

The impacts of variation orders on South Africa public sector construction projects

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Abstract

The complexity, uncertainty, long-duration and the involvement of the sequential tasks and relationships of participants in/of the construction projects render this category of projects prone to variations along their progress. Variations create extra work, time, and money for the construction projects and they vary from one project to another. This paper investigates the impacts of variation orders on public sector projects in South Africa. To achieve the objectives of the study, a critical review of literature was done coupled with questionnaire survey to collect information on possible impacts of variations on the public projects in SA. Through the review of literature 7 major possible impacts of variation orders were identified which provided the basis for the formulation of the questionnaire. The questionnaire was distributed to professionals who work for companies that undertake public construction projects in South Africa. Targeted number of respondents was 50; however a total number of 70 questionnaires were sent out to make up for the cases where respondents did not return questionnaires. Overall, 50 questionnaires were returned and after a careful examination of the received questionnaires only 39 were usable. These formed the basis of the analysis for the study, since it accounts for 78% of the initial sample. Findings revealed that variation orders have major impact on i) time overruns, ii) cost overruns, iii) quality standard enhanced, iv) disputes amongst parties to the contract, and v) productivity degradation, iv) complaints of one or more parties to the contract. It was further noted from the results that variation orders rarely affected health and safety aspect of the public construction projects since all the factors relating to health and safety were the lowest ranked; health and safety degradation, additional health and safety officials, additional health and safety equipment. However, this results are in disagreement with the results on the critical determinants of variation orders on SA public sector construction projects because health and safety conditions was ranked the highest reason for variation orders under other related reasons for variation orders. What these findings mean is that safety considerations may be the reason to cause variation orders but variation orders do not affect health and safety on the construction project.

Keywords

South Africa, variation order, prevalence, public construction projects

1. Introduction

The construction industry is complicated and uncertain in nature as each construction project has its own unique circumstances and conditions and also consists of a large number of interdependent and sequential tasks, (Wambeke et al., 2011; Alsuliman et al., 2012). Construction projects also have a long duration and complex relationships among the participants, (Arian and Pheng, 2005). The complexity, uncertainty, long-duration and the involvement of the sequential tasks and relationships of participants in/of the construction projects render this category of projects prone to variations along their progress. Even in the most thoughtfully planned project it may be necessary to order variations due to various factors (Arain & Pheng, 2007). Hence, Fisk & Reynolds (2010) emphasize that it is standard practice in construction contracts to allow the owner the right to make changes in the work after the contract has been signed and during the construction period. However, ordered variations must not be so large as to alter the nature of the contract, (Twort & Rees, 1995).

Variation orders play a fundamental role in any construction project, (Brahtz, 1980). Studies prove that variations are inevitable on construction projects in this regard thus instituting variation orders. On most, if not all, construction projects there will be changes to scope, time, cost and/or quality of the work, (Revy, 2002). Ndiokubwayo, (2008) informs that the occurrence of variation orders is prevalent on construction projects. Additionally, it is almost becoming a rare thing for a project not to have variations, thus becoming a normal occurrence in all construction projects (Sunday, 2010; Levy, 2012). Furthermore, Nachatar et al., (2010) argues that there can only be a minority of contract of any size in which the subject matter when completed is identical in every respect with what was contemplated at the outset. However, other researchers argue that some variation orders are beneficial as they can reduce the duration of a construction project or even eliminate unnecessary costs. Additionally, variations are also said to be ordered for the value of the project, hence it may be found that they enhance the performance of the end product rather than the on-going construction project itself. Variation orders are proved to be more associated with the participants in the construction project, i.e. the client, consultants i.e. quantity surveyors/architects/ engineers, etc. and the contractor. In addition, reasons such as the procurement systems, weather conditions or other natural events and differing site conditions are proved to also cause variations. Moreover, Barrie (1992) identified other factors that may lead to variation orders such as; regulatory agency change/government regulations changes i.e. for example building and/or construction regulations changes; change in the law; third-party interference; and third party non-performance.

