ASSESSMENT OF THE EFFECT OF VARIATION ON THE PERFORMANCE OF PAVED ROAD PROJECTS IN UGANDA- A CASE OF UGANDA NATIONAL ROADS MAINTENANCE PROGRAM-RWENZORI REGION

BY

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A DISSERTATION SUBMITTED TO KYAMBOGO UNIVERSITY DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE DEGREE IN CONSTRUCTION TECHNOLOGY AND MANAGEMENT OF KYAMBOGO UNIVERSITY

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CERTIFICATION

This is to certify that we have read and hereby recommend for acceptance by Kyambogo University, a dissertation titled: **"Assessment of the effect of variation on the performance of paved road projects in Uganda- A case of Uganda national roads maintenance program-Rwenzori Region"** in fulfilment of the requirements for the award of a degree of Master of Science in Construction Technology and Management of Kyambogo University.

……..….. Date …….

Assoc. Prof.. Muhwezi Lawrence (Supervisor)

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DECLARATION

I, Lukala Justine, hereby declare that this submission is my own work and that to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree of the university or other institute of higher learning, except where due acknowledgement has been made in the text and reference list.

Signature: _____ Date: _____

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DEDICATION

This dissertation is dedicated to my Mother Mrs. Abedi Contensia and my beloved wife Mrs. Joyce Lukala for the great support they offered to see me attain a success through my studies.

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LIST OF ABBREVIATIONS/ACRONYMS

AC	Asphalt Concrete
ACODE	Advocates Coalition for Development and Environment
BMAU	Budget Monitoring and Accountability Unit
DBST	Double Bituminous Surface Treatment
EOT	Extension of Time
FY	Financial Year
GDP	Gross Domestic Product
LHS	Left Hand Side
MoFPED	Ministry of Finance, Planning and Economic Development
MoMs	Mean of Means
MoWT	Ministry of W orks and Transport
NDP	National Development Plan
NPA	National Planning Authority
RHS	Right Hand Side
SPSS	Statistical Package for Social Sciences
UNBS	Uganda National Bureau of Standards
UNRA	Uganda National Roads Authority
UNRWA	United Nations Relief and Works Agency
URF	Uganda Roads Fund
UTB	Uganda Tourism Board
VEC	Vector Error Correction

ABSTRACT

The Ugandan government has outlined infrastructure development as government priority. However, escalation in cost and time overruns of paved road projects is leading to lower density of roads network. This study was conducted in the Rwenzori region in Uganda considering Kyenjojo – Fort Portal (50km) road, Fort Portal – Hima (55km) road, Hima - Katunguru (58km) road and Katunguru - Ishaka (58km) road rehabilitated under Uganda National Roads Maintenance Program. Both qualitative and quantitative data were collected using survey questionnaires from a sample size of 79 elements and documentary reviews. Data on causes of variation, impacts and mitigation strategy actions were analyzed using IBM SPSS and ranked through mean item scores. The study revealed that delayed issuing of approval documents, changes in scope of works and changes in design were the highly ranked client's causes of variation. Changes in design, design flaws and delayed decision making were common with consultant whereas poor coordination and project management, delayed acquisition of permits and shortage of skilled manpower were highly ranked contractor's causes. Delayed project completion, increased project cost and rework and demolitions were the highly ranks impacts of variation. The mitigation strategy actions to control variation and enhance performance were; adequate planning and availability of fund before works start on site, detailed site investigation at pre-construction stage while comprehensive design and financial reviews, client expedite approvals and decision making were recommended at construction stage. In Project performance (PP) model, impacts of variation (Iv) ranked highest with 34.08%, followed by mitigation strategy to control variation (Mv): 33.27%, then causes of variation (Cv): 32.65%. The research recommends a study on developing an appropriate approach of capturing data with regard to variation in paved road rehabilitation projects.

Key words: *Variation, Paved roads, Project performance, Model, Rwenzori Region*

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Investment in infrastructure is at an all-time high globally (Thacker et al., 2019) as it is essential for development (Tortajada, 2014). Orr and Kennedy (2008) estimated the infrastructure projects demands to be between $40 trillion and $50 trillion over the next two decades. Globally, public construction projects has been characterized by the occurrence of cost overrun (Sinesilassie et al., 2018) and delayed completion times due to changes in scope of works such as design changes (Habibi & Kermanshachi, 2018; Durdyev et al., 2017). The World Bank (2009), estimated the total global coverage of paved roads to be over 69% globally and 67% in developing countries by 2019.

