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Evaluating the Cause and Effects of Variation Order in Building Construction at Knust, Kumasi, Ghana.

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A B S T R A C T

In building projects, Variation Order (VO) is a common occurrence. It entails a modification of the contract's original scope of work. VO is induced by a number of reasons. Variations can lead to disagreements and discontent among building project participants. Controlling VOs in a construction project is therefore critical. The first objective is to define and comprehend the causes and effects of VO. As a result, the goal of this research is to identify the major causes and impacts of VO in building projects in KNUST. Data was gathered through semi-structured questionnaires and observations utilizing qualitative methodologies. This research exposes the significant factors that caused variation order in building construction in knust which shows that, lack of appropriate site information before design stage, change in design by consultant, error and omission in design, failure of contractor to provide the requied materials form outsourcing, of which the effect these factors had on building construction were the delay in payment, cost overruns and time overruns The research recommends that, Clients should always opt for professional supervisors of possible experienced project managers to supervise their projects, Detailed and comprehensive site investigation should be done at the design phase to avoid delays and variations, Preparation of good estimate should be done for preparation of BOQ, Stakeholder should act promptly when confronted with issues that may lead to variation order in building construction, contractors must hire an experienced staff based on the project requirement and timeline.

Keywords: KNUST, Construction, Variation Order (VO), Bill of Quantity (BOQ)

1. Introduction

It is vital to identify the strong relationship between design and construction process at the onset of any project. These procedures should be considered as part of a larger system. Design, in general, is the process of defining the characteristics of a new facility, which is usually represented by comprehensive plans and specifications; construction planning, on the other hand, is the process of identifying the activities and resources needed to make the design a physical reality. As a corollary, construction is regarded as the completion of a drawings produced by architects and engineers. Numerous operational tasks must be completed in both design and construction, with a variety of precedence and other relationships among the various tasks .Tunde, R. et al. (2015) In an integrated system, design and construction planning can almost run concurrently, examining various options that are desirable from both perspectives and avoiding the need for extensive revisions under the guise of value engineering. Additionally, as the project develops from planning to design, an evaluation of designs for constructability can be carried out. For example, if the sequence of a structure's assembly and the key loadings on a partially constructed structure during construction are carefully examined as part of the overall structural design, the design's effects on construction false work and assembly details can be predicted. .Tunde, R. et al. (2015

Designers create the graphic and written representations that contractors and subcontractors use to bring concepts and ideas to life. Inadequate and incomplete design and documentation have a direct impact on the project's physical reality (Tuloli et.al, 20211). While the design must be "effective," it must also be communicated successfully through paperwork (drawings, specifications, and Bills of Quantities), as well as a qualified contractor and subcontractors who can help turn the concepts and ideas into physical reality (Balbaa et.al, 2019).

The issue of variation during building is one of the most serious issues confronting the construction project. Variation can also be referred to as a change order, a variation order, or a variation instruction. In any building project, these modifications are unavoidable. When there are several variations, the situation may become worse. Variations order are unavoidable in every building project; thus, they must be carefully managed (Arain et al., 2015).

The owner's needs may change during the design or construction process, market conditions may force modifications to the project's characteristics, and technical advancements may affect the design and engineer selection. The engineer's examination of the design may result in adjustments that improve or optimize the design and, as a result, the project's operations. Errors and omissions in engineering or construction may also necessitate a change. All of these issues, as well as a slew of others, need costly and typically unwelcome modifications (Elshaikh, E. et al. 2019). Adjustments in drawings and contract documentation most often result in a change in the contract price or schedule. Contractual conflicts are also more likely as a result of variations (Sunday, O. A. 2010).

There are two categories of variants: positive and negative variations. Variations that are beneficial to the project's quality, cost, schedule, or degree of difficulty are known as beneficial variations. Variations that reduce owner value or have a negative impact on a project are known as detrimental variations (Muhammad, N. Z. et al. 2015). When the opportunity arises, the project team should be able to take advantage of beneficial variations. The necessity of making changes to a construction project is a normal occurrence. Even the most carefully orchestrated project may require adjustments due to a variety of factors. When the problem is studied collectively as early as possible, the variations can be minimized because the problems can be identified and beneficial changes can be made Pourrostam, T. et al. (2012)

Variation order

Variation Orders and Change Authorization both relate to the same thing: a 'Change' to the scope of work, or Change of Work Scope in Indonesian. The terms 'Charge Order' are commonly used in the United States, while the terms 'Variation Order' are more widely used in the United Kingdom. (Amoatey, C. T. et al. (2015).

Some references to contract terms that use the FIDIC (International Federation of Consulting Engineers) as a foundation use the term 'Variation,' which has the same meaning. Once it has been returned in terms of what is used in a mutually approved Work Contract to define the project's change (change) (M.karim, et al 2020).

According to clause 13 of the FIDIC, a contract change is defined as a variation or adjustment. All changes to the Work that are ordered or accepted as a change under Clause 13 [Variation and Adjustment] are referred to as variations. While adjustments are a form of variation, there are two types of adjustments: adjustments due to changes in rules and adjustments owing to cost changes. External project issues such as delays in work owing to legislative changes and changes in project expenses due to lowering foreign exchange rates cause changes in modifications .Mohammad, N. and Hamzah, Z. (2019)

There is a difficulty with variation order on site, which has an impact on the project's work completion objective and the company's profit target. According to Oyewobi, L. O. et al. (2016), a significant number of changes might have a cumulative and unsettling effect. If the impact is not compensated for in the variation sequence, the work time performance may suffer. Some research questions can be formed based on the description that has been reviewed in the background and problems of this research:

Figure 2.1: Operational Model Scheme(Desyardi Et Al., 2019)

In building projects, Variation Order (VO) is a common occurrence. It entails a modification of the contract's original scope of work. VO is induced by a number of reasons. Variations can lead to disagreements and unhappiness among building project participants (Pourrostam, T. et al. (2012). Variation orders have become a prevalent problem in Ghanaian building projects, arising from a variety of sources and having a detrimental influence on projects.

