IMPACT OF VARIATION ORDERS ON PUBLIC CONSTRUCTION PROJECTS

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The almost inevitable 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. The study examines the impact of variation on construction projects in relation to the handler that is the in-house staff and the consultants. To achieve the study objectives, a critical review of relevant literature was done coupled with questionnaire survey to collect information on potential causes of variations in the public projects with special emphasis on projects carried out by the class 1 and 2 contractors for government. Through the literature review, 53 causes of variation orders were identified which provided the basis for the formulation of the questionnaire. The identified causes were earlier subjected to test by the professionals to determine the relevance of the causes of variation in Seychelles construction projects. 58 questionnaires were distributed to the in-house construction professionals, consultants and contractors involve in handling government projects. 30 in house staff responded to the questionnaire and 18 responded by both the consultants and contractors who were involved in government construction projects. Through the analysis of the data it was discovered that the projects handled by the consultants are more prone to variation orders than projects handled by the in-house professionals. Aside the study also discovered that the percentage difference in the initial contract sums and final sums was significant both for the projects managed by the in-house project staff and the consultants but higher in the consultants managed projects. The study concluded that the projects handled by the consultants suffered both cost and time overruns than the projects handled by the in-house staff.

Keywords: variation orders, consultants, Seychelles.

INTRODUCTION

The complexity of the construction industry due to different stakeholders' involvement makes it differ from other industry. This complexity gives rise mostly to unwanted situation like variations with their attached effects, and the more variation orders on a project, the greater the likelihood that they become time consuming and costly in construction projects (Mohamed, 2001). It is almost becoming a rare thing for a project not to have variation, thus becoming a normal occurrence in all construction projects. Most contracts these days must make provisions for possible variations given the nature of building construction project (Finsen, 1999; Wainwright and Wood, 1983). An unfortunate aspect of the variation clause is that it tends to encourage clients to change their minds and embark on building projects without having properly thought through their project requirements (Finsen, 1999). Uff (2005) further pointed out that a clause permitting variation of works is an essential feature of

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any construction contract because without it the contractor is not bound to execute additional work or to make omissions or changes. It is the same for the architects, they tend not to crystallize their intentions on paper before the contract is signed because they know the variation clause will permit them to finalize their intentions during the term of the contract (Wainwright and Wood, 1983). Ashworth (2001) added that the advantage of the variation clause is that it allows the architect or other designers to delay making some decisions almost until the last possible moment.

The Seychelles construction industry

The Seychelles Construction Industry is classified into five different groups by the Seychelles Licensing Authority. It consists of formal sector comprises foreign and indigenous companies, which are classified into five major groups according to their level of capitalization, numbers of professionals involve in the company. Table 1 shows the categorization of the Construction Industry according to Seychelles Licensing Authority. Seychelles construction industry contributes around 10% of the nation GDP due to heavy investment from the tourism sector which is the main contributor to the economy of the nation. (Bureau of African Affairs, 2009)

Table 1: Categorization of the construction industry according to Seychelles licensing authority

Class	Description of Class
I	Has capacity both financially and manpower to execute any type of buildings and all kinds of civil works
II	Has capacity both financially and manpower to execute double story building and feeder roads only.
III	Has capacity to execute only single story buildings and other maintenance works
IV	Has capacity to execute only building maintenance and other ancillaries works
V	Has capacity to execute only minor works maintenance and landscaping works.

The prevalence of variation in most of the government projects despite the clause in the letter of financial warranty to the project officer not to incur additional cost or variation in the process of executing the project does not stop various variations in the project, thus the need to examine types of variation common to the government projects which probably are unavoidable and their impacts on the industry and the nation's economy.

Scope and objectives of the study

The study focus on public projects and limited to educational, housing and hospital projects with particular emphasis given to in-house and consultant managed project so as to

- examine the nature, causes and effects of those variations that is prevalent on government projects in Seychelles.
- identify the most variation prone projects between in-house professionals and consultant managed projects.

LITERATURE REVIEW

Construction industry due to its compartmentalization has made variation almost an inevitable element and has become so prevalent that it is hardly possible to complete a project without changes to the plans or the construction process itself. (Kwakye, 1997; Ssegawa *et al.*, 2002). The contract provision seems to support the variation orders in construction project and being misunderstood by the stakeholders both on its application and limit. (Fisk, 1997). A variation is an unwanted situation in a project but with stand-by defence in the contract condition. As it is a common phenomenon in all types of construction projects (Fisk, 1997; O'Brien, 1998; Ibbs *et al.*, 2001), it can

cause substantial adjustment to the contract duration, total direct and indirect cost, or both (Ibbs *et al.*, 1998).