In Africa, there is scanty information about the present levels, historical progression, and linkages of transportation infrastructure (Jedwab & Storeygard, 2019). The World Bank (2011) established that compared to any other world regions, Africa had the lowest spatial density of roads with only 204 km of roads per 1000 km^2 of land area falling below the world average of 944 km/1000 km^2. This anomaly according to World Bank is attributed to limited involvement of stakeholders in implementation, decision making, and monitoring processes. To address this anomaly, most African countries have undertaken swift measures including policy reforms, much as Banaitiene (2006) highlighted that these reforms have also not fully improved the performance of roads in Africa. Whereas the road transport use dominates over 80% of most African countries, their conditions remains very poor by international standards with an average of about 43% of the major road network in good repair and maintenance condition, 30% in good condition, and the remaining 27% in poor condition (World Bank, 2011).

The bulk and quality of infrastructure services positively affects growth and therefore, by investing in larger infrastructure stocks African countries are likely to gain more (Calderón, 2009) due to the strong relationships between investment in transportation and the resultant economic development (Jedwab & Storeygard, 2019).

Building projects especially within the public sector in developing countries are susceptible to variation due to the alterations in original project scopes (Perera et al., 2021). Variation is among the contentious concerns as it impacts on the project cost and timeline (Noruwa et al., 2020; Aftab et al., 2014; Hao et al., 2008). Further, variation poses negative impact on construction productivity, leading to a decline in labor efficiency and a considerable loss of man hours (Ala'a, 2012). In some cases, the cost of variation can be as high as 100% of the original budget, much as the industry standard on variation cost should be around 10% (Arain and Pheng, 2005).

Various scholars have studied construction project performance (Yan et al., 2020; Crowther et al., 2021; Oke et al., 2020; Vahabi et al., 2020). Ultimately, project performance can be measured through a number of performance indicators such as time, cost, quality, client satisfaction, client changes, business performance, functionality, profitability, health and safety (Shahrzad and Hamidreza, 2011). Project success can be categorized as objective measures of implementation time, cost, quality, safety and environmental considerations, and project participant satisfaction (Chan and Chan, 2004; Crawford and Pollack, 2004). However, by focusing on the above measures, important success determinant characteristics such as the effects of relevant political, legal and economic systems, market conditions, specific location, weather and environmental concerns, level of technological advancement, value of a project, quality of a project etc. are all not considered (Cho, 2009).

Institutional reforms have been initiated to improve infrastructure performance through the establishment of additional institutions such as the Uganda National Roads Authority and the Uganda Roads Fund (to finance road maintenance). In spite of the efforts made, the explanations for poor quality roads, service delivery delays and cost overruns on road infrastructure projects in Uganda continue to evade the project implementers (Barasa, 2014). Furthermore, despite an increase in the road sector fund allocation in the national budget, service delivery pointers has continue to linger below the expected levels (Bogere, 2013).

In the Rwenzori region, no matter how hard the consultants, contractors and clients tried, the road was never completed as per the budgeted cost, scheduled time and scope. This was evident for instance in the Kyenjojo – Fort Portal road (50km), Fort Portal - Hima (56 km), Hima – Katunguru road (58 km) and Katunguru – Ishaka (59 km) rehabilitation projects which were never completed within the scheduled time and scope.

1.2 Statement of the Problem

Road infrastructure is a key factor in socioeconomic development and every country make every effort to invest on roads. However, these are done at a cost, which are affected by a number of factors. Paved road projects faces challenges such as variation in quality, project completion time and cost and these negatively affect the performance of road projects. These cost and time overruns are attributed to variation/changes in the scope of works, delayed payments and inadequate design among others.

The sharp rise in road construction costs in Uganda has long been a subject of debate. Road rehabilitation projects are never completed within the estimated time, cost, quality and scope.

The Minister for Tourism, Wildlife and Antiquities, Maria Mutagamba (2013) on world tourism day stated that the poor road network in Rwenzori region could hurt the tourism industry if nothing is done to repair them. The Rwenzori region is home to several tourist attractions such as National parks and crater lakes. However, the roads that lead to the tourist's sites are in a very poor state, which hinders access to areas rich in wildlife.

Correspondingly, the four roads in the Rwenzori area were slated for rehabilitation by the government; Kyenjojo – Fort Portal (50km) Road, Fort Portal – Hima (55km) Road, Hima - Katunguru (58km) Road and Katunguru - Ishaka (58km) Roads which are under rehabilitation have failed to get completed as planned. The cost and time have gone far beyond the original plan.

Escalation in time and cost overruns of paved road projects has led to lower density of road network and resulted into an increase of roads in poor condition, an increase of unfunded road development and maintenance projects leading to premature failure of roads, low economic activities due to increased travel time, safety is uncertain. An upsurge in the accumulation of unfunded road maintenance could cause more roads to slide from lower-cost maintenance interventions to higher-cost reconstruction interventions.

