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Impact of Variation on the Cost Performance of Public Building Projects in Birnin Kebbi, Nigeria

Usman Muhammad
Lecturer, Department of Quantity Surveying,
Waziri Umaru Federal Polytechnic Birnin Kebbi, Nigeria
Abdullateef Abdul Karim Jimoh
Lecturer, Department of Quantity Surveying,
Waziri Umaru Federal Polytechnic Birnin Kebbi, Nigeria
Umar Muhammad Birnin Kebbi
Lecturer, Department of Quantity Surveying,
Waziri Umaru Federal Polytechnic Birnin Kebbi, Nigeria
Hamisu Abdullahi
Lecturer, Department of Quantity Surveying,
Waziri Umaru Federal Polytechnic Birnin Kebbi, Nigeria

Abstract:
Variations are an unwelcome but unavoidable part of any construction project, and they are the most common source of claims that lead to time and cost overruns. Projects with a lot of variation cause the contractor's production to be lower than expected. The impact of variation on the cost performance of public building projects was investigated in this study. Through a well-structured questionnaire, primary and secondary data were gathered from the Kebbi State Housing Corporation and the Kebbi State Ministry of Works and Transport, BirninKebbi, through which 58 questionnaires were administered and 52 retrieved. Correlation analysis, the Relative Importance Index (RII), the Mean Item Score (MIS), and the Relative Importance Index (RII) were used for the data analysis. Changes in specifications were determined to be the most common cause of variation on public building projects (RII = 0.96). It was also revealed that the initial and final contract sums have a strong, positive, and significant link. The most effective technique for reducing the frequency of variation was determined to be client, consultant, and contractor efforts to restrict variation orders (MIS=4.89). The influence of variation on the cost performance of public building projects was shown to be significant.

Keywords: *Variation, cost, performance, construction, public building projects*

1. Introduction

The construction industry is critical to the economic development of most countries throughout the world; it is one of the largest single industries that contribute significantly to the development of a country with abundant resources (Bruno, Fadhlin and Zuhaili, 2017). Variation has grown so common in the construction industry as a result of its compartmentalization that it is nearly impossible to complete a project without adjustments to the blueprints or the construction process itself (Sunday, 2010). The most common causes of claims that result in cost and time overrun in variation (Oladapo, 2007).

Variation has long been known to have a detrimental impact on construction productivity, resulting in a decrease in labor efficiency and, in some situations, a significant loss of man hours Variation has long been known to have a detrimental impact on construction productivity, resulting in a decrease in labor efficiency and, in some situations, a significant loss of man hours Ala'a (2012). Oladapo(2007) various studies have highlighted variation orders as one of the sources of project cost overruns Owners and contractors frequently face major challenges as a result of variations or change orders, resulting in cost overruns and costly disagreements (Zulkfili et al., 2009).

Ibbs et al. (2007) investigated the quantitative implications of project modification in construction projects and concluded that variation orders have a significant impact on project performance, since they negatively affect productivity and costs. Some cost overruns, such as those caused by unplanned events as a result of rework, are unavoidable since they cannot be reasonably avoided (Oyewobi and Ogunsemi, 2010). The magnitude of the many causes of variation described by numerous authors over the years illustrates that variation has become ingrained in building projects and affects a wide range of stakeholders. As a result, in order to minimize or limit the unfavorable circumstances that may lead to these flaws, it is necessary to evaluate and analyze the sources of variation orders in order to comprehend their effects on project cost

performance and delivery. The study determined the sources of variation on public building projects, established the influence of variation on cost performance of public building projects, and provided techniques for limiting the incidence of variation on public building projects in order to achieve the goal.

2. Literature Review

This section gives a review of relevant literature to the theme of the study. In the context of this study, 'Variation' means change, modification, alteration, revision or amendment to the original purpose of the contract and /or its works that affect building projects in terms of Cost, Time and Quality.