According to Balbaa, A. A. K. et al. (2019) 17.3 percent of Malaysia's 417 government contract projects were considered sick in 2005. (suggesting projects that were either delayed more than three months or completely abandoned). According to a research conducted by the Social Security and National Insurance Trust (SSNIT) in 2013, around 4,700 state housing projects in Ghana have been stopped or abandoned for a variety of reasons (Ndihokubwayo, R. and Haupt, T. C. (2015). Understanding the issues with variation orders is critical to completing successful projects in this regard.

Muhammad, N. Z. et al. (2015) distinguished between two forms of variation: helpful and detrimental variation. A beneficial variation is an adjustment made to a project's quality, budget, timeline, or technical concerns (Ndihokubwayo, 2014). Harmful variation is a difference that has a detrimental impact on the client's or project's value. Client, consultant, contractor, and other modifications were identified as four essential assets . The following are some of the changes

Owner related variations: Modifications in the job description or the project management plan can occur for a variety of reasons, including illegal project planning or the owner's failure to engage in the design process. These changes can lead to deviations from the contract amount (Tunde, R. et al. (2015). Owner’s financial problems significantly affect project implementation because of the impact on the cash flow and the cost management plan. This may increase project time as they may force the owner to change the material, specifications or quality to reduce financial requirements (Elshaikh, E. et al. (2019) Inadequate project objectives, The owner must define the project objectives. Otherwise, the designer may lose time during project design with many constraints that may cause changes during construction and affect project progress (Halwatura, R. U. and Ranasinghe, N. P. N. P. (2013). Professionals should participate in the design phase to help clarify project objectives and recognize that their requirements are not met in the early stages (Memon et al., 2014). Replacement of materials can be due to the landlord’s financial problems or a change in specifications by the owner and this may lead to changes during the construction phase and changing procedures may result in differences in the method of application (Balbaa, A. A. K. et al. (2019)). An impediment to the prompt decision-making process, owners, must make quick decisions, especially; during project construction in order to prevent any delay based on late decisions by the owner, otherwise there will be a change in project schedule and cost (Memon, A. H., Rahman, I. A. and Hasan, M. F. A. (2014) The obstinate nature of the owner if the owner is obstinate, this may lead to change orders during the execution of the project due to the consequences of decisions and orders made by the owner that do not match the vision of the professional at later stages of the project (Aldibat

Albtoosh, far A. and tarmazi haron, A. (2017). Change in specifications by owner. This may occur for many reasons such as insufficient project objectives or a change in design or financial problems (Amoatey, C. T. et al. (2015). Employer intervention may result in late intervention by the employer during the design stage and the construction phase and the delay in the review and approval may affect the progress of the project).

Consultant related variations: Change in design by the consultant is mainly for design improvement. The consultant may have to make changes in design, specifically on projects that construction starts before the design is finished (Balbaa, A. A. K. et al. (2019). Also, this may occur when the design is revised by the consultant who may have a different view of the design or due to the rescheduling of work (Mohammad et al., 2019). The change in design by the consultant is mainly for improving the design, the consultant may resort to changes in design and specifically on projects that begin construction before the design is finished (Oyewobi, L. O. et al. (2016). This may also occur when the consultant revised the design and may have a different opinion of the design or rescheduling of the work (Mohammed et al., 2019). Variation may occur due to errors and omissions in design drawings depending on the time of error detection (Sunday, O. A. (2010) Any conflict in contract documents may increase in time and cost. So, contract documents must be clear and precise If the final time of value engineering is delayed, it may lead to variation and iincreasedcosts. Change in the specification by the consultant commonly occurs due to inadequate project objectives. This may result in change requests and may increase the project budget and schedule (Balbaa, A. A. K. et al. (2019)). Poor work drawings may cause errors during construction, causing variations. These differences may affect the progress of the work, since, rework may be required that may cause delay and increase in cost (M.karim, K. H., Ali, N. and Majeed, B. (2020).

Contractor related variations: Contractors have creative and practical ideas that make designs more actual and applicable many variations may occur because of the lack of involvement of the contractor in the design phase of the project (M.karim, K. H., Ali, N. and Majeed, B. (2020). Contractors must have a good procurement and resource plan and any procurement problem may lead to variation during the construction phase and affect the completion of the project (Elshaikh, E. et al. (2019). Projects with new technologies need special resources and skilled manpower; variations may occur due to unavailability of skills and may affect the project schedule (Elshaikh, E. et al. (2019The contractor's financial problems may affect the progress of the project due to financial obligations where the contractor must pay the worker's wages regardless of whether the owner pays the contractor or not and the failure of these obligations may affect the quality and implementation of the project (Pourrostam, T. et al. (2012)The desire profitability of the contractor may cause variation as it is considered as additional financial rewards for additional works resulted from variations. Variation may occur due to unexpected site conditions such as different soil conditions or unforeseen problems in the construction of the substructure that could not be found during the contractor's site investigation which may require additional cost and time to be added and request changes (Tunde, R. et al. (2015)Poor workmanship may result in demolition and rework that may affect project progress and increase project budget . It would be difficult to the contractor with unfamiliar local conditions to carry out work that may result in variations and increase time and cost of the project (Sunday, O. A. (2010)). Fast-track construction needs a well-organized system to carry out the independent project activities otherwise high risk of variations may occur during construction that may affect project execution, increasing the total cost and the time of the project (Sunday, O. A. (2010). The poor procurement process may result in variations and affect project cycle, causing delay project completion . Long lead procurements affect the project schedule and may affect project construction. The contractor may be forced to accelerate the construction process to deliver the project on time which may result in changes due to the increased cost and additional workmanship • Oyewobi, L. O. et al. (2016) The supplier or subcontractor is a major problem, especially, if the site management is bad. It is highly anticipated that there will be poor coordination among sub-contractors of different disciplines and may lead to changes and delays of the project .