It was asserted that variation orders cannot be avoided completely (Mohamed, 2001) and Ssegawa *et al.* (2002) further added that the presence of variation clauses in contracts amounts to admitting that no project can be completed without changes. Even if carefully planned, it is likely that there will be changes to the scope of the contract as the work progresses (Harbans, 2003). Hanna *et al.* (2002) indicated that variations occur given the uniqueness of each project and the limited resources of time and money available for planning. Hanna *et al.* (2002) in their study "Quantitative definition of projects impacted by Change orders" found out that it is the inevitable changes arising from variation that impacts on a project and that the changes may lead to disruptions and changes in work condition which eventually leads to loss of productivity. Their research also shows that other factors interact with the amount of change (such as timing of change, type of change, project size) or are caused by change (disruptions such as over-manning, overtime, absenteeism) that determine if a project will be or has been impacted. Their summary further shown that, most projects are impacted by change which is attributed by the designer and those due to misunderstanding of the designs by the contractor.

Table 2: Various causes of variation order and their categorization

Category of Variation	Causes of Variation	Identified Author(s)
Design Consultant related changes	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 and Assaf, 1992; CII, 1994a; Assaf, *et al.*,1995; Chappell and Willis, 1996; Fisk, 1997; O'Brien, 1998; Mokhtar, *et al.*, 2000; Wang, 2000.
Owner related changes	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.	Fisk, 1997; O'Brien, 1998; Wang, 2000; Gray and Hughes, 2001; Arain and Pheng (2005); Mokhtar, *et al.*, 2000; Gray and Hughes, 2001.
Contractor related changes	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 and Assaf, 1992; Thomas and Napolitan, 1994; Clough and Sears, 1994; Assaf, *et al.*, 1995;Puddicombe, 1997; Fisk, 1997; O'Brien, 1998; Wang, 2000; Arain and Pheng, 2005.
Other changes	Weather conditions; Safety considerations; Change in government regulations; Change in economic conditions; Socio-cultural factors; Unforeseen problems.	Fisk, 1997; Kumaraswamy, *et al.*, 1998; O'Brien, 1998; Wang, 2000; Arain and Pheng, 2005.

Variation orders occur due to a number of reasons ranging from finance, design, aesthetic, geological, weather conditions to feasibility of construction, statutory changes, product improvement, discrepancies between contract documents (Hanna *et al.*, 2002; Ssegawa *et al.*, 2002; Harbans, 2003; Uyun, 2007). The nature and frequency of variation occurrences vary from one project to another depending on various factors (Kaming, *et al.*, 1997).

Causes of variation orders

Various authors had identified different causes of variation orders in construction project both on the private and public projects. The enormity of the various causes of variations identified over the years by various author shows that variation has come to stay as part of the construction projects and it cut across various stakeholders. Table 2 shows various causes of variation order and their categorization. It has been categorized into consultant related, owner related, contractor related variation order and the other changes that can be referred to as force majeure.

Effects of variation orders

The effects of variation on construction projects were observed by many researchers and quoted by Faisal and Low in their study "The potential effects of variation orders on institutional building projects" highlighted various effects of variation orders as researched by different authors to be progress being affected but without any delay. (Assaf *et al.*, 1995), increase in project cost, delay in payment, hiring new professionals to take care of complex technological projects (CII, 1995), increase in overhead expenses (O'Brien, 1998), quality degradation, logistics delays (Fisk, 1997), productivity degradation, interruption, delays and redirection of work that are associated with variation orders have a negative impact on labour productivity, procurement delay (O'Brien, 1998), rework and demolition (Clough and Sears, 1994),. (Fisk, 1997), damage to firm's reputation (Fisk, 1997; Kumaraswamy *et al.*, 1998), poor safety conditions (O'Brien, 1998; Arain and Pheng, 2005), poor professional relations (Fisk, 1997), completion schedule delay, and completion schedule delay is a frequent result of variations in construction projects (Ibbs, 1997b).

RESEARCH METHOD

Three sets of questionnaires (A, B and C) were administered in 2009 to collect data. Questionnaire A sought respondents' opinions from the project management staff, questionnaire B sought from consultants and questionnaire C from contractors on the nature and causes of variation and the contributions of project owners, contractors, and consultants to the occurrence of variations. A minimum of 10 respondents were chosen from each project implementation units within government sector (housing, education and health services) to have 30 respondents representing the employer, 10 consultants and 18 contractors that are involve in the construction project were contacted for participation. In general, a total number of 58 questionnaires were given out. Out of the 58, only 48 were returned. Data were collected on 25 projects that falls within the selected group examined.