2.1. Variation Concept

Any materials to be utilized in the works may be changed or altered in kind or standard as part of the variation (Yusuph et al., 2017). Variations and their consequences in construction projects arise for a variety of reasons; for example, most public construction projects are subject to changes that may be induced by a change of heart or any unforeseen scope of the project voiced by any of the project participants (Yusuph et al., 2018). Furthermore, Yusuph et al. (2018) state that variations can be useful (advantageous) or detrimental (disadvantageous). Beneficial variations are those that have a positive impact on the project's cost, time, and quality. Negative variations, on the other hand, have a negative impact on the project, leading to scenarios such as increased budget, extended timeline, project abandonment, rework, interruption, and conflicts. Variations in construction projects are also a persistent concern around the world, and the situation is getting worse (Yusuph et al., 2017).

2.2. Variation Causes in Public Building Projects

A variation is an unfavorable situation in a project that has a contractual defense; it is a typical occurrence in all sorts of construction projects (Sunday, 2010). According to Abdulmalik and Abdullahi (2017), variation occurs due to a range of factors, some of which are predictable while others are not, and are classified as consultant-related, client-related, contractor-related, and other variations, which include: Changes in the project's scope, timetable, financial difficulties of the owner, impediment to timely decision-making, and the owner's obstinacy, Owner's change in specifications, design change, contract document conflicts, design complexity, insufficient working drawing details, consultant's change in specification, unavailability of equipment, skilled manpower shortage, contractor's financial difficulties, poor workmanship, poor procurement process, lack of strategic planning, and inadequate design.

In a related study by Oladapo (2007), the following causes of variation on building projects was revealed; Change in specifications, Natural occurrence (changes in weather and geological conditions, etc.), Changes in scope, Changes in government, Adjustment of PC and provisional sums, Discrepancies in contract documents. According to Andualem (2016) as cited in 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. The main causes of variation orders, according to Mohammad et al. (2010), are the owner's change of plan, substitution of materials by the owner, consultant's change in design, faults and omissions in design, and the owner's financial concerns.

2.3. The Effect of Variation on Public Building Project Cost Performance

Variations are an unwelcome but unavoidable reality of any construction project, but they have a negative impact on project delivery in terms of increased project cost, which is one of the most common effects of variation as cost performance of building projects, quality degradation, cause reworks and demolition, delay in completion, logistic delays, health and safety issues, professional relations, and laborer productivity (Abdulmalik and Abdullahi, 2017). Changes that occur during construction will harm every project, according to a related study conducted by Zulkfili (2009). As a result, anytime a change occurs, the contractor must adapt the contract's work and reallocate time, material, and labor resources. Increases in project cost, hiring new professionals, increases in overhead expense, delays in payment, quality degradation, productivity degradation, procurement delay, rework and demolition, logistics delays, damage to firm's reputation, poor safety conditions, poor professional relations, disputes among professionals, and additional payments for contract modifications were all revealed in the study.

Cost overruns in construction projects have obvious consequences for key stakeholders and the construction sector as a whole. Cost overrun means additional costs over and above those agreed upon at the start, resulting in lower returns on investment for the end user. The additional costs are passed on to the end user as increased rental/lease charges or prices. To experts, cost overrun indicates a failure to give value for money, which could destroy their reputations and cause clients to lose faith in them. Cost overrun means additional costs over and above those agreed upon at the start, resulting in lower returns on investment for the end user. The additional costs are passed on to the end user as increased rental/lease charges or prices. To experts, cost overrun indicates a failure to give value for money, which could destroy their reputations and cause clients to lose faith in them. If the contractor is found to be at fault, it means a loss of revenues due to non-completion, as well as defamation, which could damage future job opportunities.

2.4. Strategies for Reducing Variation Incidence in Public Building Projects

Minimizing variations will undoubtedly save you time and money (Tiware and Kulkarni, 2013). In fact, in any sector, a finished product must meet a specific level in order to deliver customer pleasure and the expected value for money (Basheka and Tumutegyereize, 2013). Furthermore, practically all clients in the construction industry want fully

functional buildings delivered on time, on budget, and with the quality and scope they expect. This is only achievable if variances are effectively discovered, understood, and controlled at all stages of a building project's development. As a result, the project management team must have the necessary knowledge, skills, and abilities to deal with the day-to-day challenges of change management (Zadeh et al., 2016).