Variation orders create extra work, time, and money for the construction projects and they vary from one project to another. Due to many known technical and political reasons, researchers inform that construction projects in developing countries receive more variation orders than projects in developed countries. South Africa is a developing country and its public construction sector account for between 30 and 40% of construction spend and is a major industry client according to the CIDB. Many research studies that have been undertaken on variation orders in South Africa have focused on its construction industry as a whole and not many on its public construction sector. Therefore, this study focused on the South African public sector construction industry only. The study investigated the impact of variation orders on South African public construction projects. This problem was solved by the guidance of the following objectives; possible impacts of variation orders namely; impact on cost, time, productivity, contractual relationships, quality, firm's reputation, etc. However due to financial and time limitations, this study was conducted in South Africa's Gauteng Province with a specific focus on the City of Johannesburg Metropolitan Municipality.

In achieving the objectives of the study a quantitative research approach was followed and to satisfy this approach, a structured questionnaire survey research design was adopted for collecting data. Questionnaire surveys are highly structured and place an emphasis on the careful random selection of samples, so that results can be generalized to other situations or contexts, (Gray, 2009). The targeted population was the construction firms that undertake public sector construction projects in South Africa and the targeted respondents were quantity surveyors and construction manager/site agents. These professional teams are believed to be the most having to deal with variation orders even when it's not them who initiates those variation orders. Data was analysed using descriptive statistics. The value of this study is to assist and advise ways on how to better minimize variations on South African public construction projects and consequently reduce their impact on the performance of those public construction projects. Hence this study is for government agencies, construction companies particularly those who undertake public construction projects and for the professional teams such as architects, quantity surveyors, construction managers, and/or construction project managers in the South African public construction sector.

2. Literature review

2.1 Possible impacts of variation orders

Variation orders affect the cost, time and quality of the construction project. In addition, variation orders may get to an extent of disputes among the parties to the construction projects. Moreover, variation orders are also proved to have an effect on the health and safety conditions on a construction project.

2.1.1 Impact on cost

Variations add to the total cost of a project (Brahtz, 1980; Morledge & Smith, 2013). Variations in the scope of work may exceed the cost of the immediate change itself, (Fisk & Reynolds, 2010; Morledge & Smith, 2013). Levy (2012) and Enshassi et al (2010), informs that there is direct and indirect costs to a construction project that result from variation orders. Direct costs constitute the additional costs incurred to perform the activities of the current variation orders and include: i) resources used including labour, material, plant, as well as transportation, to carry out the actual variation orders; ii) increase in overheads-related charges and professional fees; iii) cost of resources that were used to carry out the terminated or substituted works; iv) cost of demolition of terminated or substituted works; and v) cost for resources lying idle before the ordered task restarts. The process and implementation of variations in construction projects would increase the overhead expenses for all the participants concerned, (Arain & Pheng, 2005). Overhead charges are normally provided for from the contingency fund allocated for the construction project. Indirect costs are those incurred as a result of occurrence of variation orders and include: i) change in cash flow; ii) loss of productivity; iii) cost for redesign and administration of variation order; iv) litigation-related costs in case disputes arise due to variation orders, v) cost of premiums for bonds and insurances, permits, fees, sales, and use tax, and vi) additional cost of supervision and field office personnel directly attributable to the variation. Variation orders also lead to delay in payment. If the main contractor was not paid due to variations he or she in turn will not be able to pay his or her subcontractors.

2.1.2 Impact on time

Variation orders ultimately change the schedule of construction works and often results in time delays. In addition, Twort & Rees, (1995) state that extensive variations can make the contractor's task of constructing the works to his original programme impossible, and therefore result in completion time changes. Kwakye, (1997) argues that variation orders especially additional work disrupt production and construction programme. Wambeke et al (2011) studied two types of variations with regard to time and the variations are; the starting times variation and the task duration variation. The starting time variation is the difference between the planned and actual starting time of a task on a weekly work plan. The task duration variation is the difference between the planned and actual task duration. Amongst many causes of variations identified by Wambeke et al (2011) that resulted in time delays was lack of crew

skills/experience, the quality of documents, (errors in designs and/or drawings), weather impacts, etc. Often, the execution of a variation order involves slowdowns or delays of the contractor's operations, (Fisk & Reynolds, 2011). The study of Yogeswaran et al (1998), informs that the effect of variations on the project time is observed to be considerable; 50% of the projects surveyed for the purposes of this study had been granted an extension of time due to variations.