Project management related variations: Lack of coordination between parties may affect project execution and may result in variations and dissatisfaction of the owner (M.karim, K. H., Ali, N. and Majeed, B. (2020). Lack of communication between parties has a negative effect on project execution and causes rework, demolition and major variations (M.karim, K. H., Ali, N. and Majeed, B. (2020). Lack of strategic planning is normal in projects that construction starts before the finishing of the design The failure of meeting the safety regulations and requirements may cause variations. Also, safety is a very important factor to finish the project successfully .

Other related variations: Bad weather for outside activities may cause an increase of the overall duration and cost where extra days to be added to compensate for the delayed days.Pourrostam, T. et al. (2012)Change in economic conditions and a regulation is one of the most significant factors that may cause variations on the project cost and may affect the duration of the project execution (Pourrostam, T. et al. (2012)).

Causes of Variation Orders in Construction

Change in schedule: During the building phase of a project, a change in timeframe may necessitate a significant reallocation of resources. A shift in the schedule will need the contractor to either offer additional resources or keep certain resources idle. Additional costs are incurred in both scenarios (M.karim, K. H., Ali, N. and Majeed, B. (2020).

Change of scope: One of the most common causes of variation in construction projects is a change in the plan or scope of the project, which is usually the result of insufficient planning during the project definition stage or a lack of involvement of the owner in the design phase.

Owner's financial problems: The owner's financial difficulties may have an impact on the project's progress and quality. This issue can cause modifications in work timelines and standards, lowering construction quality (M.karim, K. H., Ali, N. and Majeed, B. (2020).

Inadequate project objectives: Inadequate project objectives can lead to variation in construction projects, limiting the designer's ability to create an acceptable design and perhaps leading to modifications later in the construction process).

Impediment to prompt decision-making process: The ability to make quick decisions is critical to project success (• Balbaa, A. A. K. et al. (2019). Failure to make a timely choice may result in a delay, necessitating the use of a modification order due to cost increases.

Obstinate nature of the owner: A construction project is the outcome of the united efforts of the specialists engaged, who must work at numerous project interfaces (Balbaa, A. A. K. et al. (2019). If the owner feels apprehensive, this could lead to significant changes in the project's final stages.

Change in specifications by the owner: In construction projects with inadequate project objectives, specification changes are common). If these changes in the design or requirement specification are carried out, the construction phase would be affected.

Change in design by the consultant: In today's professional practice, a consultant's change in design enhancement is the norm (Arain et al., 2014). In projects where construction begins before the design is finalized, design changes are common . Depending on when the modification occurs, it has a variety of effects on the project.

Design complexity: Complex designs necessitate specialized talents and construction techniques (M.karim, K. H., Ali, N. and Majeed, B. (2020). The flow of construction operations is affected by complexity, but smaller and linear building projects are generally simple to manage (Fisk, 2010).

Inadequate working drawing details: Working drawings must be clear and concise in order to convey a complete concept of the project design . Inadequate working drawing details can lead to a misinterpretation of the project's actual requirements (Arain et al., 2014), resulting in project variations.

Effects of Variation Orders in Construction

Delay in completion; Variations frequently impede project progress, causing delays in meeting project milestones during construction). According to Aldibat Albtoosh, far A. and tarmazi haron, A. (2017), a deviation can cause projects to be delayed by 9% of their original planned period. According to Elshaikh, E. et al. (2019), who studied delays in Hong Kong construction projects, 50 percent of the projects evaluated were delayed due to variances. The contractor would strive to adapt the variances by utilizing the free floats in the construction schedules in order to reduce the project's delay.

Increase in project cost; The most common effect of variations is an increase in project cost (CII, 2011). Any changes or additions to the design made during the project's execution may result in the demolition or rework of any project component, raising the project's cost (Elshaikh, E. et al. (2019). As a result, in order to maintain the overall project cost, a contingency payment is often allotted in every construction project to account for unexpected project changes. Variations also necessitate processing procedures, paper work, and reviews prior to implementation.

The process and implementation of construction project changes would increase overhead costs for all parties involved. Normally, the contingency budget set up for the construction project is used to cover these costs.

Quality of projects: Variations have a negative impact on work quality . According to CII (2011), frequent deviations have a negative impact on work quality since contractors must adjust for losses by reducing corners.

Causes rework: If the deviations appear while the construction is underway or even completed, they frequently result in rework and demolition (Pourrostam, T. et al. (2012). (CII, 2011). Modifications during the building phase are to be expected, however variations during the design phase do not necessitate any rework or demolition on construction sites.