Any construction project, by definition, develops in a sequential manner and requires interaction among many project participants; as a result, a clear and complete project brief is essential for describing the project objectives to all project participants (Yusuph et al., 2018). As a result, design flaws and non-compliance with the owner's requirements may be reduced, and the size of deviations in all stages of project development may be minimized. However, past research has revealed both parallels and variations in terms of variation mitigating factors. This scenario could be due to differences in investigation methodologies and locations, including efforts by the client, consultant, and contractor to control variation orders, comprehensive site investigation, clear project specifications, engagement of a project manager to manage the project teamwork spirit, proper use of project data compiled by the client, variation logic and justification, and use of knowledge base on previous related projects. Initiatives to combat corruption, the value of indirect effects, the control of variation orders arising from contractual clauses, and the adoption of a restricted tendering technique for awarding projects.In a study conducted in Turkey, Abdul Rahman et al. (2012) found that cost variationis the most significant issue that the construction industry suffers globally. According to their findings, some of the most effective strategic planning to be met for cost variation to be minimized to its barest point includes: Effective site administration and supervision, as well as proper project planning and scheduling Meetings to discuss progress on a regular basis, proper emphasis on previous experience, experienced subcontractors and suppliers are used. Appropriate construction methods are used. Make use of the most up-to-date technology. Channels of communication and information that are clear, Coordination between the parties on a regular basis, Perform a project task and resource planning exercise prior to the start of construction.

3. Methodology of Research

The five-point Likert's Scale format was used to create the structured questionnaires used to collect data for the study. To meet the research objectives, RII, MIS, and correlation were used to evaluate the data obtained. A table was also created to collect data on ten (10) recently completed projects spanning the years 2015 to 2020. The formula given in Equation 1.0 and 2.0 is used to apply RII and MIS for data analysis in this study.

(W)/RII = (W)/RII = (W)/RII = (W)/ (A X N)

..... (1.0)

Where A=5 is the maximum value of weight (i.e. highest factor), W = the weights of each of the factors reported by respondents and was in the range of (1 - 5), and N is the total number of respondents.

MIS = (W)/(N)..... (2.0)

Where: = Total number of responses, W = Weight, and N = Summation

Correlation coefficient (R)

Correlation is strong if R is less than 50%, according to the decision rule.

Correlation is weak if R is less than 50%.

Table 1 summarizes the decision rule used for the RII and MIS analyses.

SCALE	Cut-Off Point		Interpretation			
	RII	MIS	Frequency of Occurrence	Level of Importance	Level of Significance	Level of Effectiveness
5	0.81 - 1.00	4.51 - 5.00	Very Often	Very Important	Very Significant	Very Effective
4	0.61 - 0.80	3.51 - 4.50	Often	Important	Significant	Effective
3	0.41 - 0.60	2.51 - 3.50	Fairly Often	Fairly Important	Fairly Significant	Fairly Effective
2	0.21 - 0.40	1.51 - 2.50	Less Often	Less Important	Less Significant	Less Effective
1	0.00 - 0.20	1.00 - 1.50	Rarely	Least Important	Least Significant	Least Effective

Table 1: Data Analysis Decision Rule
Source: Adapted and Modified from Shittu et al. (2015)

The RII results of the reasons of variation on public building projects, of which 21 factors were found, are presented and discussed in this part. Table 2 shows the outcomes of the RII.