Developing models that inform ways of managing variation in project at pre-construction and construction stages is envisaged to reduce time and cost overruns while achieving the desired quality to improve the performance of paved road projects. This is hoped to culminate into financial savings thus more paved road projects.

1.3 Objectives of the Study

1.3.1 Main Objective

The main study objective was to assess the effect of variation on the performance of paved road projects in Rwenzori Region, Uganda.

1.3.2 Specific objectives of the study

i. To establish the causes of variation on paved road projects in Rwenzori Region, Uganda.;
ii. To determine the impacts of variation on the performance of paved road projects in Rwenzori Region, Uganda..;
iii. To suggest management system for the mitigation of variation on paved road project in Rwenzori Region, Uganda.

1.4 Research Questions

The questions below were used to direct the study in order to give the correct answers to the study.

i. What are the causes of variation on paved road projects in Uganda?
ii. What is the impact of variation on performance of paved road projects in Uganda?
iii. What mitigation strategy actions can be used to control variation and enhanced performance of paved road projects in Uganda?

1.5 Justification of the study

The Minister for Tourism, Wildlife and Antiquities, Maria Mutagamba (2013) on world tourism day stated that the poor road network in Rwenzori region could hurt the tourism industry if nothing is done to repair them. The Rwenzori region is home to several tourist attractions such as National parks and crater lakes. However, the roads that lead to the tourist's sites are in a very poor state, which hinders access to areas rich in wildlife. Yet tourism

accounted for UGX. 6,888.5bn or 7.3% of Uganda's GDP in 2017. In addition, the tourism sector created 229,000 jobs for Ugandan residents (UTB report, 2017).

MoFPED (2017) report indicated that the government has outlined road infrastructure development as government priority assuming that once roads are made it would spur growth in: agriculture, tourism, oil and gas, land value, and real estate which would in turn spur employment. The public is concerned why the road project was never completed within the estimated time, quality, scope and cost. BMAU (2017) observes that 80% of construction projects for roads experience time delays, while 40% have cost overruns. BMAU (2017) attributes time and cost overruns to changes or changes in scope of work, late payments, and inadequate design. Yet financing road projects is challenged owing to the fact that Uganda Government's obligation arrears stand at 1.997 trillion Uganda shillings, representing 13%, more than the maximum allowable 3%, of the approved budgets (MoFPED, 2017). Continuous accumulation of government arrears leads to reduced government economic activities, delayed payment to contractors' certificates leading to increased interest, inflation, and low coverage of paved road network. The purpose of this study is to propose a model to enhance performance of paved road projects for efficient use of grant budget, planning time, and optimization of quality for more paved road networks.

1.6 Significance of the study

The National Development Plan identified the major physical infrastructure deficits that are constraining the country's development potential as lying in the sectors of transportation, energy, water for production and communications (NPA, 2010). In response to this, Uganda road sector received Shs 4.7 trillion (14.5%) Shs 4.6 trillion (21%) of the Country's budget in FY 2018/2019 and 2017/2018 respectively. However, UNRA's mission focuses on the

development and maintenance of national road network in response to Uganda's economic development needs and this was thwarted by the road projects' poor performance. The goals of optimizing quality, timeliness, cost-effectiveness, and ensuring the safe and efficient mobility of people and goods across the country have become very difficult to achieve (MoWT, 2017).

Despite Uganda's attempts to advance road infrastructure projects performance, the exact reasons for project delays, overruns in project cost and poor quality paved roads remain unclear. The study gives knowledge about project variation causes, impacts, and mitigation strategy actions to minimize variation on road projects which are crucial factors for improving performance of paved road construction projects. Additionally, the study provides recommendations for mitigation strategic actions to minimize changes to paved road projects. This leads to improved client's/stakeholders' satisfaction through a safe and efficient mobility of goods and services. The study also provides a platform for future research on pavement performance enhancement management.

1.7 Scope of the Study

1.7.1 Geographical scope

The road rehabilitation projects under Uganda National Roads Maintenance Program - Rwenzori region included; Kyenjojo-Fortportal (50km), Fort Portal- Hima (55km) and Hima – Katunguru (58km) road and Katunguru - Ishaka (58km): These roads were selected to improve regional movements within the North Western and southern parts of Uganda and international linkage through Lamia and Mpondwe on the border with the Democratic Republic of Congo (DRC) and Katuna on the border with the Republic of Rwanda. The roads promote growth in Agriculture and tourism industry and reduce vehicle-operating costs. However, the projects have experienced a lot of delays and cost overrun to the extent where

some of the projects were divided into two contracts. The delayed completion and cost overrun on these projects have caused frustration to the government development plan. Therefore, the study was limited to these four projects which are inter-linked for easy access to the data required for the study. All the four roads had exceeded their expected completion time and achieved substantial completion. The data from the four roads rehabilitation projects are believed to be representative of road rehabilitation projects under the program for the entire country.