2.1.3 Impact on quality

Changes frequently have an impact upon the performance of other work that is not in itself changed, (Fisk & Reynolds; 2006). Fisk & Reynolds (2006) further explains that the impact of one phase work that is being changed on another phase of work that is not being changed refers to the indirect delay or interference. Interferences may lead to quality defects. Hence, it may be assumed that variation orders lead to quality degradation of the construction project.

2.1.4 Impact on productivity

Variation orders have a direct relationship with individual and group productivity, especially in cases of lack of materials and information, as well as the work being out of sequence, (Alsuliman & Barron, 2013). In addition Arain & Pheng (2005), inform that interruption, delays and redirection of work that are associated with variation orders have a negative impact on labour productivity. The impact of variation orders on productivity has been studied by many researcher; Ibbs (2012) "Construction Change: Likelihood, Severity, and Impact on Productivity". According to the study; Variation orders productivity Overtime: A Primer for the Construction Industry, outlined by Levy (2012) shows the impact of some types of variation orders on labour productivity include: stacking of trades: Multiple operations in physically limited space impact productivity from 10 to 30 % depending on weather it is minor or severe; morale and attitude: Multiple contract variations, disruption of labour rhythm, and competition for overtime can negatively impact productivity from 5 to 30 % for loss of morale; reassignment of manpower: Moving men off one task to another when variations occur can damage productivity as much as 15 %; crew size inefficiency: Adding new workers to an otherwise productive team affects labour rhythm; concurrent operations: Stacking of the contractor's own crew and adding new operations to an already planned sequence, unless a gradual and controlled process is implemented, will result in a loss productivity from 5 to 25 % whether minor or severe; dilution of supervision: If supervision must be shifted, or new foremen or journeymen must be instructed to supervise both basic and proposed changes, efficiency of operations will be affected by as little as 10 % or as much as 25 %; learning curve: There will be a period when orientation to a new area and new work will require some time to acclimate to this new environment. Loss of productivity can range from 5 to 30 %; errors and omissions: When they are encountered, they are usually dealt with on a crash basis, and can create out-of-sequence work with diminished supervision. Minor situations result in minor losses (1 %), and major problems raise the level of inefficiency to 6%; beneficial occupancy: Crews having to work around a client's partial move-in activities can be disruptive. Loss of productivity to the contractor's crews can range from 15 to 40%; joint occupancy: Work being performed by other trades, possibly those employed by the client, results in a 5 to 20% loss; site access: Interference with planned work areas, poor man-lift management, and congested areas can affect productivity as much as 30%; logistics: When client-furnished material begins to flow uncontrolled into contractor work areas, contractor productivity can be reduced by as little as 10% and as much as 50%. When the ordered variations require new materials, tools and equipment, they will result in delays, (Arain & Pheng; 2005);

2.1.5 Impact on contractual relationships

Variation orders on construction projects can cause serious problems and Kwakye, (1997) discusses that when problems are not immediately solved as they arise, they can become major issues which will eventually end up in court or before an arbitrator for resolution. Additionally Fisk & Reynolds (2010) argues that constructive changes are a major source of construction disputes. A constructive change arises when the contractor alleges that the client has acted, or failed to act, which resulted in a variation in the contract requirements. Disputes concerned with this change revolve around the interpretation of the plans

and specifications. The client and his agents interpret the plans and specifications in such a way that they benefit the project, whilst the contractor read the plans and specifications in a manner that will minimize performance costs. Frequent communication and strong coordination can assist in eliminating the disputes between professionals, (Arain & Pheng, 2005).

