

# Causes of Variation Orders on Public Building Projects in Addis Ababa

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**Abstract:** Variation is inevitable in construction projects due to the complex nature of the construction industry. It is common 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 exposed to variation orders. These variations are known to impact various aspects of the projects. The study investigates the various causes of variation orders on public building projects in Addis Ababa. To achieve the study objectives, through a comprehensive study of literatures review 38 common causes of variation orders were identified. A desk study, interview and questionnaire survey were carried out to identify the causes of variation orders. The desk study conducted on five selected public building projects and the causes of variation orders were identified. Interviews were made with selected experienced public building project participants for expert opinion. The questionnaire responses were analyzed using the relative index method. A triangulation method on the desk study, survey and the literatures was done to improve the validity of the findings from the study. The results indicated that design changes, incomplete contract documents, impediment in prompt decision making process, inadequate working drawing details, and change in specifications were the main causes of variation orders on public building projects. The study concluded based on the findings of the research and recommendations were forwarded to minimize the occurrence of variation on public building projects in Addis Ababa.

**Key words:** Variation order, cause, public projects, Addis Ababa

## 1. INTRODUCTION

The construction industry in Ethiopia has been on fast growing mode which plays an instrumental role in the country development. Addis Ababa in the last ten years experienced a huge volume of work in the field of constructions. Large and complex government buildings have been built, attracting domestic contractors and construction companies from all over the world. This situation coupled with inexperienced consultants and the client has led to inadequate design resulting in many changes to plans, specifications, and contract terms which resulted in variation orders. Variations and conflicts in construction projects, at work, and even in our daily lives are very common (Arain and Pheng, 2006). Variation orders have an impact on overall project performance (Ruben, 2008). This is because variations can cause substantial adjustment to the contract duration, total direct and indirect cost, or both. In most cities of the country like Addis Ababa where new infrastructure and buildings are being built, the occurrence of variation orders on public projects seems usual. Due to general background of the problem in the construction industry and the specific problem within the public buildings, there is a cause for a study to investigate the impact of variation orders on public building projects in Addis Ababa.

## 2. LITERATURE REVIEW

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. Usually, any standard form of building contract will contain a definition of a variation in terms of specific actions and activities. The building contract dictionary defined variations as alterations, additions or omissions in work, materials, working hours, work space, etc. As defined in PPA (2006) conditions of contract, "variation" is an instruction given by the engineer, which varies the works. According to FIDIC (1999) conditions of contract, "variation" means any change to the works, which is instructed or approved as a variation. Various authors had identified different causes of variation orders in construction projects both on the private and public projects. Contractual clauses relating to variation allows parties involved in the contract to freely initiate variation orders within the ambit of the scope of the work without alteration of the original contract (Ruben, 2008). But variation orders are common in construction projects, and improved understanding would require identifying their causes. The works of many researchers show that that variation has come to stay as part of the construction projects and it cut across various stakeholders. According to Sunday (2010), the main causes of variation orders on construction projects are 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. As Mohammad *et al.* (2010) identified, change of plan by the owner, substitution of materials by the owner, change in design by the consultant, errors and omissions in design, and owner's financial problems are the main causes of variation orders. Ming *et al.* (2004) noted that at a more detailed level, the causes of construction project variation are usually

generated from either design or construction activities. The design generated causes include design changes, design errors, omissions and operational improvements. Construction driven causes are often linked to the unsatisfactory site conditions that hinder good workmanship, material handling and plant operation. Ssegawa *et al.* (2002) investigated the opinion of project parties regarding the frequency of occurrence, causes, and originators of variation orders. The study found that additions and omissions are the most common cause of variations in projects, which represented about 45.7% of all variation orders in building projects. As Ruben (2008) found out, the most frequent causes of variation orders were change of schedule, specifications and design and errors in design and inadequate working drawing details. Lots of studies are conducted to identify the causes of variation orders (Mohammad *et al.*, 2010; Arain and Pheng, 2006; Sunday, 2010; Ssegawa *et al.* (2002); Ruben, 2008; Thomas and Napolitan, 1994; Fisk, 1997). The main causes of variation orders from the literatures are:

