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Recommended Strategies to Minimize Variation Orders on Public Building Projects

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ABSTRACT

Due to the complex nature of the construction industry variation is common in construction projects. It occurs in all types of construction projects and it determines the time limits and anticipated budget of the projects. Variation order is observed as one of the most frequently occurring issues in construction projects in Ethiopia. Like other regions of the country, construction projects in Addis Ababa are suffering from variation orders. These variations are known to impact various aspects of the projects. This study suggested strategies to minimize variation orders on public building projects. The objective of the study was to recommend strategies to minimize variation orders. Through a comprehensive study of literature review, resulted in identification of 15 strategies to minimize variation orders and these variables were mapped in frequency table. Interview and questionnaire survey were carried out to seek recommended strategies to minimize variation orders. Interviews were made with selected experienced public building project participants for expert opinion. Questionnaires distributed to the relevant public building project participants and the responses were analyzed using the relative index method. Data analysis was done for the interview and questionnaire survey together with literatures to improve the validity of the findings from the study. The result suggested the best recommended strategies to minimize variation orders. These strategies were to produce a concluding design and contract document, to complete drawings at tender stage, and to supervise the works with experienced and dedicated supervisor to minimize variation orders on public building projects. The study concluded based on the findings of the research and recommendations forwarded to minimize variation orders.

Key words: Variation order, strategies, public projects, Addis Ababa.

I. INTRODUCTION

In most countries where new infrastructure and buildings are being built, the occurrence of variation seems usual. Most public building projects in Ethiopia were delayed with certain amount of variation orders increasing the cost of the project from the original value of the contract sum. Nowadays, variation orders have become a common problem in public building projects in Ethiopia. Variation orders are issued to correct or modify the original scope of work because changes during construction of projects are unavoidable. The major causes of delay, disputes and sometimes generate significant cost and environmental impacts are variation orders issued during construction of projects. Yet, no unique method is available for minimizing variation orders effectively. However, variations can be minimized with an appropriate strategy. Variation orders on public building projects have the potential to affect public building projects, and setting the strategies might lead to their reduction, possible elimination and subsequent improvement in overall performance of public building projects. Due to

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general background of the problem in the construction industry and the specific problem within the public buildings, there is a cause for the study to suggest recommended strategies to minimize variation orders on public building projects. Based on the problem statement above, the objective of the study was to suggest strategies to minimize variation orders on public building projects. There are many projects which are being implemented in Ethiopia. In order to achieve the stated objective of the study, the scope would be too large to tackle. Therefore, the study was limited to Addis Ababa which is the capital of Ethiopia where many public building projects are under construction. The steps outlined in this study were introduction, literature review, methodology, data analysis and discussion, and conclusions.

II. LITERATURES REVIEW

Construction project is a mission, undertaken to create a unique facility, product or service within the specified scope, quality, time and cost. The one thing certain on any project is that there will be variations occurring along the way sometimes even before the signing of the contract. Variations are inevitable in any construction projects (Ibbs *et al.*, 1998). Despite the best efforts of all concerned parties during the planning, implementation and administration of the contract, variation will almost certainly occur. The most frequent type of variation met in building projects are variations to the original scope of work or those that arise from unexpected conditions in the field. Even two buildings of same design, that is very similar, have differences caused by the terrain, existing utilities, or other factors such as subsurface conditions. Basically variation orders are acceptable as part of the contract administration process.

There is no single definition of what constitutes a variation. The term 'variation' as described and/or defined by various standard forms of contract differs from one to another but in principle the definition and/or meaning is more or less similar. According to FIDIC (1999), "variation" means any change to the works, which is instructed or approved as a variation. A variation order is the formal document that is used to modify the original contractual agreement and becomes part of project's documents (Fisk, 1997). The work of Ming *et al.* (2004) mentioned that a variation in construction projects refers to an alteration to design, building works, project programs or project aspects caused by modifications of preexisting conditions, assumptions, or requirements. In general, the term 'Variation' usually means a change, modification, alteration, revision or amendment to the original intent of the contract and/or its works.