3. Research Methodology

A quantitative research approach was followed in this study. This approach attempts to deal with complexity by reducing and simplifying situations to the point where they can be examined, measured, and tested, (SACQSP, Mod.18: 25). A questionnaire research design was adopted for the study and the questionnaire was based on the reviewed literature. A research design is the conceptual within which research is conducted; it constitutes the blueprint for the collection, measurement and analysis of data, (Gray, 2009). The questionnaires were structured and closed questions were used for the purposes of this research. The use of close-ended questions provided participants with a multiple of options to choose from without allowing them to put their opinions in their own words. The main advantage of using close-ended questions is their simplicity for data collection and analysis thus they are less time consuming. A questionnaire survey was carried out in the Gauteng Province's City of Johannesburg and City of Ekurhuleni, Metropolitan Municipalities, South African. The research was conducted with respect to construction professionals who undertake public sector construction projects only. A simple random sampling strategy was used when distributing questionnaires. Questionnaires were sent to the identified respondents via email and others personally. Respondents had the leisure of completing questionnaires in their own time and space and were well informed of the purposes of the study, the importance of their participation in the study and were they can find the results if they are interested in knowing the outcomes of the study. A total number of 70 questionnaires were sent out to make up for the cases were respondents did not return questionnaires and a total number of 50 questionnaires were returned. After a careful examination of the received questionnaires only 39 were usable. These formed the basis of the analysis for the study, since it accounts for 78% of the respondents' rate. The secondary data for the study was derived from the review of literatures, published and unpublished. Three different Likert scales (2, 3 and 5-point) were used to record the responses. The Likert scales were transformed to a Mean Item Score (MIS) for each of the research objectives as applicable.

4. Findings

4.1 Biographic data of the respondents

Firstly, almost half of the companies that participated in this study were contracting firms (44%). That was followed by client (15%), consulting firms (12.82%), cost consulting (10.26%), developer (10.26%), and lastly project management (7.69%). Since this study is on variation orders, having the contracting firms as the main participants made this study worthwhile because contractors are the people who deal with variation orders directly and from day to day during construction projects developments. Secondly, the professional group that participated the most in this study were quantity surveyors with over half (62%) of the participation rate. This is good for this study because quantity surveyors are somehow always affected by variation orders. Thirdly, most participants have been in the construction industry for the period of 1-5years i.e. 26 out of 39 participants. There are few respondents who have been in the construction industry for the period 6-10years and 11-15years and no participants at all under the periods; 16-20years and 20years & above. This is still worthwhile for this study because 1-5years experience means that probably most participants might have been involved in at least a construction project that took as long as three years. Lastly, most participants have been involved in 1 to 2 public construction projects (48%) which is almost half of the whole rate. This was followed by public projects experience of between 3 to 4 (26%), 5 to 6 (15%), 7 to 8 projects (5%), and more than 8 projects (5%). This is as well worthwhile for this study because it may be assumed that being involved in at least one complete project one had fair exposure to variation orders.

4.2 The impact of variation orders

Respondents were requested to show the level of agreement on what variation orders resulted to. The following 5-point Likert scale was used to measure frequency; 1 = Never (N), 2 = Seldom (SE), 3 = Sometimes (SO), 4 = Often (O), 5 = Always (A). According to Table 4.1 it is evident that variation orders greatly led to time overruns (MIS=4.17), cost overruns (IS=4.00), disputes amongst parties to the contract (MIS=4.00), cost reduction (MIS=3.89), and quality degradation (MIS=3.89). Looking at the results based on cost it is clear that not all the respondents agree that variation orders result in cost overruns because cost reduction is also one of the highest ranked factor which variation orders resulted in according to the response of the respondents. Similarly, it is also the same with the results on quality. Other respondents highly agree that variations lead to quality degradation whilst others highly agree that variations lead to quality enhancement. The three lowest ranked are factors that related to health and safety; Additional health and safety equipment (MIS=3.28), Additional health and safety officials (MIS=3.28) and Health and safety degradation (MIS=3.50).