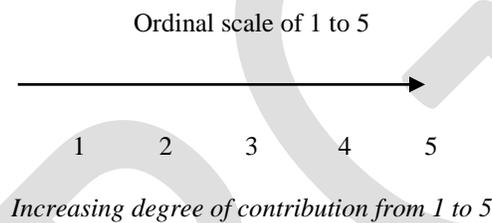
- Change of plans or scope
- Change of schedule
- Change in specifications
- Change in design
- Errors and omissions in design
- Inadequate working drawing details
- Non-compliant design with government regulations
- Impediment in prompt decision making process
- Unforeseen problems
- Replacement of materials or procedures
- Inadequate shop drawing details
- Lack of judgment and experience
- Financial problems
- Inadequate scope of work for one or more parties to the contract
- Design complexity
- Lack of communication
- Defective workmanship
- Design discrepancies
- Inadequate project objectives
- Long lead procurement
- Lack of coordination
- Fast track construction
- Ambiguous design details
- Unavailability of skills
- Weather conditions
- Lack of strategic planning
- Lack of knowledge of available materials and equipment
- Lack of involvement in design of one or more parties to the contract
- Non-compliant design with owner's requirement
- Health and safety considerations
- Lack of a specialized construction management
- Obstinate nature of one or more of the parties to the contract
- Differing site conditions
- Poor procurement process
- Conflicts between contract documents
- Value engineering
- Change in economic conditions
- Honest wrong beliefs of one or more parties to the contract
- Lack of required data
- Unavailability of equipment
- Unfamiliarity with or unawareness of local conditions
- Socio-cultural factors
- Change in government regulations
- Speculation on desired profitability
- Technology change

### 3. 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. A desk study, interview and questionnaire survey were carried out to identify the causes of variation orders on public building projects. A triangulation method on the desk study, survey and the literatures was done to improve the validity of the findings from the study. The desk study conducted on five selected public building projects and the causes of variation orders were identified. Interviews were made with selected experienced public building project participants for expert opinion. The questionnaire responses were analyzed using the relative index method. Qualitatively, the study focused to obtain the perceptions of public building construction stakeholders relative to the causes of variation orders. The variables that identified from the literatures were quantitatively measured to determine the most frequent causes of variation orders on public building projects.

The questionnaire was designed to gather data from professionals that were involved in public building projects in Addis Ababa. The respondents were asked to rate the questions on Likert's scale of five ordinal measures as shown in **Figure 3.1** below.

The ranking of the responses was by using Likert's scale of five ordinal measures which arranged in ascending order from 1 to 5. It included a total of 38 required responses.



**Figure 3.1:** Five ordinal measures by Likert Scale

The main approach used to analyze the data was by using the Relative Index (RI) technique. The responses were analyzed using the Microsoft Excel software package. The analysis included ranking the factors in terms of degree of effecting. In the computation of the relative index the following formula was used;

$$RI = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1)}{5(n_5 + n_4 + n_3 + n_2 + n_1)}$$

Where:

*RI*: Relative Index

*n*<sub>5</sub>, *n*<sub>4</sub>, *n*<sub>3</sub>, ... : number of responding indices.

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). The Spearman (rho) rank correlation coefficient for any two groups of ranking is given by the following formula:

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

Where:

- $Rho (\rho_{cal})$ : 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.

#### 4. Result Analysis and Discussion

This part of the paper analyses the data collected using questionnaires, desk study and interviews. The collected data from the questionnaires were tabulated and analyzed according to their ranking on Relative Index (RI). Interviews from selected respondents are presented, together with observations from desk study. The objective of this chapter is to identify the highest ranked factors for discussion and to find correlation with findings from the interviews and desk study.

##### Result Analysis

##### Desk Study Result

During the study period, there were a total of thirty-eight (38) public building projects which were under execution in Addis Ababa and twenty-eight (28) project samples are taken for the study. From this number five (5) completed projects in which variation orders (VO) approved were selected for desk study in order to fully understand the causes and impacts of variation orders and to determine what recommendations or strategies could be taken to minimize variation orders on public building projects. These projects were 100% completed and selected as a representative to the occurrences of variation orders of each of the public building projects. The list of selected projects is as shown in **Table 4.1**.

**Table 4.1:** List of selected public building projects

Project Code	Project Name	Contract Amount (Birr)	V.O (Birr)	Percent of V.O (%)
Project A	Sport Commission	51,931,227.89	8,284,485.09	15.95
Project B	Education Bureau	60,343,438.45	4,091,699.06	6.78
Project C	Police Commission	99,444,398.79	8,152,255.70	8.20
Project D	Credit & Savings Institution	36,914,578.87	7,234,368.3	19.60
Project E	Fire and Emergency Service	58,076,253.18	5,150,610.80	8.87

(Source: Addis Ababa Housing Development & Construction Bureau (2012))