Many times delays, cost overrun and quality defects of a construction can be attributed to variation at various stages of the project. Variations and conflicts in construction projects, at work, and even in our daily lives are very common (Arain and Pheng, 2006). The potential impact of variation orders can be minimized if possible strategies are clearly suggested. As Arain (2005) suggested, variations can be reduced with due diligence during the design stages. Furthermore, it would assist professionals in taking proactive measures for reducing variation orders for building projects if strategies are suggested. In order to minimize variation orders control system should be established for the ultimate benefit of owners. As Baharuddin (2005) concluded, variation orders can be minimized if all the parties involved in projects are aware that preliminary work before tendering must be carried out, for example detailed site and soil investigations. While design errors and omissions cannot be completely avoided, they can be reduced especially if designers assessed their workloads before committing

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themselves to new contracts (Ruben, 2008). In another way, the designers should ensure enough time and experienced human resources to deliver a sound design within the proposed time frames. Ruben (2008) identified recommendations to reduce the occurrence of variation orders. Among other recommendations, Baharuddin (2005) identified the suggested strategies to reduce the occurrences of variation orders. Many studies were conducted to find out possible strategies to minimize variation orders.

List of strategies that suggested by different researchers to minimize variation orders are identified as follows (Bower, 2000; Baharuddin, 2005; Chan and Yeong, 1995; Arain, 2005; Ruben, 2008; Bin-Ali, 2008; Willis, 1980; Ming *et al*., 2004; Levy, 2006; Al-Hakim, 2005a; Sweeney, 1998; Formoso, 1999). These are:

- Adequate planning is required by all involved parties before works start on site;
- The consultant should produce a concluding design and contract document;
- Drawings should be complete at tender stage;
- Adequate time should be spent on pre-tender planning phase;
- Clients should provide a clear brief of the scope of works;
- All parties should forecast to overview unforeseen situations;
- Closer consultant co-ordination is required at design stage;
- Enhance communication between the parties;
- Works should be supervised with an experienced and dedicated supervisor;
- Consultant should ensure that the design/specifications fall within the approved budget and the budget team should participate during the design phase;
- Get accurate information and research with regard to procurement procedure, material and plant;
- Carry out detail site investigation including detail soil investigations and consider it during tendering stage;
- Have the land application or land purchase completed before awarding contracts;
- Once the tender is awarded, there should be no changes to the specifications; and
- Place experienced and knowledgeable executives in the engineering and design department.

III. RESEARCH METHODOLOGY

Due to the nature of data to be collected from the relevant parties for the study, a purposive sampling method was adopted to select the population for the study. A combination of qualitative and quantitative approaches was used in the study. Questionnaire survey and interview were carried out to identify the recommended strategies to minimize variation orders on public building projects. Interviews made for expert opinion with three selected public building project participants and the recommended strategies to minimize variation orders were identified. Qualitatively, the study focused to obtain the perceptions of public building construction project stakeholders relative to the recommended strategies to minimize variation orders. The variables which identified from the literatures were quantitatively measured to determine the most recommended strategies to minimize variation orders on public building projects.

The questionnaire was designed to gather data from professionals that involved in public building projects. The ranking of the responses was by using Likert's scale of five ordinal measures which arranged in ascending order from 1 to 5. The main approach used for data analysis was the Relative Index (RI) technique.

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$$RI = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n)}{5\,(n_5 + n_4 + n_3 + n_2 + n)}$$

Where:

RI: Relative Index

n_5, n_4, n_3, ... : number of responding indices.

The responses were analyzed using the Microsoft Excel software package. The analysis included ranking the factors in terms of degree of effecting. The Spearman (rho) rank correlation coefficient is used for measuring the differences in ranking between two groups of respondents scoring for various factors (i.e. clients versus consultants, clients versus contractors, and consultants versus contractors).

$$\text{Rho } (\rho_{cal}) = 1 - \frac{6 \times (\sum d_i^2)}{N \times (N^2 - 1)}$$

Where:

Rho (ρ_{cal}): Spearman's rank correlation coefficient;

d_i: the difference in ranking between each pair of factors; and

N: number of factors (variables).

The value of the Spearman (rho) rank correlation coefficient varies between *-1* and *+1*. A correlation coefficient of *+1* implies perfect positive correlation, *0* implies no correlation and *-1* implies perfect negative correlation.

IV. DATA ANALYSIS AND DISCUSSION

This part of the paper analyses the data collected using questionnaires and interviews. The collected data from the questionnaires were tabulated and analyzed according to their ranking on Relative Index (RI). Interviews results which collected from selected public building projects participants are presented. This part of the paper identifies the highest ranked factors for discussion which found from the interview and questionnaire survey.