Logistics delays: Variations may necessitate the purchase of new or additional materials and equipment, resulting in logistical delays Logistics delays are one of the primary repercussions of differences in construction projects, according to Muhammad, N. Z. et al. (2015)

2. Methods and Materials.

2.1 Source of data

To achieve the objectives set for this research, the data sources adopted were both primary and secondary sources. The primary data was collected through personal interviews, observations, and investigations.

Secondary sources were also obtained from books and other publications such as government statistical records, and official local records. (example written reports, internet sources, and websites).

2.2 Population and Sampling Technique.

The target population for this research was therefore people who possessed information that was crucial to the study. The study targeted 65 respondents representing the sample size for the research project. These include; Architects, Quantity Surveyors, Consultants, clients and Building Engineers. These people were then used as informants to identify other projects which qualified to participate in the study. The process will be continued until no more substantial information is obtained through additional respondents.

The non-probability sampling was adopted for this study since not all population members in these institutions have the opportunity to participate in the research hence there is randomization and it also allows for the sample to be representative, which increases reliability.

The multi-sampling method was used in this research. This is because the study involves a case study method in which the sample to be interviewed are comprised of sub-groups and individuals as well as key respondents. Therefore, each group had different methods of sampling since the information needed called for such a technique. The sampling methods included purposive and convenience sampling techniques. This method was used for selecting key respondents namely Architects, Quantity Surveyors, Consultants, contractors, clients, and Building Engineers due to the nature of the information needed.

2.3. Sample Size Determination.

In qualitative studies, the concept of saturation was suggested to achieve a suitable sample size (Glaser and Strauss, 1967). Saturation happens when more respondents do not add extra data or views to the research.

For ethnography research, approximately 30 to 50 participants have been suggested and interviews for grounded theory are also suggested to be 30 to 50 respondents (Morse, 1994), meanwhile, Creswell (2009) suggests only 20 to 30 respondents for the interviews. In the case of, phenomenological studies, 5 to 25 participants have been suggested by Creswell (2009).

From the above, it can be realized that these recommendations are only estimations on how many participants a researcher will need and that the number of participants will ultimately be dependent on when saturation is reached.

3. Results and Discussion

3.1 Background Respondents

The questionnaires were circulated to the targeted respondents to identify the most common and relevant factors that cause variation order in building construction. The survey questionnaires were distributed to clients, architects, quantity surveyors and engineers who have been involved in construction. 65 stakeholders who were intended for the questionnaires were selected from both institutions.

3.2 Respondents Gender

The gender of respondents in the field of building construction was considered, due to the nature of the topic. All of them (100%) are corporate members of their professional societies. Table 4.1 evidently shows the work experience of the respondents in KNUST.

Table 3.1 Respondents (Gender)

	KNUST		**UENR**	
Gender	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Male	39	86.7	15	75.0
Female	6	13.3	5	25.0
Total	45	100	20	100

Source: Field Survey Data (August, 2021)

Table 3.1 reveals the gender of the respondents on the field. From the table out of the 45 professional respondents considered on KNUST campus, 39 out of the 45 respondents were male representing (86.7%), followed by 6 out of 45 respondents representing (13.3%) as it has been demonstrated in Figure 4.1.

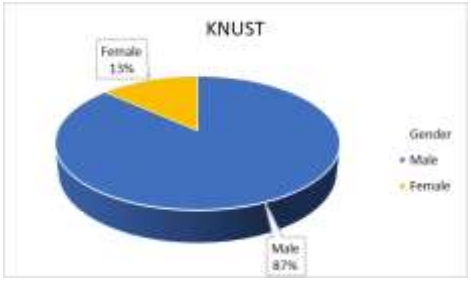

Figure 3.1: Gender (KNUST) (Field Survey Data (August, 2021)

3.2.2 Respondent Age Range

The age range of respondents in the field of building construction was considered. The ages for all the respondents range from 20-60 years. Also, all of them (100%) are corporate members of their professional societies. Table 4.2 evidently shows work experience of the respondents both in KNUST

Table 3.2 Respondents (Age Range)

	KNUST	
Age Range	**Frequency**	**Percentage (%)**
Between 20-29 Yrs.	14	31.1
Between 30-39 Yrs.	16	35.6
Between 40-49 Yrs.	8	17.8
Between 50-59	4	8.9
60yrs And Above	3	6.7
Total	45	100

Source: Field Survey Data (August, 2021)

Table 4.2 reveals the age range of the respondents in relation to the number of years spent on the field. From the table out of the 45 professional respondents considered on KNUST campus, 14 out of the 45 respondents were between the age of 20-29years representing (31.1%), 16 representing (35.6%) between the age of from 30-39years, 8 representing 17.8% between the ages of 40-49 years, 4 representing 8.9% also between the ages of 50-59 years and finally 3 out the 45 representing 6.7% were above 60 years as it has been demonstrated in Figure 3.3

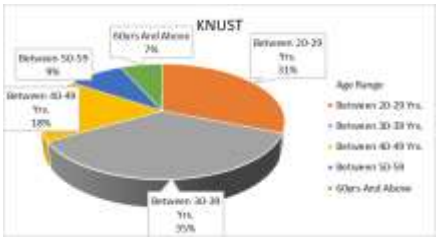

Figure 3.3: Age (KNUST) (Field Survey Data (August, 2021)

3.2.3 Respondents Working Experience

Experienced respondents in the field of building construction were considered, due to the nature of the topic. The construction work experience for all the respondents ranges from 1-20 years. Also, all of them (100%) are corporate members of their professional societies. Table 4.3 evidently shows work experience of the respondent in KNUST

Table 3.3 Respondents (working Experience)

	KNUST	
Years Range	**Frequency**	**Percentage (%)**
1-5 Years	9	20
6-10 Years	12	27
11-15 Years	6	13
16-20 Years	10	22
20years above	8	18
Total	45	100

Source: Field Survey Data (August, 2021)

Table 3.3 reveals the level of experience of the respondents in relation to the number of years spent on the field. From the table out of the 45 professional respondents considered on KNUST campus, 12 out of the 45 respondents had the range of 6-10years representing (27%), followed by 10 out of 45 respondents representing (22%) with working experience ranging from 16-20years as it has been demonstrated in Figure 3.5.