Table 3: Types of Respondent from Different Project Implementation Unit

Type of Respondent	Project Manager		Quantity Surveyor		Architect		Building Inspector		Project Officer		Total	
No.of Respondents	9	30%	5	17%	3	10%	4	13%	9	30%	30	100%

Table 4: Type of respondent from Consultants and Contractors Side

Type of Respondent	Project Manager		Quantity Surveyor		Engineer		Managing Director		Clerk of Works		Total	
No.of Respondents	4	22%	2	11%	3	17%	4	22%	5	28%	18	100%

The respondents' information is as shown in tables 3 and 4 above, the level of calibre of respondents shows that the respondent are capable of knowing what transpire on the project and information to be supplied by them can be reliable. Table 3 shows the in-house government employed professionals managing various government projects while Table 4 shows professionals involve in government projects as either as consultants or as contractors.

Analysis of Results

The 53 causes of variation order identified in the literature were examined using relative importance index to ascertain their applicability to Seychelles construction industry.

The relative index analysis for each variable is calculated by using the formula as follows:

"Very important" equals 5 points
"Important" equals 3 points
"Less important" equals 1 point

Importance Index (II) was used for each category and calculated as follows:

$IIR1 = 5x1 + 3x2 + 1x3/(x1+x2+x3)$ ……..(1)

Where:

IIR1 : importance index (R1 denotes variation category 1 in this case)
x1 : Number of respondents answering very important
x 2 : Number of respondents answering important
x 3 : Number of respondents answering less important

Table 5: Projects Examined for Variation Order

Type of Project	Section of Government Project	Number of Project in the last five years	Average Floor Area	Contract Sum (SCR' million)	USD (in millions)
School Building	Education	4	4500	30.38	2.53
Clinics	Health	3	495	3.76	0.31
Hospital	Health	1	1095	24.87	2.07
Low Cost Mass Housing	Housing	6	13824	76.93	6.40
Gas Storage Plant	Health	1	363	1.95	0.16

Table 5 shows the type of projects considered for the study, they are selected from education, health services and housing. All the three units have their own project implementation unit responsible for the management of their various projects.

The respondents had earlier rated the 53 various causes of variation from the literature review as follows: 1=not applicable; 2=partially applicable; 3=very much applicable.

The rating frequency was calculated with their importance index. The importance index of the first 27 causes of variation was between 91.58% and 51.11%, while the rest falls below 50% importance index level showing probably their non-applicability to Seychelles construction industry, particularly examined projects.

Table 6: Consultant Related Causes of Variation

Causes of Variation	Importance Index (%)	Rank
Inadequate working drawing details	86.67%	1
Design discrepancies	76.00%	2
Conflicts between contract documents	74.67%	3
Inadequate scope of work for contractor	74.67%	4
Errors and omissions in design	68.57%	5
Consultant's lack of required data	68.57%	6
Lack of coordination	67.14%	7
Consultant's lack of judgment and experience	62.96%	8
Lack of consultant's knowledge of available materials and equipment	62.67%	9

Table 7: Owner Related Causes of Variations

Causes of Variation	Importance Index (%)	Rank
Change of plans or scope by owner	85.33%	1
Impediment in prompt decision making process	82.67%	2
Inadequate project objectives	76.00%	3
Replacement of materials or procedures	70.67%	4
Change in specifications by owner.	69.33%	5
Change of schedule by owner	56.00%	6
Owner's financial problems	52.73%	7

Table 8: Contractor Related Causes of Variations

Causes of Variation	Importance Index (%)	Rank
Differing site conditions	84.00%	1
Shortage of skilled manpower	80.00%	2
Contractor's desired profitability	77.33%	3
Contractor's financial difficulties	76.00%	4
Contractor's lack of required data	66.67%	5
Lack of communication	66.67%	6
Contractor's lack of judgment and experience	65.71%	7
Defective workmanship	52.00%	8

Table 9: Other Causes of Variation

Causes of Variation	Importance Index (%)	Rank
Change in economic conditions	76.00%	1
Unforeseen problems	71.43%	2
Change in government regulations	62.67%	3

Tables 6, 7, 8 and 9 show the various causes of variations as it is applicable in Seychelles construction industry with particular focus on the public projects. The respondents were requested to rate the causes of variations already identified as applicable using the parameter specified above. It was observed that variation order such as inadequate working drawing details, design discrepancies, conflicts between contract documents, the change of plans or scope by owner, impediment in prompt decision making process, inadequate project objectives, and replacement of materials or procedures, differing site conditions, shortage of skilled manpower, contractor's desired profitability and contractor's financial difficulties are all rated high. Table 9 shows other causes of variation that can be referred to as force majeure.