Analysis

Interview

Interviews were made between selected construction industry practitioners who are currently involved in public building projects focusing on their perceptions on recommended strategies to minimize variations orders. In total three interviews were conducted, namely with a senior project supervision and follow up team leader (A) from the clients' group, a senior contract administrator (B) from the consultants', and a senior project manager (C) from the contractors' group as shown in **Table 4.1** below. The interview aimed at discovering the strategies to minimize the occurrence of variation orders on public building projects.

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Table 4.1: Interview results

Questions	Interviewee A	Interviewee B	Interviewee C
What do you suggest to minimize the variation orders on public building projects?	▪ Produce a complete design and contract document ▪ Prepare a completed detail drawings ▪ There should be communication between parties	▪ Designs should be complete at tender stage ▪ Carry out detail site investigation before tendering stage ▪ Forecast unforeseen situations before tendering	▪ Prepare a complete drawing and contract document before tendering stage ▪ Completed detail drawings should be submitted on time ▪ Works should be supervised with experienced supervisors

The interviewee suggested that it is possible to minimize the occurrence of variation orders with the common strategies which always pointed out by experienced construction practitioners. According to the interviewee, a complete design and contract documents should be produced, complete detail drawings should be submitted on time, a detail site investigation should be carried out and unforeseen conditions should be forecasted before the tendering stage, and supervising the works with experienced supervisors can minimize variation orders on public building projects.

Questionnaire Survey

The respondents were grouped into three major groups namely client, consultant and contractor. The returns from the three groups are tabulated in **Table 4.2** below which shows an average response rate. Out of 45 targeted responses, only 32 (71%) of them completed and returned the questionnaire.

Table 4.2: Questionnaire return rate

Group	Number of Questionnaires distributed	Number of Questionnaires Returned	Response Rate (%)
Client	12	9	75
Consultant	5	4	80
Contractor	28	19	68
Total	**45**	**32**	**71**

In the structured part of the questionnaire, the respondents were asked to rate the degree of contribution of the variables drawn from the literature review. Furthermore, the respondents were also asked to add other variables or recommendations that they perceived as being necessary. The responses were analyzed using the Microsoft Excel software package.

From the suggested strategies identified from the literatures, fifteen (15) mutually exclusive strategies to minimize variation orders on building projects were used in questionnaire survey. The analysis was divided in to three groups the clients' point of view, the consultants' point of view and the contractors' point of view and a correlation test was done between the groups. A ranking system using the Relative Index (RI) method was

calculated to find the most significant factor. The value of RI ranges from 0.2 to 1. The value 0.2 represents the lowest strength and the value 1 representing the maximum strength.

A correlation test is done between different groups of respondents. As shown in **Table 4.3** below, the correlation coefficient indicates that there is a strong correlation between all groups. This implies that most of the respondents have the same perception about recommended strategies to minimize variation orders.

Table 4.3: Summary of correlation test on the ranking of recommended strategies

Respondents	Rho(ρ_{cal}) = 1 – $\frac{6x(\sum d_i^2)}{N x (N^2 - 1)}$	Relation of the respondents
Client Vs Consultant	0.997	strong
Consultant Vs Contractor	0.998	strong
Client Vs Contractor	1.000	strong

From **Table: 4.4** below, it was possible to rank the recommended strategies to minimize variation orders. The most raked strategies from the questionnaire the response were adequate planning in advance is required by all involved parties before works start on site (RI=0.900) followed by the consultant should produce a concluding design and contract documents (RI=0.856). Drawings should be complete at tender stage (RI=0.844) was the next. The fourth ranked strategy was the consultant should co-ordinate closely at design stage (RI=0.838) and fifthly supervising the works with an experienced and dedicated supervisor (RI=0.838) are the top ranked strategies. According to the respondents, the least ranked strategy was once the tender is awarded, there should be no changes to the specifications (RI=0.638).