Figure 3.5: Working Experience (KNUST) (Field Survey Data (August 2021)

3.2.4 Respondents Professional Designation

The profession of the respondents in the field of building construction were also considered. They were mainly architects, engineers, quantity surveyors, project managers and clients as evidently shown in Table 3.4

Table 3.4 Respondents Professional Designation

	KNUST	
Years Range	**Frequency**	**Percentage (%)**
Architect	9	20
Engineer	10	22
Quantity Surveyor	11	24
Project Manager	8	18
Client	7	16
Total	45	100

Source: Field Survey Data (August, 2021)

The results from Table 4.4 have represented in Figure 4.7 below shows that most of the respondents on KNUST campus (24%) are Quantity Surveyors, (22%) are Civil Engineers, and (20%) are architects, (18%) are project Managers while 7 out of the 45 respondents representing (16%) are Client.

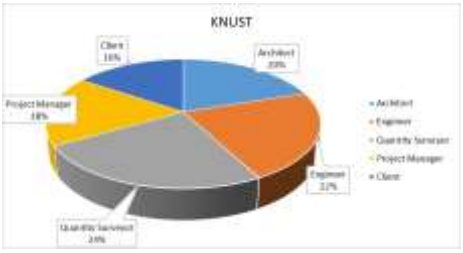

Figure 4.7 Professional Designation (KNUST) Source: Field Survey Data (August, 2021)

4.2.5 Respondents Types of Project

Respondents in KNUST based their answers to the research questions given them on the experience they have had handling some of the listed projects in Table 4.5. According to the Experts, they encountered this problem (Variation Order) in the course of executing these project

Table 3.5 Respondents Type of Project

	KNUST	
Years Range	**Frequency**	**Percentage (%)**
Residential Building	15	33
High Rise Building	5	11
Commercial Building	2	5
Estate Building	3	7
Public Building	20	44
Total	45	100

Source: Field Survey Data (August, 2021)

Table 3.5 gives a clear picture of projects Experts in both institutions KNUST based their experience on variation order on. From Figure 4.9 below 20 respondents out of 45 representing the majority (44%) on KNUST campus said they mostly encounter variation order challenge in the construction of Public Buildings, 15(33%) respondents also going in for residential building and 5(11%) for high rise building 3(7%) estate building and finally 2(5%) for commercial building.

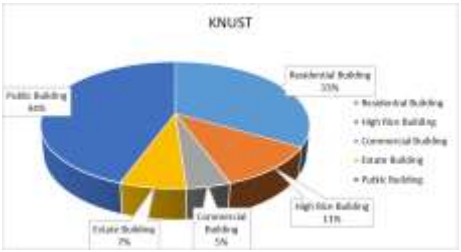

Figure 3.9 Types of Projects (KNUST) Source: Field Survey Data (August, 2021)

3.3 Summary of Causes of Variation Order in Building Construction (Analysis II)

The Figures below show the ratings by respondents on the various causes of variation order in building construction. The rating ranges from 1 to 5, where 1 is the least impact and 5 is the highest impact. The final results are summarized below .

3.3.1 Respondents from KNUST

Figure 3.3.1. Time overrun as an effect of variation order was ranked on a scale of 4, out of the 45 respondents who responded to this question 25 respondents believed it to have a great effect on projects

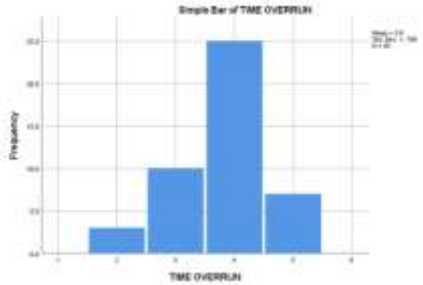

Figure 3.3.1 Time overrun as an effect of variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.1 Time overrun as an effect of variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.2. Cost overrun as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 24 respondents believed it to have a great effect on projects

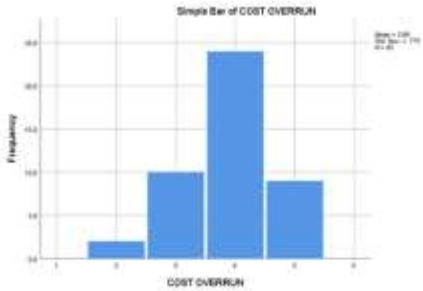

Figure 3.3.2 Cost overrun as an effect of variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.3. Dispute between contract parties as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 23 respondents believed it to have a great effect on projects.

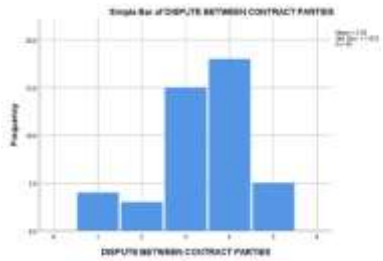

Figure 3.3.3 Dispute between contract parties as an effect of variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.4. Delay in payment as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 31 respondents believed it to have a great effect on projects.