1.7.2 Content scope

The study investigated causes of variation, impacts of variation, established measures to reduce variation at both pre-construction stage and construction stage and developed a model for enhancing the performance of paved road projects in Uganda, Rwenzori region.

1.8 Operational definitions

1.8.1 Performance

Performance relates to the accomplishment of a given task measured against pre-set known standards of accuracy, completeness, cost, and speed (Bierbusse and Siesfeld, 1997). The concept of project performance has not been clearly defined in the construction industry (Ingle and Mahesh, 2016). In construction project, performance is understood as the quality of the operation of a construction site, and also how successful the site's operation is (Salminen 2005). However, the concept of project performance is being developed in many ways as criteria for evaluating the success of a project (Arazi et. al., 2011). But, there is no single uniform measure for project success and the success criteria vary from project to project (Kylindri et. al., 2012). Construction projects are always measured at least by comparing achievements to project objectives, determined by budget and schedule. However, project performance can be estimated from numerous stakeholder viewpoints, emphasizing discrete measures of performance.

1.8.2 Quality

Traditionally, quality means conformance to standards such as the design and specifications. Quality in project delivery is viewed as meeting and exceeding the clients' standards and specifications in accordance with construction design details (Netscher, 2015). As such, quality-based yardsticks of performance have focused mainly on issues such as the quantity of deficiencies created and the cost of quality. In this study, the term "quality", refers to the absence of defects like cracks, riding comforts, absence of reworks, proper drainage and absence of environmental issues.

1.8.3 Time

This refers to the period undertaken to achieve the stated goal and objectives.

1.8.4 Cost

This refers to the expenditure incurred to achieve an objective.

1.9 Conceptual framework

A conceptual framework is an illustration of what the researcher expects to find through research. Its purpose is to show a relationship between the dependent and independent variables under study. The conceptual framework in Figure 1.1 explains how variation affects the performance of paved road projects. Variation takes on dimensions of causes, impact and measures for mitigation of the impacts while performance takes on dimensions of time, quality and cost. The causes of these variation may be borne by the Client, Consultant or the Contractor.

Particular to well-defined schedule of works, the optimum project performance is realized if the work progress runs efficiently within the period, budget and designed quality. However, it is sheldom that a project performs according to scheduled due to several reasons such as variation on the design drawings or contract. Since there are variations in road construction

projects, there exists causes of these variations. They also affect the road performance in terms of time, cost and quality. This calls for mitigation measures to help in reducing the severity of the impacts which should be implemented at all the stages of the project.

