following this is the owner's financial problem which occupies the 5th rank. Value engineering and quality improvement jointly occupy the 6th most important

factor causing variation order. The least factor responsible for variation order from the perspective of all the groups was acceleration of work.

Research Design and Methodology

Research Design

This study was conducted through a survey research design. Geoffrey *et al.* (2005) noted that the principal advantage of survey studies is that they provide information on large groups of people, with very little effort, and in a cost-effective manner.

Data Collection Instrument

Questionnaires were used as the main instrument for collecting data. The questionnaires were divided into two parts. The first part requested the respondent's profile while the second part focused on the causes of variation orders in civil construction projects in Kenya. A five point Likert scale ranging from (1 least frequent to 5 extremely frequent) was adopted to capture the frequency of occurrence of factors causing variation orders.

Population and Sampling

The target population for this study 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. The probability sampling method of simple random sampling was adopted to select respondent companies. Mugenda & Mugenda (1999) provided the following formula used to determine the sample size;

$$n_f = \frac{n}{1 + \frac{n}{N}}$$

Where: N – total number of population; n_f – sample size from finite population; n – sample size from infinite population = S^2/V^2; where S^2 is the variance of the population elements and **V** is a standard error of sampling population (Usually **S** = 0.5 and **V** = 0.1 for 90% confidence interval).

The target population, N was 12 for clients, 32 for consultants, and 51 for contractors. Therefore, the minimum sample size was 11, 25, and 34 for clients, consultants, and contractors respectively. For this study, the respondents sampled were 12 clients, 32 consultants and 51contractors, so as to ensure that the entire target population is captured.

Data Analysis

Sambasivan & Soon (2007), noted that the relative importance index (RII) method was adopted for similar studies to determine the relative importance of various factors. The five point Likert scale which ranged from 1 (Least Frequent) to 5 (Extremely Frequent) was transformed into 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 highest weight = 5; and N = the total number of respondents.

The Kendall's coefficient of concordance was used to test the correlation. Kothari (2004) provided the formula for Kendall's coefficient of concordance **(*W*)** as follows:

$$W = \frac{s}{\left[\frac{k^2(N^3 - N)}{12}\right]}$$

Where: $s = \sum(R_J - \overline{R_J})^2$, **N** = number of objects ranked; **K**= number of sets of rankings i.e., the number of judges; R_J= ranks assigned by k judges and $\overline{R_J}$ **=** Absolute mean of ranks.

Respondents' Profile

Table 2 provides the profile of the respondents who participated in the study. The sample was dominated by contractors due to their proportion in the target population. The majority of the respondents were site engineers, construction managers, directors and quantity surveyors comprising 78% of the respondents. Moreover, the majority of respondents had experience of over 10 years.

Table 2: Respondents Profile

General Information	Frequency	Percentage
Company Description		
Client	12	16
Consultant	24	32
Contractor	38	52
Position in Respective Company		
Director	8	11
Site Engineer	25	34
Project/ Construction Manager	16	22
Quantity Surveyor	8	11
Project Engineer	5	7
Design Engineer	6	8
Resident Engineer	2	3
Contracts Engineer	1	1
Clerks of Work	3	4
Participants Years' of Experience		
Below 5	3	4
5-10	10	14
11-15	12	16
16-20	20	27
Over 20	29	39

Research Results

Causes of Variation Orders

This study investigated the factors contributing to variation orders in civil construction projects in Kenya. The questionnaire listed 30 causes of variation orders for civil construction projects in Kenya. Each respondent was asked to rate each issue based on his/her professional judgment. The causes of variation orders were analyzed and ranked according to their responses. Table 3, shows the top ten most important causes of variation orders in civil engineering construction projects in Kenya.

Table 3: 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	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

Discussion

Top Ten Most Important Factors Causing Variation Orders

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

Delay in acquisition of right of way is the most important cause of variation orders in civil engineering construction projects in Kenya. It was ranked first, according to overall correspondents with RII of 0.859. 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. This result does not match with literature review due to the difference in situations between Kenya and the other countries.

Differing site conditions was found to be the second most important cause of variation order in civil engineering construction projects in Kenya. It was ranked second overall with RII of 0.832. 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 consultants. 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.