S/No	Causes	RII	Rank	Decision
1	Change in specifications	0.96	1st	Very often
2	Owner's financial problems	0.89	2nd	Very often
3	Change in economic conditions	0.84	3rd	Very often
4	Replacement of materials or procedures	0.83	4th	Very often
5	Change in government	0.77	5th	Often
6	The change of plans or scope by owner	0.77	5th	Often

S/No	Causes	RII	Rank	Decision
7	Errors and omissions in design	0.75	7th	Often
8	Change in design by consultant	0.73	8th	Often
9	Technology change	0.73	8th	Often
10	Design complexity	0.71	10th	Often
11	Inadequate working drawing details	0.70	11th	Often
12	Impediment in prompt decision making process	0.68	12th	Often
13	Lack of coordination	0.63	13th	Often
14	Conflicts between contract documents	0.61	14th	Often
15	Poor procurement process	0.60	15th	Fairly often
16	Shortage of skilled manpower	0.59	16th	Fairly often
17	Unforeseen problems	0.56	17th	Fairly often
18	Discrepancies in contract documents	0.52	18th	Fairly often
19	Safety considerations	0.46	19th	Fairly often
20	Weather conditions	0.44	20th	Fairly often
21	Socio-cultural factors	0.43	21st	Fairly often
	Average	0.68		Often

Table 2: Causes of Variation on Public Building Projects
Source: Researcher's Data Analysis (2021)

Table 2 demonstrated that change in specifications was ranked first (1st) among the reasons, with a high degree of frequency and a RII score of 0.96. Other reasons of variance are rather common (RII = 0.61–0.77) and (RII = 0.43–0.60), respectively. Causes of variation on public building projects occur frequently on average (RII = 0.68). As a result, the RII ranged from 0.43 to 0.96, with an average of 0.68. This finding is consistent with Abdulmalik and Abdullahi (2017), who found that the most common causes of variance were the owner's financial concerns and changes in specification.

3.1. Impact of Variation on the Cost Performance of Public Building Projects:

The results of descriptive data analysis utilizing the Relative Importance Index (RII) are presented and discussed in this part, as shown in table 3.

S/No.	Impact	RII	Rank	Decision
1.	Increase in project cost	0.94	1st	Very Important
2.	Quality degradation	0.90	2nd	Very Important
3.	Delay in completion	0.87	3rd	Very Important
4.	Health and safety issues	0.80	4th	Important
5.	Cause reworks and demolition	0.80	4th	Important
6.	Logistic delays	0.79	5th	Important
7.	Professional relations	0.73	6th	Important
8.	Increases in overhead expense	0.70	7th	Important
9.	Productivity degradation	0.65	8th	Important
10.	Disputes among professionals	0.60	9th	Fairly Important
11.	Completion schedule delay	0.55	10th	Fairly Important
12.	Procurement delay	0.54	11th	Fairly Important t
	Average	0.74		Important

Table 3: The Effect of Variation on Public Building Project Cost Performance
Source: Researcher's Data Analysis (2021)

Table 3 shows the impact of twelve (12) different variables on the cost performance ofpublic building projects. The most significant impacts were an increase in project cost, a reduction in quality, and a delay in completion (RII = 0.94, 0.90, and 0.87, respectively). Six (6) of these effects are deemed significant. These issues vary from health and safety concerns (RII = 0.80) to productivity loss (RII = 0.65). The remaining three impacts were deemed to be of moderate importance. Professional disagreements, completion schedule delays, and procurement delays all have RIIs of 0.60, 0.55, and 0.54, respectively. With an average RII of 0.74, the impact of variance on cost performance is significant. This is in line with the findings of Abdulmalik and Abdullahi (2017), who highlighted Quality degradation as the most significant cost performance impact of variance.

3.2. Inferential Data Analysis on Impact of Variation on Cost Performance of Public Building Projects

Pearson Correlation was employed as a tool for inferential analysis in the study to establish the impact of variation on cost performance of public building projects. In the quest to achieve this, Archival data were collected on Initial Contract Sum (ICS) and Final Contract Sum (FCS) from ten (10) recent projects as shown in table 4.