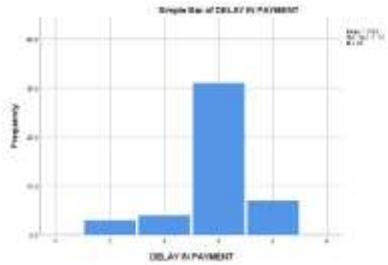

Figure 3.3.4 Delay in Payment as An Effect of Variation (KNUST) Source: Field Survey Data (August 2021)

Figure 3.3.5. Additional specialist equipment & staff as an effect of variation order was ranked on a scale of 3, because out of the 45 respondents who responded to this particular question 18 respondents believed it to have a moderate effect on projects.

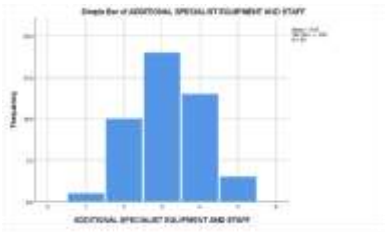

Figure 3.3.5 Additional Specialist Equipment & Staff as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.6. Degradation of quality standards as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 15 respondents believed it to have a great effect on projects.

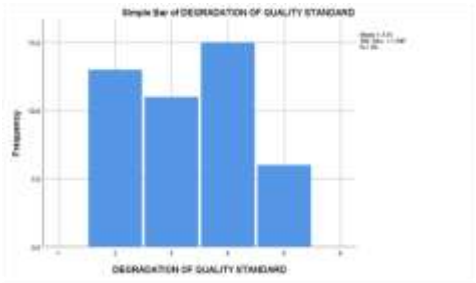

Figure 3.3.6 Degradation of Quality Standards as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.7. Productivity degradation as an effect of variation order was ranked on a scale of 3, because out of the 45 respondents who responded to this particular question 19 respondents believed it to have a moderate effect on projects.

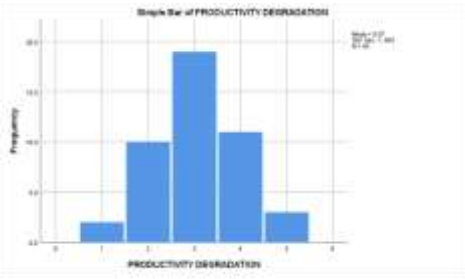

Figure 3.3.7 Productivity Degradation as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.8. Rework and demolition as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 21 respondents believed it to have a great effect on projects.

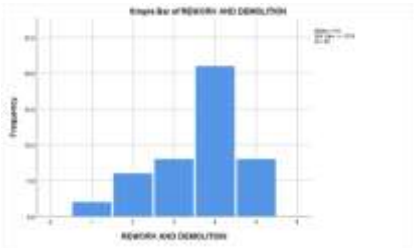

Figure 3.3.8 Rework and Demolition as An Effect of Variation (KNUST) Source: Field Survey Data (August 2021)

Figure 3.3.9. Logistics delays (Procurement delay) as an effect of variation order was ranked on a scale of 4, because out of the 45 respondents who responded to this particular question 26 respondents believed it to have a great effect on projects.

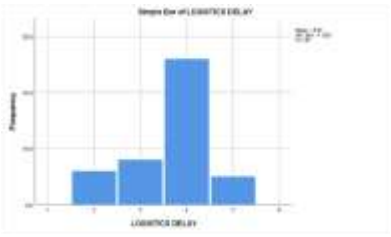

Figure 3.3.9 Logistics Delays (Procurement Delay) as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021

Figure 3.3.9 Logistics Delays (Procurement Delay) as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021)

Figure 3.3.10. Additional payment for contractors as an effect of variation order was ranked on a scale of 4, there was a break-even between the 45 respondents who responded to this particular question 16 respondents believed it to have a great effect on projects

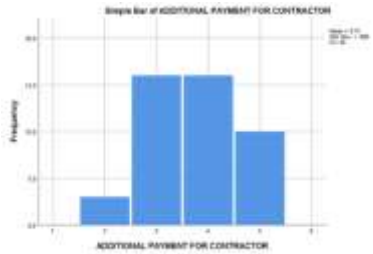

Figure 4.4.10 Additional Payment for Contractor as An Effect of Variation (KNUST) Source: Field Survey Data (August, 2021)

3.3.2 Discussion of Results (Effect of Variation Order)

Table 3.6 below shows the summary of the rating of the effects of variation order in building construction agreed by KNUST. The score represents the various rating while the effects of variation order are the various effects rated according to their impart from respondents from the institution. From the table, the effects of the variation order with the highest impact on construction are grouped under score 5 and the effects with the least impact are also grouped under scored 1.

Out of the 10 effects given,3 of these effects was rated on the same score by the respondents from both KNUST as explain in the table below;

Table 3.6 Effects of Variation Order Agreed on By Both Institution

Score	**Effects of Variation order Agreed by Both Institution**
1 *Very low impact*	-
2 *Low impact*	-
3 *Medium impact*	-
4 *High impact*	➢ Additional payment for contractor
5 *Very high impact*	➢ Rework and demolition ➢ Logistics delays (Procurement delay)

Source: Field Survey Data (August, 2021)

From the table above it can be understood that out of the 10 effects given to the respondents from KNUST, they both agreed that;

- Additional payment for contractor
- Rework and demolition
- Logistics delay (procurement delay)

are some of the effects of a variation order in building construction they have encountered in their years of working.