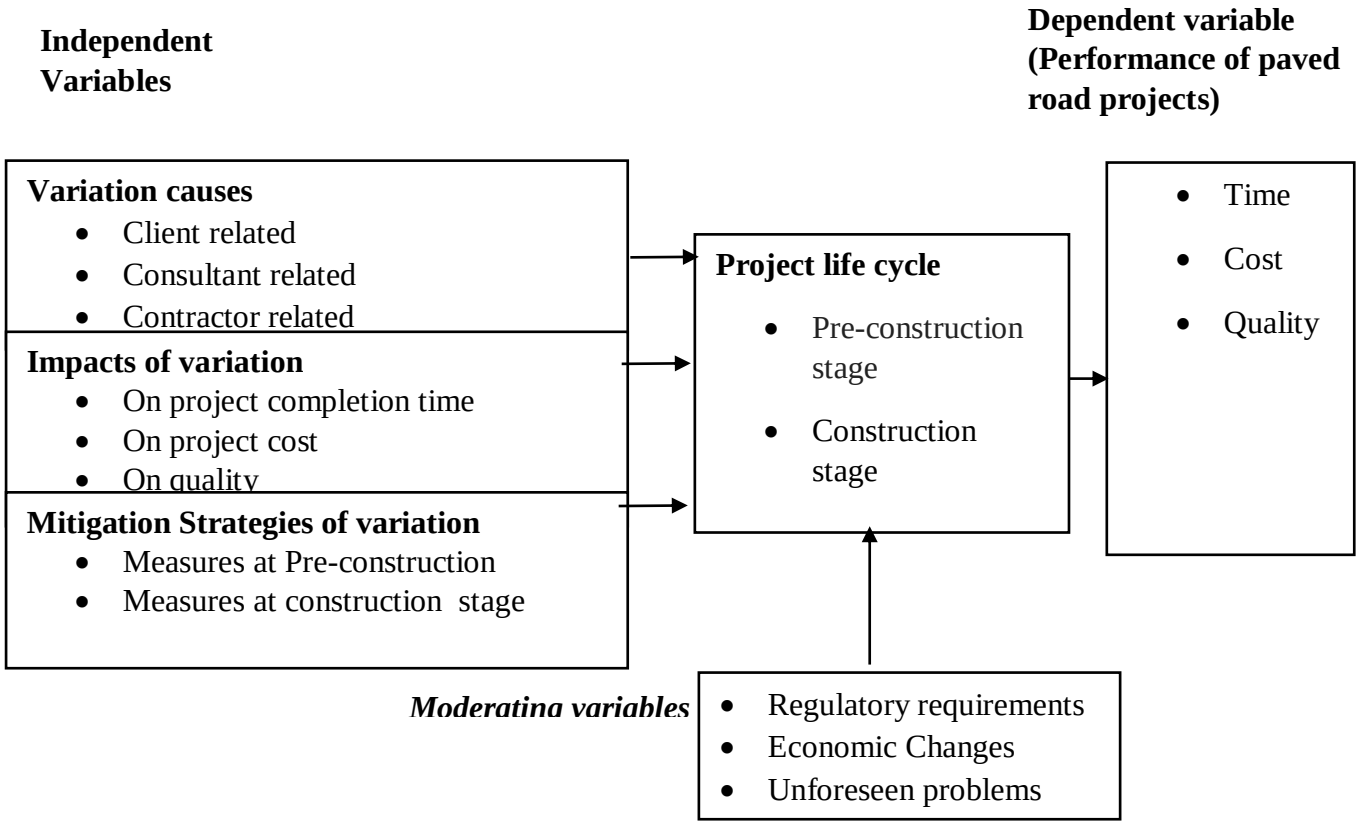

Figure 1. 1 : Conceptual framework of the study

1.10 Chapter Summary

The chapter has covered what the researcher did to find solutions to the effect of variation in project scope on performance of paved road projects by addressing problems identified through the specific objectives stated. The extent of research is covered under the scope, Justification and significance of the research that raised the need to have the research undertaken. Conceptual framework indicates the causes, impacts, mitigation measures as independent variables and cost, time and quality as dependent variable. A model for

performance enhancements in order to realize the desired research outcomes of reducing time lapses and cost overrun with optimal quality was proposed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provided a review of literature on performance, variation on project cost, project time, and designed quality. It also presented the theory that underpinned the study. Thus, this literature review is presented in relation to the objectives that guided the study. Salaman (2005) says there are two theories underlying the concept of performance management and these are the goal-setting theory and the Expectancy theory. However, the study looked at the goal setting theory only. The goal setting theory was fit for the study because it focuses on accomplishing individual goals of employees, which in turn affect performance.

2.2 Theoretical Review

Salaman *et. al*., (2005) indicate that there are two theories underlying the concept of performance management and these are: The goal-setting theory and the Expectancy theory. Expectancy theory had been proposed by Victor Vroom in 1964. The Expectancy theory bases on the supposition that individuals modify their organizational behavior on the basis of expected satisfaction of treasured goals that they have set. Individuals adjust their behaviors in such a manner which is most probable for them to attain the set goals. The theory triggers the concept of performance management since it is believed that performance is influenced by expectations about the future events (Salaman *et al*., 2005).

The goal setting theory fitted the study because it focuses on accomplishing individual goals of employees which in turn affect performance. Goals of road construction projects depend a lot on the human component of resources; therefore, once the individual goals of the employees are achieved, then the goals of the project can be achieved too. Goal-setting theory,

proposed by Edwin Locke in 1968 proposes that, individual goals set by an employee plays a pivotal role in inspiring him or her for superior performance. This is because the employees keep following their goals. Failure to achieve the goals, the employees will have to either improve their performance or adjust to more realistic goals. In case of performance improvement, it will result in the achievement of aims of performance management system. However, individual goals are derived from the main goal of the organization, such that once they are achieved, then the goals of the organization are automatically achieved. Thus these two should not contradict. The theory simply states that the source of motivation is the desire and intention to reach a goal. According to Locke and Latham (2002), individuals or teams becomes motivated to perform better if they find their current performance not achieving the set goals, through increasing their efforts or changing work strategies. The goal-setting theory predicts that peoples' efforts are channeled towards accomplishing their set goals, which at the end affects performance. This theory fits the study because it focuses on accomplishing individual goals of employees which in turn affect performance. Goals of road construction projects depend a lot on the human component of resources; therefore, once the individual goals of the employees are achieved, then the goals of the project can be achieved too (Locke and Latham, 2002).