PROJECT	ICS (₦)	FCS (₦)	CD (₦)	Difference %
A	52,000,000.00	95,000,000.00	43,000,000.00	33.33
B	26,000,000.00	82,642,907.00	56,642,907.00	188.89
C	35,000,000.00	54,000,000.00	19,000,000.00	13.89
D	1,200,000.00	4,000,000.00	2,800,000.00	75
E	10,526,000.00	41,286,333.26	30,760,333.26	28.57
F	15,776,450.00	28,000,000.00	12,223,550.00	66.67
G	12,500,000.00	64,014,562.68	51,514,562.68	100
H	34,783,530.00	98,000,000.00	63,216,470.00	81.25
I	4,577,850.00	28,539,600.00	23,961,750.00	166.67
J	52,175,295.00	1,263,533,000.22	1,211,357,705.22	180
			Average	93.43
			Min.	13.89
			Max.	188.89

Table 4: Research Data
Source: Researcher's Survey (2021)
Note: Initial Contract Sum (ICS), Final Contract Sum (FCS). Cost Difference (CD)

4. Results and Discussion for Pearson Correlation Analysis

One analysis was carried out using the Pearson Correlation Analysis in order to establish the impact of variation on cost performance of public building projects. The results of these analyses are summarized in Table 5 and discussed below

Analysis No.	Variables		Observations		Inferences	
	X_1	X_2	R (%)	P_{value}	Strength of Relationship	Remark
1	Initial Contract Sum	Final Contract Sum	71.00	0.000	Strong	S

Table 5: Results of Pearson Correlation Analysis
Source: Researcher's Data Analysis (2021)
KEY:Stands for Significant

The analysis revealed that the original contract sum and the final contract sum have a strong, positive, and substantial association. The R value (correlation coefficient) was found to be 71%, showing a substantial degree of relationship between the variables. The positive correlation between the variables suggests that an increase in the original contract sum will result in an increase in the final contract sum, and a decrease in the initial contract sum will result in a drop in the final contract sum.

4.1. Results of the Strategies for Mitigating Variation in Public Building Projects

This section presents and discusses the findings of the Mean Item Score (MIS) ranking of the solutions for minimizing the incidence of variation. Table 6 summarizes the outcomes of the identified strategies.

S/No	Strategies	MIS	Rank	Decision
1	Effort by client, consultant and contractor to control variation orders	4.89	1st	Very Effective
2	Use of proper project scheduling techniques	4.72	2nd	Very Effective
3	Clear project specifications	4.50	3rd	Effective
4	Engagement of a project manager to manage the project teamwork spirit	4.48	4th	Effective
5	Comprehensive site investigation	4.40	5th	Effective
6	Proper use of project data compiled by client	4.37	6th	Effective
7	Effective site management and supervision	4.21	7th	Effective
8	Frequent progress meeting	4.00	8th	Effective
9	Clients involvement during construction phase	3.89	9th	Effective
10	Prompt written approval procedures	3.80	10th	Effective
11	Use of knowledge base on previous related projects	3.75	11th	Effective
12	Clear information and communication channels	3.67	12th	Effective
13	Initiatives aimed at curbing corruption	3.54	13th	Effective
14	Use up to date technology utilization	3.43	14th	Fairly Effective
15	Use of experienced subcontractors and suppliers	3.00	15th	Fairly Effective
	Average	**4.04**		**Effective**

Table 6: Strategies for Mitigating Variation on Public Building Projects
Source: Researcher's Data Analysis (2021)

In Table 6, fifteen (15) effective solutions for minimizing the occurrence of variation on public building projects have been found. These solutions range from the client, consultant, and contractor working together to restrict variation orders (MIS = 4.89) to the use of experienced subcontractors and suppliers (MIS = 3.00), both of which are fairly effective. The discovered techniques for reducing the incidence of variation have an average MIS of 4.04, indicating that they are effective and capable of reducing the incidence of variation.

5. Conclusion

The major goal of the customer is to complete their project on time and on budget, which should also be the emphasis of the consultant who is representing the client in accomplishing the project's cost, time, and quality objectives. The impact of variation on the cost performance of public building projects has been highlighted in this study. Following an exhaustive literature research and analysis, it was determined that there are four (4) main sources ofvariation on public building projects, the most common of which is a change in specifications. The most effective technique for limiting the occurrence of variation has been shown to be an effective effort by the client, consultant, and contractor to restrict variation orders. The initial contract sum and the final contract sum have a strong, positive, and substantial relationship. However, it is ultimately found that variation has a major impact on the cost performance of public building projects.

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