3.4 Discussion of Results

As discussed earlier, table 3.5 was used to rate the mode of the causes and effects of variation order in building construction as they were rated by KNUST respondents.The purpose of this section is to find the major causes and effect of variation order in building construction as suggested by respondents from the from Knust. The means to determine these factors is the Relative Importance Index (RII).

The relative important index RII is a statistical mean of determining the ranking of various causes and effects of variation order in building construction. Since the study focuses the relative significant causes and effects of variation order in building construction, this method was adopted. The method is adopted in this study in diverse groups such as Client, Architects, Quantity Surveyors and Engineers. As a result of the relatively small sample size and to achieve a relevant result, the analysis had put together all the groups of respondents. The relative important index (RII)= (∑W)/A*N, where RII is the relative important index, W is the weighting given to each other by the respondents, A is the highest weight and N being the total number of respondents. The Relative Important Index (RII) value had from 0 to 1. The higher the value of the relative important index, the more important is the cause of variation order. Results from the respondents have been tabulated below.

The tables below are the summary of the data collected. All calculation was done using the Relative Important Index (RII) formula stated above. Results from the respondents are analyzed using the Relative Importance Index tool to determine the most significant causes and effects of variation order in building construction.

3.4.1 Discussion of Results (causes KNUST)

Table 3.7 and 3.8 show summary of the views of respondents, their RII and mean in KNUST on causes of variation order.

Table 3.7 Ranking the Causes of Variation Order (KNUST)

Frequency and percentages (n=45)

No	**Factors**	**Very Low Impact**	**Low Impact**	**Medium Impact**	**High Impact**	**Very High Impact**	**Mean**	**RII**	**Rank**
		1	**2**	**3**	**4**	**5**			
1.	Change in design by consultant during construction stage	-	9 (20%)	9 (20%)	19 (42%)	8 (18%)	3.58	0.72	2nd
2.	Errors and omissions in design	2 (4%)	5 (11%)	20 (45%)	14 (31%)	4 (9%)	3.29	0.66	9th

3.	Conflict between contract documents	3 (7%)	22 (49%)	10 (22%)	5 (11%)	5 (11%)	2.71	0.54	17th
4.	Lack of coordination among project parties in design stage	1 (2%)	2 (4%)	22 (49%)	18 (41%)	2 (4%)	3.4	0.68	6th
5.	Design complexity	4 (9%)	15 (34%)	11 (24%)	11 (24%)	4 (9%)	2.91	0.58	13th
6.	Time limitation in the design phase	-	7 (16%)	16 (36%)	20 (44%)	2 (4%)	3.38	0.68	7th
7.	Inadequate working drawing details	-	11 (24.4%)	11 (24.4%)	11 (24.4%)	12 (26.7%)	3.53	0.71	3rd
8.	Change in plan and scope by owner	1 (2%)	8 (18%)	14 (31%)	15 (33%)	7 (16%)	3.42	0.68	5th
9.	Owner's financial difficulties	-	8 (18%)	14 (31%)	16 (35%)	7 (16%)	3.47	0.70	4th
10.	Change in specification of materials and procedure by owner	4 (9%)	5 (11%)	19 (43%)	15 (33%)	2 (4%)	3.13	0.63	12th
11.	Lack of appropriate site information before design stage.	1 (2%)	2 (4%)	12 (27%)	20 (44%)	10 (23%)	3.8	0.76	1st
12.	Failure of the contractor to provide the required material from outsourcing	4 (9%)	11 (24%)	12 (27%)	9 (20%)	9 (20%)	3.18	0.63	11th
13.	Lack of specialized construction manager	11 (24%)	14 (31%)	9 (20%)	4 (9%)	7 (16%)	2.6	0.52	19th
14.	Misunderstanding of contract documents during cost estimate stage	5 (11%)	14 (31%)	18 (40%)	3 (7%)	5 (11%)	2.76	0.55	15th
15.	Contractor's desired profitability	6 (13%)	17 (38%)	13 (29%)	4 (9%)	5 (11%)	2.67	0.53	18th
16.	Changes in the BOQ of work	4 (9%)	5 (11%)	20 (44%)	11 (25%)	5 (11%)	3.18	0.64	10th
17.	Weather conditions	2 (4%)	19 (42%)	15 (34%)	7 (16%)	2 (4%)	2.73	0.55	16th
18.	Change in macro-economic conditions	3 (7%)	5 (11%)	21 (47%)	7 (15%)	9 (20%)	3.31	0.66	8th
19.	Extension of time	8 (18%)	13 (29%)	9 (20%)	7 (15%)	8 (18%)	2.87	0.57	14th

Source: Field Survey Data KNUST (August, 2021), (- = No responds)

From the table above, the causes of variation order in building construction according to the respondents from KNUST are arranged in order of importance, thus 1 being a major cause and 19 being a least cause according to the respondents from this institution;

1. Lack of appropriate site information before design stage
2. Change in design by consultant during construction stage
3. Inadequate working drawing details
4. Change in plan and scope by owner
5. Lack of coordination among project parties in design stage
6. Time limitation in the design phase
7. Change in macro-economic conditions

8. Errors and omissions in design
9. Changes in the BOQ of work
10. Failure of the contractor to provide the required material from outsourcing
11. Change in specification of materials and procedure by owner
12. Design complexity
13. Extension of time
14. Misunderstanding of contract documents during cost estimate stage
15. Weather conditions
16. Conflict between contract documents
17. Contractor's desired profitability
18. Lack of specialized construction manager
19. Owner's financial difficulty

3.4.2 Effects of Variation Order in Building Construction

Table 3.8 shows a summary of the views of respondents, their RII and mean of effects of variation order