Table 4.4: Frequency of recommended strategies to minimize variation orders

Recommended Strategies to Minimize V.O	RI	Ranking
All involved parties should plan adequately before works start on site	0.900	1
The consultant should produce a concluding design and contract documents	0.856	2
Complete the drawings at tender stage	0.844	3
The consultant should co-ordinate closely at design stage	0.838	4
Supervise the works with an experienced and dedicated supervisor	0.838	5
Enhance communication between all parties	0.831	6
Place experienced and knowledgeable executives in the engineering and design department	0.831	7
Consultants should ensure that the design/specifications fall within the approved budget	0.825	8
Carry out detail site investigation including detail soil investigations and consider it during tendering stage	0.825	9

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Spend adequate time on pre-tender planning phase	0.806	10
Get accurate information and research with regard to procurement procedure, material and plant	0.794	11
Clients should provide a clear brief of the scope of works	0.788	12
All parties should forecast unforeseen situations	0.788	13
Have the land application or land purchase completed before awarding contracts	0.731	14
Once the tender is awarded, make no changes to the specifications	0.638	15

Discussion

According to the findings from the interview made, it was recommended to carry out detail site investigation before tendering, to produce a complete design and contract documents, there should be communication between the parties, and works should be supervised with a dedicated supervisor. As the interviewee pointed out, preparing complete detail drawings can reduce the risk of variation. They suggested that open communication among all parties involved in the project is the key to reduce variations. Experienced and dedicated supervisors can also reduce variation orders as the interviewee suggested.

According to the findings from the questionnaires ranked previously in **Table 4.4** and the interview conducted, the first most recommended strategy was consultants should produce a concluding design and contract documents. As Arain (2005) concluded, variations can be reduced with due diligence during the design stages. The controls for the frequent change in design by consultant, and inadequate working drawing details would be through systematic detailing of design. This would provide an opportunity for the consultant to review and finalize the design during the design phase.

Completing drawings at tender stage was the second most recommended strategy to minimize variation orders. Any change or modification made later will result in an additional works which leads to variations. The design team should submit complete design for tendering. This would assist in reducing the occurrence of variations during the construction phase where the impact of variations can be severe on the project.

The third most recommended strategy was to supervise works with an experienced and dedicated supervisor. This was because experienced supervisors can forecast what will happen on site from their past experience. They are also decision makers on issues related to design and the actual site condition at the right time. Experienced supervisors are also responsible for their job and this surely helps to minimize variations on the project.

Enhancing communication between all involved parties was the fourth most recommended strategy to minimize variation orders. Different parties involve in a project work differently, so a clear communication between the parties is necessary. This was because communication can increase project performance during the execution of a project.

The fifth most recommended strategy was to carry out detail site investigation including detail soil investigation and considering it during tendering. According to Baharuddin (2005), variation orders can be minimized if all the parties involved in projects are aware that preliminary works like detailed site and soil investigations before

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tendering. This was because the design and construction methodology varies from one site to the other. Even the same type of projects cannot be executed with the same cost and schedule due to difference in site conditions.

V. CONCLUSION AND RECOMMENDATIONS

The study suggested recommended strategies to minimize variation orders on public building projects. From the interview, it was repetitively suggested that designs and contract documents should be complete at the tender stage to minimize the occurrence of variation orders on public building projects. According to the findings from the questionnaires the most recommended strategy was to plan adequately before works start on site by all parties. From the interview and the questionnaire survey result, it was concluded that the following best strategies were recommended to minimize variation orders on public building projects: a concluding design and contract documents should be produced; drawings should be complete at tender stage; works should be supervised with an experienced and dedicated supervisor; enhancing communication between all parties; carrying out detail site investigation including detail soil investigations and considering it during tendering stage. It is recommended that the client should allow sufficient time to prepare an elaborately detailed project brief. This will eliminate frequent variations to the original plan of the project due to client change of mind. Variations can be minimized if consultants produce a complete design as change of design causes variations on public building projects. Direct communication among the project team is a key to eliminate variations occur due to communication gap during design and construction phase. Consultants should give sufficient time for planning and design phase, this will assist in minimizing variation orders due design changes at construction stage. A detailed design would be able to exert control to unnecessary interference from consultants or other external influences. The consultants should prepare complete contract document before the tendering stage. This minimizes variation orders occur due to change of specifications. Contractors should identify and inform the varied item of work to the client before the activity starts to reduce variations. Because the client will have sufficient time to check the varied item in different perspectives to give work order at minimum variations. There should be improvement in project management on the part of the client during project execution stage so as to minimize the occurrence of variation orders on public building projects.

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