Impact of variation order

Tables 10 referred to projects handled by the consultant showing that the variation on the projects affected the projects by both cost and time overruns, while Table 11 shows the impact of the variation on project affecting both cost and time as well. From Table 10 and 11, the total initial contract sum was SCR 137,880,926.00 (11,490,077.17 US Dollar) and the final cost was SCR 172,756,244.08 (14,396,353.67 US Dollar), this represent an approximate cost overrun of 25.29%. The result shows an increase in the duration of the projects from 178 months to 226.5 months, representing an average of 27.25% time overrun.

Table 10 shows that the cost and time of projects handled by the consultants has an increase of 28.68% and 31.96% respectively while Table 11 shows the effect of variation on projects handled by the in-house staff with an increase of 19.97% and 21.60% in their cost and time respectively.

Table 10: Projects Managed By Consultant

Project Type	Contract Sum	Final Cost	% Cost due to variation	Initial Duration (Months)	Final Duration (Months)	% Time overrun due to variation
New Primary School	15,187,500.00	18,935,775.00	24.68%	28	33	17.86%
Secondary School Region A (Renovation)	5,467,500.00	7,326,450.00	34.00%	8	12	50.00%
Hospital	24,865,716.00	37,795,888.32	52.00%	13	18	38.46%
Housing 1	16,485,120.00	18,793,036.80	14.00%	16	22	37.50%
Housing 2	10,990,080.00	14,177,203.20	29.00%	14	19	35.71%
Housing 5	9,341,568.00	9,434,983.68	1.00%	12	15	25.00%
Gas Storage Plant	1,952,600.00	2,001,415.00	2.50%	6	9	50.00%
TOTAL	84,290,084.00	108,464,752.00	28.68%	97	128	31.96%

DISCUSSION AND CONCLUSION

There are clear evidences from various literatures that variations contribute to cost and time overruns of a project. Although various research only focuses on the causes and impact of variation order on construction projects but without consideration for the effects of project handler in relation to the causes of variation order.

Table 6,7 and 8 show that all the various project stakeholder contributed to variations as also shown in the study conducted by Ssegawa *et al.* (2002) and Arain and Pheng, (2005).

Table 11: Projects Managed by the In-house staff

Project Type	Contract Sum	Final Cost	% Cost due to variation	Initial Duration (Months)	Final Duration (Months)	% Time overrun due to variation
Primary School Region A and B(Renovation)	3,037,500.00	3,159,000.00	4.00%	6	7	16.67%
Secondary School Region B (Renovation)	6,682,500.00	9,756,450.00	46.00%	11	15	36.36%
Clinic A	1,252,350.00	1,327,491.00	6.00%	6	7	16.67%
Clinic B	1,252,350.00	1,365,061.50	9.00%	6	6.5	8.33%
Clinic C	1,252,350.00	1,415,155.50	13.00%	6	9	50.00%
Housing 3	15,386,112.00	22,156,001.28	44.00%	18	28	55.56%
Housing 4	10,990,080.00	11,649,484.80	6.00%	14	12	-14.29%
Housing 6	13,737,600.00	13,462,848.00	-2.00%	14	14	0.00%
TOTAL	53,590,842.00	64,291,492.08	19.97%	81	98.5	21.60%

Table 12 shows that variations had a greater impact on projects handled by the consultants than the projects handled by the in-house staff considering the fact they both handled almost similar projects though different volumes. The general assertion that public projects are prone to variation (Ogunlana *et al.* 1996; Arain and Pheng 2005; Oladapo 2007) is clearly shown both on the side of the consultants and the in-house staff as revealed in Table 12.

From interview with some of the respondents, it was generally believed that the condition at which each handler operate might have contributed to freedom to vary projects specification and scope. Although this could be taking up as a further study, to ascertain the reasons for cost and time overrun in consultants handled projects.

Table 12: Impact of variations on project in relation to handler

Project Handler	Contract Sum	Final Cost	% Cost due to variation	Initial Duration (Months)	Final Duration (Months)	% Time overrun due to variation
Consultants	84,290,084.00	108,464,752.00	28.68%	97	128	31.96%
In-House Staff	53,590,842.00	64,291,492.08	19.97%	81	98.5	21.60%

The study has shown that inadequate workings drawing details, design discrepancies, and conflicts between contract documents are the most prevalent sources of variations due to consultants, change of plans or scope by owner, impediment in prompt decision making process, and inadequate project objectives contributed mostly to variations by the owner. Contractors' prevalent reasons for variations are differing site conditions, shortage of skilled manpower, and contractor's desired profitability. There is a relationship between the ratings by the respondent concerning the consultant related variations and the projects handled by the consultants.

The study concludes that impact of variation has greater significant impact on the projects handled by the consultants than the in-house project staff irrespective of the type and size of the projects. It is hoped that these will encourage the management to review the conditions at which the consultant and the in-house staff operate to better understand the usefulness of the consultant and the in-house construction professional staff.

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