According to Locke and Latham's goal setting theory, there are several conditions that are particularly vital in an effective goal accomplishment. Example consist of acceptance and commitment to the goals, being specific to the goal, goal difficulty, and the resulting feedback. Before a goal can be motivating to an individual, one must accept the goal. Goal acceptance is the principal step in creating motivation (Locke and Latham, 2002). Goal commitment reflects the amount of determination one uses to realize an accepted goal.

A goal must be specific and measurable. It should answer the; who, what, when, where, why, and how of the expectations of the goal. The more specific the goal, the more explicitly performance will be affected. Specific goals enhances higher task performance than those goals that are vague and abstract (Locke and Latham, 2002).

Goals are proven to be an effective motivation tactic if difficulty is taken into consideration. The goals should be set high enough to prompt high performance but also low enough to be achievable, however the more challenging the goal, the higher the performance. Performance steadily increases as goal difficulty increases. Goals that are way too easy or very much too difficult to attain have negative effects on employees' motivation and performance. The set goals should be realistic, attainable, and challenging. The greatest motivation and performance is achieved with moderately difficult goals (somewhere between too easy and too difficult). Goals should be attainable, but also challenging, therefore if a goal is out of reach, a person will work harder to reach that goal as opposed to how hard they will work for an easier goal.

In order for goals to remain effective and retain commitment, there should be feedback. Sorrentino (2006) says that without feedback people are unaware of their progression or regression; it also becomes difficult to gauge the level of effort required to pursue the goal effectively. Feedback permits for individuals and their teams to identify any flaws in their existing goals, and thus allows for adjustments to be done (Smith and Hitt, 2005).

2.3 Key variables under study

2.3.1 Variation

Variations are the most disruptive and unpleasant events of the projects because of their impacts on quality, cost and completion date of the project. Variation is any alteration to the

terms of a project contract by the owners or their representative in terms of additional works or deletion from original scope of work, and thus altering the original contract amount and/or the project completion date (Msallam *et al*., 2015). According to Bromilow (1988), variation is the degree to which the contract is varied between the time it is let and the time the certificate of practical completion is issued. Thus, variation may be called alteration or modification of the design, quality or quantity of the work shown on the contract drawings and defined by or denoted to in the contract bills and includes the addition, reduction, omission or substitution of any work, the alteration of the kind of standard of any of the materials or goods to be used in the works. The nature of variation can be assessed by making reference to both the rationale for their occurrence and their subsequent effects. Beneficial and detrimental variation are the two main types of variation (Arain and Pheng, 2005).

According to Bromollow (1981), variation is the amount to which the contract is varied between the time it is let and the time the certificate of practical completion is issued. Variation arise for a variety of causes, of which some causes are foreseeable and others unforeseeable. Some causes are born to the client or Consultant or by the Contractor while there are those caused by both or all the parties in contract

Beneficial Variation

A beneficial variation is issued for purpose of improving the quality, reducing cost, schedule, or the addressing any difficulty arising in a project. It is initiated for value analysis purposes to realize an equilibrium between functionality, durability and the cost elements of a project to the clients' satisfaction (Ruben, 2008). A beneficial variation removes unnecessary project costs and therefore optimizing benefits against resource input (Arain & Pheng, 2005). A beneficial variation order, therefore, seeks to optimize the client's benefits against the resource input by eliminating unnecessary costs (Reuben, 2008).

Detrimental Variation

A detrimental variation on the other hand has negative impacts on the client's value or project performance (Arain and Pheng, 2005), and thus have a compromise for the value system of the clients (Ruben, 2008).

2.3.2 Variation in cost

Apart from being exceptional, luxurious and often being executed within a restricted time frame, construction projects have been described as complicated and uncertain in nature, as no two construction projects are ever exactly the same. Cost variation is the surplus in actual cost in comparison to the initial original cost estimates for the project (Tejale, 2015).

2.3.3 Variation in time

Mukuka *et al*., (2015) discussed the effect of construction schedule overrun in Gauteng construction projects in South Africa. The data were obtained from both primary and secondary sources. The study concluded that extension of time, loss of profit, dispute, poor quality of work, claims, delays are the major criteria for project schedule overrun.

2.3.4 Variation in Quality

Traditionally quality is the conformity to specifications and hence quality-based measures of performance have focused on issues such as the number of defects produced and the cost of quality (Aftab et al., 2014). Variation affects the quality of work adversely. It was reported that the quality of work is frequently affected by frequent variation because contractors have to compensate for the losses by cutting corners (Ruben, 2008).