Table 4.1: Results of variation orders

	Outcome	MIS	SD	RANK
RVO1	Time overruns	4.17	0.737	1
RVO2	Cost overruns	4.00	0.926	2
RVO3	Disputes amongst parties to the contract	4.00	0.793	2
RVO4	Cost reduction (optimum)	3.89	1.116	3
RVO5	Quality degradation	3.89	0.919	3
RVO6	Quality standard enhanced	3.81	1.064	4
RVO7	Additional specialist personnel	3.81	0.959	4
RVO8	Complaints of one or more parties to the contract	3.78	1.017	5
RVO9	Productivity degradation	3.75	0.967	6
RVO10	Time reductions	3.67	1.195	7
RVO11	Professional reputation of one or more parties adversely affected	3.58	0.874	8
RVO12	Additional specialist equipment	3.58	1.025	8
RVO13	Productivity improvement	3.56	1.027	9
RVO14	Health and safety degradation	3.50	0.878	10
RVO15	Additional health and safety officials	3.28	1.219	11
RVO16	Additional health and safety equipment	3.28	1.233	11

Respondents were requested to indicate the level of impact of variation orders on factors that have already been identified using the following five point Likert scale; 1 = No Impact (NI), 2 = Minor Impact (MII), 3 = Neutral (N), 4 = Moderate Impact (MOI), 5 = Major Impact (MAI). According to Table 4.2, it was found that variation orders had a major impact on time overruns (MIS=4.37) followed by cost overruns (MIS=4.11), quality standard enhanced (MIS=4.05), disputes amongst parties to the contract (MIS=4.00), and productivity degradation (MIS=3.97). It is further noted from Table 4.16 that variation orders rarely affected health and safety; health and safety degradation (MIS=3.66), additional health and safety officials (MIS=3.61), additional health and safety equipment (MIS=3.61).

Table 4.2: Impact of variation orders

	Outcome	MIS	SD	RANK
IVO1	Time overruns	4.37	0.786	1
IVO2	Cost overruns	4.11	0.887	2
IVO3	Quality standard enhanced	4.05	0.957	3

IVO4	Disputes amongst parties to the contract	4.00	0.900	4
IVO5	Productivity degradation	3.97	0.915	5
IVO6	Complaints of one or more parties to the contract	3.95	1.113	6
IVO7	Professional reputation of one or more parties adversely affected	3.95	0.837	6
IVO8	Additional specialist equipment	3.89	0.936	7
IVO9	Additional specialist personnel	3.87	0.875	8
IVO10	Quality degradation	3.84	0.945	9
IVO11	Time reductions	3.79	0.991	10
IVO12	Productivity improvement	3.79	1.072	10
IVO13	Health and safety degradation	3.66	1.125	11
IVO14	Cost reduction (optimum)	3.63	1.152	12
IVO15	Additional health and safety officials	3.61	1.128	13
IVO16	Additional health and safety equipment	3.61	1.277	13

4. Discussion and Conclusion

Literature reveals that variation orders greatly affect the following on construction projects; cost, time, quality, productivity, contractual relationship, firm's reputation, health and safety conditions, and many other aspects of a construction project. According to the findings of this study not all the respondents agree that variation orders result in cost overruns because cost reduction was also one of the highest ranked factors which variation orders resulted into according to the response of the respondents. Similarly, it is also the same with the results on quality. Other respondents highly agree that variations lead to quality degradation whilst others highly agree that variations lead to quality enhancement. The results revealed that variation orders greatly lead to; i) time overruns, ii) cost overruns, iii) disputes amongst parties to the contract iv) cost reduction, and v) quality degradation. Moreover, the findings of this study revealed that variation orders have major impact on i) time overruns, ii) cost overruns, iii) quality standard enhanced, iv) disputes amongst parties to the contract, and v) productivity degradation, iv) complaints of one or more parties to the contract. It was further noted from the results that variation orders rarely affected health and safety aspect of the public construction projects since all the factors relating to health and safety were the lowest ranked; health and safety degradation, additional health and safety officials, additional health and safety equipment. However, this results are in disagreement with the results on the critical determinants of variation orders on SA public sector construction projects because it health and safety conditions was ranked the highest reason for variation orders under other related reasons for variation orders. What these findings mean is that safety considerations may be the reason to cause variation orders but variation orders do not affect health and safety on the construction project.

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