Change of plans or scope by client was ranked the third most important cause of variation orders in civil engineering construction projects in Kenya with an RII of 0.762. 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.

The fourth most important cause of variation orders in civil engineering construction projects in Kenya was found to be *change of schedule by the client*, with an RII of 0.751. 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.

With an RII of 0.741, *lack of coordination between overseas and local designer* was revealed to be the fifth most important cause of variation orders in civil construction projects in Kenya. 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.

Comparison with Previous Results on Causes of Variation Orders

Table 4 shows comparison of causes of variation order between the results of this study and those by Ndihokubwayo (2008) , Halwatura & Ranasinghe (2013) and Amiruddin *et al.* (2012) in South Africa, Sri Lanka, and Iran respectively. It is clear that the ranking of causes of variation in these four countries are different. This was not completely unexpected because each country has different challenges in her construction industry. However, factors such as change in design by consultant, errors and omissions in design, differing site conditions, change of plans or scope by client, inclement weather conditions and conflict between contract documents appear in top ten of all these rankings. This revelation indicates that these factors can indeed be accepted as the most important causes of variation orders globally.

Table 4: Ten Most Important Factors Causing Variation Orders Comparison of Kenya and Literature

Rank	Kenya (Author)	South Africa Ndihokubwayo (2008)	Sri Lanka Halwatura & Ranasinghe (2013)	Iran Amiruddin *et al.* (2012)
1	Delay in land Acquisition/	Change of plans or scope	Poor estimation	Change of plans or scope by
2	Differing Site Conditions.	Change of schedule	Poor investigation	Errors and omissions in
3	Change of Plans or Scope by Client.	Change in specifications	Unforeseen site conditions	Differing site conditions
4	Change of Schedule by Client.	Change in design	Change in design by consultant/design changes	Contractor's financial difficulties
5	Lack of Coordination between Overseas and Local Designers.	Errors and omissions in design	Additional preliminaries due to time extension	Weather condition
6	Change in Design by Consultant.	Inadequate working drawing	Client-initiated variations	Conflict in the project site
7	Inclement Weather Conditions.	Design discrepancies	Other organizations	Employer’s financial
8	Errors and Omissions in Design.	Impediment in prompt decision making process	Errors and omissions in design	Value engineering

9	Unavailability of Materials and	Unforeseen problems	Inadequate scope of work for contractor	Quality improvement
10	Conflict between Contract Documents.	Replacement of materials or	Inadequate planning	Acceleration of work

Correlation between Parties

To test the level of agreement between the client, consultant and contractor, the Kendall's coefficient of concordance was used and the results were as shown in Table 5. It was revealed that there was a weak correlation (0.577) between clients and both consultants and contractors. Nonetheless, a strong correlation (0.965) was found between consultants and contractors. These findings are baffling given the often perceived adversarial relationship between the consultant and the contractor in any given construction project.

Table 5: Correlation Analysis

			Client	Consultant	Contractor
Kendall's tau_b	Client	Correlation	**1.000**	**.577**	**.577**
		N	30	30	30
	Consultant	Correlation	**.577**	**1.000**	**.965**
		N	30	30	30
	Contractor	Correlation	**.577**	**.965**	**1.000**
		N	30	30	30

Conclusions and Recommendations

The study objective was to investigate the factors causing variation orders in civil construction projects in Kenya. Among the 30 identified causes of variation orders, the results indicated that, delay in acquisition of right of way, differing site conditions, change of plans or scope by client, change of schedule by client, lack of coordination between overseas and local designers were outstanding as the five most important cause of variation orders. In this category, the first four factors are all attributable to the client, thus suggesting that the client is the most predominant origin agent of variation orders in civil engineering construction projects in Kenya. Further, the client has been observed to be in disagreement with both the consultant and the contractor on the causes of variation orders, while the consultant and the contractor registered a near perfect agreement. This observation depicts the client as being out of touch with the actual causes of variation orders in his own projects. In view of the foregoing findings, it would be fair to conclude that owing to their culpability in causation of variation orders, clients need to be at the forefront of interventions to reduce variations in civil construction projects if these interventions have to bear fruits.

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. Past weather patterns/records of the construction area should be scrutinized so as to come up with a realistic schedule that takes into account the non-workable days in a calendar year.
5. 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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