2.4 Causes of variation on performance of paved road projects

Construction project variation causes have been identified by many researchers [Mohammad *et al*., (2010); Memon *et al*., (2014); Arain (2005); Sunday (2010); Halwatura and Ranasinghe, (2013)]. They also argue that economic problems, material procurement glitches, alteration in design drawing, staffing difficulties, lack of equipment, inadequate supervision, mistakes in construction, site coordination challenges, change in specifications, labor disputes and strikes are also underlying causes to variation. Agaba (2009) as an executive at the Public Procurement and Disposal Authority (PPDA), pointed that it is erroneous to blame PPDA rules for construction projects delays because delays are primarily caused by poor designs and specifications and problems with management and supervision. This implies that, for known reasons, numerous public construction projects in developing countries are subjected to excessive variation than those in developed world. Alinaitwe, Apolot, and Tindiwensi (2013) identified work scope, poor control and monitoring, rising inflation and spiking interest rates as the main reasons for delays and cost overruns in construction projects in the public sector of Uganda. Other previous researchers into the causes of variation include: Aftab (2014); Majed and Basim (2015); Fisk (1997); Ibrahim and Amund (2012); O'Brien (1998); Abdulmalik and Abdullahi (2017); Shibi (2018) and Ghanim (2014) among others.

2.4.1 Causes of variation related to the client

Ismail *et.al.*, (2012) established that variation causes related to the client include changes in scope by employers, design errors and omissions and financial problems, change of design and incomplete details of work drawings. Causes of variation arise for a number of reasons, both foreseen and unforeseen. Some result from a sincere change of conditions and others from inadequacies of the design team. Arain and Pheng (2006) recognized four source causes of variation; client, consultant, contractor and other changes. In some instances, the client

unswervingly prompts the need for variation especially when he or she fails to fulfil certain project related requirements. The changes initiated by the client are: Change of scope, Change of project schedule, Owner's financial problems, inadequate project objectives, Replacement of materials, Change in specifications.

Oladapo (2007) discovered that, alterations in specifications and scope, initiated mostly by project owners and their consultants, are the maximum predominant sources of variation. This comes mainly from changes in clients' income/financial ability, changes in clients' interests or requirements, errors in design and inadequate time for crafting of contract forms. The study concluded by highlighting that significant impact variation had on project budget and schedule further noting that the project size and type were insignificantly to the project prices and time schedule.

Amiruddin *et al*., (2012), in their analysis of factors causing variation orders and their effects in roadway construction projects observed that scope alteration by employer, design errors and omissions and financial difficulties on the clients' side were the most thoughtful factors that caused variation in road construction projects. Additionally, the end results denotes that project schedule, budget overruns and disagreement had significant effects on projects. Altogether, with above part of the literature review, total twelve major causes of variation related to client were identified by reviewing eleven previous published research works as summarized in Table 2.1.

2.4.2 Causes of variation related to the consultant

Ismail *et al.,* (2012) explains that in general, the consultant's role is to advise clients on technical matters, laws and financial aspects. Variation caused by consultant include: design

mistakes and changes, the failure to determine the best alternative design for the project in the feasibility study

Table 2. 1: Causes of Variation related to Client

Client's Related Causes	Identified Author(s)
Changes in scope	Aftab (2014), Arain and Pheng (2006), Arain et al. (2004), Memon et al., (2011), Ghanim (2014).
Changes in design	Aftab (2014), Arain et al., (2004), Abdulmalik and Abdullahi (2017)
Financial constraints	Aftab (2014), Clough and Sears (1994), O'Brien (1998).
Conflicting contract documents and clauses	Aftab (2014), CII (1986), CII (1990a)
Failure to issue working drawings at the start of the project	Aftab (2014), Arain et al., (2004), Majed and Basim (2015), Fisk (1997)
Poor procurement process	Aftab (2014), Abdulmalik and Abdullahi (2017)
Poor scheduling	Aftab (2014), Fisk (1997), O'Brien (1998).
Delayed issuing of approval documents	Aftab (2014), Anatol and Abhishek (2017)

Consultants in some cases, directly initiates orders for variation or especially if they fails to fulfil certain project requirements. The changes initiated by consultant may be design changes, design errors and omissions, conflicting contract documents, inadequacy in the work scopes for the contractor, complexity in design, inadequate drawing details, lack of knowledge by the consultant about the availability of materials and equipment (Arain and Pheng, 2006).

Ndihokubwayo and Theo (2009) while studying construction projects variation orders established that consultants failed to accept realistic project time frames and instead accepted time lines given by the clients to complete the actualisation of design. Consequently, the consultants ended up tendering irrespective of the design being completed or not as they knew other required changes would be permitted under the contract conditions. It was thus determined that the employer was the foremost source agent of construction variation orders.