The desk study findings showed fourteen (14) causes of variation orders. Due to the repetition, it was further syntheses to eight (8) from the most to the least repetitive causes of variation orders to be used in questionnaire for the verification and validation process to evaluate their degree of important. But all the eight causes were already the domain of the variables which identified from the literatures review. Below is the document study finding of summary of causes of variation orders from the five projects contract documents:

- Design changes
- Incomplete contract documents
- Incomplete working drawings
- Errors in design by the consultant
- Design modification
- Non-compliant design with owner's requirement
- Lack of communication between the parties
- Lack of decision making process by the client

#### Interview Result

These interviews were made between selected construction industry practitioners who are currently involved in public building projects focusing on their perceptions on 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. The interview aimed at discovering the causes of variation orders on public building projects. From the interview, sixteen (16) causes of variation orders were found. These variables were merged and checked if they were out of the literatures in order to include them in the questionnaire. But more of them with the same meaning were the domain of the variables identified from the literatures. The findings from the interview revealed that incomplete contract document, design changes, change in specifications, errors in design, unforeseen conditions, design complexity, lack of communication and coordination between the parties, lack of experience and of judgment were the causes which contribute to the occurrence of variation orders.

#### Questionnaire Survey Result

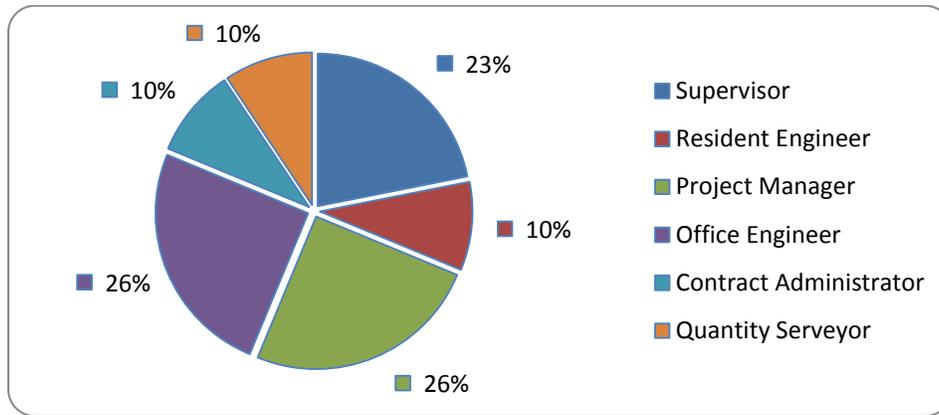
The respondents were grouped into three major groups namely client, consultant and contractor. The returns from the three groups are tabulated in **Table 4.2** below which shows an average response rate. Out of 45 targeted responses, only 32 (71%) of them completed and returned the questionnaire. Thirty one questionnaires from 9 clients, 4 consultants and 19 contractors were received.

**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
<b>Total</b>	<b>45</b>	<b>32</b>	<b>71</b>

Among the nine responses received from clients, seven (78%) of them were construction supervisors and follow-up engineers while two (22%) were contract administrators.

Among the four responses received from consultants, three (75%) of them were resident engineers and one (25%) was contract administrator. And among the nineteen responses received from contractors, eight (42%) of them were project managers, eight (42%) of them were office engineers, three (16%) were quantity surveyors. **Figure 4.1** below shows the composition of respondents by their position in their organization.



**Figure 4.1:** Position of respondents

All the respondents have different levels of work experience in building projects. It was observed that the majority of the respondents from the clients have between five to ten years of experience. Majority of the respondents from the consultants have also between five to ten years of experience. And about one half of the respondents from the contractors have less than five years of experience.

From the forty five (45) causes of variation identified from the literatures, only thirty-eight (38) mutually exclusive causes of variation orders on building projects were used in questionnaire survey. A ranking system using the Relative Index (RI) method was calculated to find the most significant factor for each section. 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 also done between different groups of respondents.

**Table 4.3:** Summary of correlation test on the ranking of causes of variation orders

Respondents	$Rho(r_{cal}) = 1 - \frac{6x(\sum d_i^2)}{N x (N^2 - 1)}$	Relation of the respondents
Client Vs Consultant	0.999	strong
Consultant Vs Contractor	1.000	strong
Client Vs Contractor	1.000	strong

From the correlation table above, it can be concluded that there is a strong correlation between the attitudes of the respondents in all the three groups. This means that most of the respondents have the same perception about the causes of variation orders.