Frequency and percentages (n=45)-KNUST									
No	**Effect**	**No Effect 1**	**Little Effect 2**	**Moderate Effect 3**	**Great Effect 4**	**Extreme Effect 5**	**Mean**	**RII**	**Rank**
1.	Time overruns	-	3 (6.7%)	10 (22.2%)	25 (55.6%)	7 (15.6%)	3.8	0.76	3rd
2.	Cost overruns		2 (4.4%)	10 (22.2%)	24 (53.3%)	9 (20.0%)	3.89	0.78	2nd
3.	Dispute between contract parties	4 (8.9%)	3 (6.7%)	15 (33.3%)	18 (40.0%)	5 (11.1%)	3.38	0.68	7th
4.	Delay in payment	-	3 (6.7%)	4 (8.9%)	31 (68.9%)	7 (15.6%)	3.93	0.79	1st
5.	Additional specialist equipment & staff	1 (2.2%)	10 (22.2%)	18 (40.0%)	13 (28.9%)	3 (6.7%)	3.16	0.63	9th
6.	Degradation of quality standards	-	13 (28.9%)	11 (24.4%)	15 (33.3%)	6 (13.3%)	3.31	0.66	8th
7.	Productivity degradation	2 (4.4)	10 (22.2%)	19 (42.2%)	11 (24.4%)	3 (6.7%)	3.07	0.61	10th
8.	Rework and demolition	2 (4.4%)	6 (13.3%)	8 (17.8%)	21 (46.7%)	8 (17.8%)	3.6	0.72	6th
9.	Logistics delays (Procurement delay)	-	6 (13.3%)	8 (17.8%)	26 (57.8%)	5 (11.1%)	3.67	0.73	5th
10.	Additional payment for contractor	-	3 (6.7%)	16 (35.6%)	16 (35.6%)	10 (22.2%)	3.73	0.75	4th

Table 3.8 Effects of Variation Order in Building Construction (KNUST)

Source: Field Survey Data (August, 2021),

Information from Table 3.8 (KNUST) shows the major effect of variation order arranged in order of their impact on the project as suggested by the respondents from KNUST.

The effect is arranged from 1 to 10 with the 1st effect having more effect on projects then the 10th effect as they have listed below;

1. Delay in payment

2. Cost overruns
3. Time overruns
4. Additional payment for contractor
5. Logistics delays (Procurement delay)
6. Rework and demolition
7. Dispute between contract parties
8. Degradation of quality standards
9. Additional specialist equipment & staff
10. Productivity degradation

Conclusion

The results obtained from this study is not much different from that obtained from literature. This means, as long as the demand for infrastructure increases, the rate of construction will also increase. For instance, literature revealed that the causes of variation order in building construction are client, consultant, contractor and other changes, that includes; Owner related variations such as;

• Change in plan and scope by owner

• Owner's financial difficulties,

• Change in specification of materials and procedure by owner,

Contractor related variations such as;

• Failure of the contractor to provide the required material from outsourcing

• Contractor's desired profitability,

And finally, Project management related variations such as;

• Lack of specialized construction manager

• Design complexity

And the effects of variation order literature revealed are; Delay in completion, increase in project cost, Causes rework and Logistics delays.

Finally, the most significant causes and effect of variation order in building construction in KNUST are listed below

Causes

• Lack of appropriate site information before design stage

• Change in design by consultant

• Error and omission in design

• Failure of contractor to provide the required materials from outsourcing

Effects

• Delay in payment

• Cost overruns

• Time overruns

Variation order cannot be exempted from building construction projects, there is the need for all the stakeholders in the industry to work in hand to curb the situation.

In the opinion of the respondents, the main causes and effect are;

Main causes

• Owners financial difficulties

• Lack of coordination among project parties in design stage

• Change in macro-economic condition

• Changes in the BOQ of work.

Main effects

• Logistics delays (Procurement delay)

• Reworks and demolition

4.1 Objective One

To evaluate the significant factors that causes and affects variation order in building construction in KNUST .

From the study, it was found that variations order in building construction are bound to occur due to certain factors which can be grouped under four main headings, namely; clients, contractors, consultant and third-party related factors. From the study, it could be realized that if factors such as Owners financial difficulties, Lack of coordination among project parties in design stage, change in macro-economic condition, Changes in the BOQ of work are identified and controlled, variation order which occur during construction shall be reduced. The highest impact which is averagely ranked as 0.80 for Lack of appropriate site information before design stage and the lowest impact which is 0.475 for Lack of specialized construction manager using the relative Importance Index (RII) tool. It could be stated emphatically that whenever the above factors are controlled in a project the variation order experienced in building construction can be avoided..

4.2 Objective Two

To identify the various effects of variation order in building construction in KNUST.

From the study, variation can have both negative and positive implication on the construction industry. According to the responses from the respondents from both institutions, variation order being it negative effects could result in Logistics delays (Procurement delay), Reworks and demolition of work as well. The project can be demolished or redone due to certain factors such as lack of skilled labor on site and the use of inferior material for construction as a result of Contractor's desire for profitability.

4.3 Objective Three

To understand the views of the stakeholders in the building construction industry concerning variation order in building construction.

From the responses obtained from the respondents, it could be stated that the respondents know about the negative impacts of variation on construction of projects and that it is gradually becoming a normal phenomenon such that they are so familiar with some of the variation such as Inadequate working drawing details. Again, 90 percent of the respondents agreed that the variation order when considered critically can be controlled in building construction.

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