From the questionnaires survey result, it was possible to rank the causes of variation orders combining the responses of all respondents as shown in **Table: 4.4** below. The most ranked causes of variation orders by all respondents were impediment in prompt decision making process, change in design by the consultant, and inadequate working drawing details dominate with the same value (RI=0.669). Change in specifications and poor procurement process came next with equal value (RI=0.663). Errors and omissions in design, lack of communication and unforeseen problems followed with the same value (RI=0.656) and then design discrepancies and contractor's desired profitability (RI=0.650). Change in government regulations (RI=0.456) and health and safety considerations (RI=0.425) were the least ranked causes of variation orders.

**Table 4.4:** Frequency of causes of variation orders

<b>Causes of Variation Orders</b>	<b>Overall RI</b>	<b>Ranking</b>
Impediment in prompt decision making process	0.669	1
Change in design by the consultant	0.669	2
Inadequate working drawing details	0.669	3
Change in specifications	0.663	4
Poor procurement process	0.663	5
Errors and omissions in design	0.656	6
Lack of communication	0.656	7
Unforeseen problems	0.656	8
Design discrepancies	0.650	9
Contractor's desired profitability	0.650	10
Lack of contractor's involvement in design	0.644	11
Change of plans or scope	0.638	12
Change of schedule	0.631	13
Lack of strategic planning	0.631	14
Contractor's lack of required data	0.613	15
Consultant's lack of judgment and experience	0.606	16
Conflicts between contract documents	0.600	17
Lack of consultant's knowledge of available materials	0.600	18
Consultant's lack of required data	0.594	19
Lack of coordination	0.588	20
Lack of a specialized construction manager	0.588	21
Differing site conditions	0.581	22
Unfamiliarity with local conditions	0.581	23
Non-compliant design with owner's requirement	0.575	24
Unavailability of skills	0.569	25

Defective workmanship	0.569	26
Change in economic conditions	0.569	27
Design complexity	0.563	28
Honest wrong beliefs of contractor	0.563	29
Technology change	0.519	30
Non-compliant design with government regulations	0.513	31
Weather conditions	0.506	32
Inadequate project objectives	0.494	33
Honest wrong beliefs of consultant	0.469	34
Fast track construction	0.469	35
Socio-cultural factors	0.469	36
Change in government regulations	0.456	37
Health and safety considerations	0.425	38

## Discussion

From the questionnaires, the desk study and interview, the common causes of variation orders on public building projects were design changes and incomplete contract documents, which resulted from numerous additional works.

The first major cause of variation orders was change in design by the consultant. This could also be caused due to the client change of mind. Design change is indeed one of the most causes of variation orders and this fact is supported by the interviewees and the observations in the desk study. This similarly confirms with the literature review that design change was one of the major causes of variation orders. Incomplete contract document was the second major cause of variation orders. This occurs due to the client or the consultant work before tendering and it increases the project cost or schedule. Contract documents of most public projects done by the clients and it could be difficult to prepare a complete document because they are busy of work. The third major cause of variation order was impediment in prompt decision making process, which is due to lack of judgment by the client or the consultant. There is no doubt that lack of decisions delay the project and causes the contractors to re-design the requirements, reschedule their works and material procurement which would have an adverse impact on the project. Inadequate working drawing details was the fourth major cause of variation order which is the out-come of the consultant. A well detailed working drawing is believed to decrease variation orders. Most professionals argue that a detailed working drawing should be prepared before the tender stage.

The fifth major cause of variation order was change in specifications which confirms with the literature review and the interview. In a design stage, it could be a failure to change the specification due to change of mind of the client or the consultant which results in variation orders. Consequently change in specifications can be the major cause.

## 5. CONCLUSION AND RECOMMENDATIONS

The desk study of the five projects confirmed that the most frequent causes of variation orders on public building projects was design changes. According to the interview made between three selected construction practitioners involved in public building projects they pointed out that the main cause of variation orders was design changes. From the questionnaire responses, it was concluded that impediment in prompt decision making process, change in design by the consultant, inadequate working drawing details, change in specifications, and poor procurement process were the most important causes of variation orders on public building

projects. From the findings of the desk study, interview and questionnaire, change in design, incomplete contract documents, impediment in prompt decision making process, inadequate working drawing details, and change in specifications were the major causes of variation orders on public building projects in Addis Ababa.

The recommendations of this study are as follows:

- The client should allow sufficient time to prepare an elaborately detailed project brief.
- Variations can be minimized if consultants produce a complete design.
- Direct communication among the project team is a key to minimize variations due to communication gap during design and execution 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 completed contract document before the tendering stage.
- 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 decision making process on the part of the client during project execution stage.
- The results of this research should help construction practitioners, policy makers and researchers in the field of construction management.

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