Anatol and Abhishek (2017) in their study established that employer associated causes included plan changes, project scope alteration, additional tasks and alteration to initial work and financial challenges. The consultant related causes included: insufficiency of drawing details, inconsistent designs, and mismatching contract documents and that, the major contractors' predominant justifications for variation were difficult site conditions, limited trained personnel, and contractor's anticipated profitability. Altogether, with above part of the literature review, total seven major causes of consultants' related variation were identified by reviewing ten previous published research works as summarized in Table 2.2.

Table 2. 2: Causes of Variation related to Consultants

Consultant's Related Causes	**Identified Author(s)**
Changes in design	Aftab (2014), Majed and Basim (2015), Fisk (1997), Ibrahim and Amund (2012), O'Brien (1998), Abdulmalik and Abdullahi (2017), Arain and Pheng (2006), Sunday (2010) and Ghanim (2014).
Design flaws (errors and omissions in design)	Aftab (2014), Hanif et al. (2014), CII (1994a), Sunday (2010), O'Brien (1998),
Delayed decision making	Aftab (2014), Gray and Hughes (2001),
Change in specifications	Aftab (2014), Sunday (2010), Abdulmalik & Abdullahi (2017)
Lack of stakeholders and the community Engagement during design implementation	Aftab (2014), Yusuph (2018)
Lack of judgment and experience	Aftab (2014), Sunday (2010)
I don't care attitude	Aftab (2014), Wang (2000),

2.4.3 Causes of variation related to the contractor

Arain & Pheng (2006) say that in some instances, suggestions for variation by the contractor may be necessary to enable contractor fulfil some requirements for the project execution. The contractor related changes may include lack of contractor's involvement in design, lack of

equipment, lack of skills manpower, contractor's financial difficulties, and defective workmanship.

Halwatura and Ranasinghe (2013) in their study concluded that consultants make unsatisfactory investigations during the initial project stages. Therefore, several site situations arise during the construction stage. Further, employers lack abled professional staff and therefore lack precision in most of their estimates. This lack of precision requires several unnecessary variation to be made during the construction phases.

Aftab *et al.,* (2014) attempted to list out the foremost sources and impacts of variation in construction projects. Average index analysis of the survey obtained information showed that Malaysian construction projects variation are often experienced in construction projects. The study identified five leading causes of variation related to the Contractor as lack of apparatus, poor workmanship, design difficulty, schedule alteration, delayed decision making procedure, logistic delays, and rescheduling conclusion and increase in project budget. The literature review has identified a total of ten major causes of variation related to contractors as summarized in Table 2.3.

Table 2. 3: Causes of Variation related to Contractor

Contractor's Related Causes	Identified Author(s)
Delayed acquisition of permits	Shibi (2018), Majed and Basim (2015), Ibrahim and Amund (2012), O'Brien (1998), Abdulmalik and Abdullahi (2017), Arain and Pheng (2006) and. Ghanim (2014).
Poor Workmanship	Aftab (2014), O'Brien, (1998), Wang (2000), Arain and Pheng (2005), Fisk (1997),
Financial constraints	Aftab (2014), Arain and Pheng (2005)
Limited equipment to perform work	Aftab (2014), O'Brien, (1998), Wang (2000), Arain and Pheng (2005)
Failure to adhere to the supervisors advice	Aftab (2014), Shibi (2018),
Delayed Commencement of works	Aftab (2014), Fisk (1997)
Shortage of skilled manpower	Aftab (2014), O'Brien, (1998), Wang (2000), Arain and Pheng (2005)
Poor coordination and project management	Aftab (2014), Clough and Sears (1994).

2.5 Impacts of variation and performance of paved road projects

Variation in project scope have deleteriously impact on the construction project productivity, resulting in labor efficiency decline and a sizeable losses of man-hours (Ala'a, 2012). According to Hao et al., (2008), construction projects variation are very common and may occur from various sources, by various causes, at any project stage, and with considerable negative impacts on costs and schedule delays.

Osman, Omran, and Foo (2009) affirmed that the potential impacts of variation on construction projects are experienced in project cost increase, extra payment to the contractor, a rise in overhead project expenses, completion delays, as well as rework and demolition. According to Aljishi and Almarzouq (2008), project cost increase and time are the main variation effects. Variation adversely affects delivery of project in form of increased project cost, degraded quality of work, leads to reworks and demolition, delayed completion, logistic delays, health and safety concerns and hampers professional relationships (Hanna *et al.*,

2004). Conclusively, with the above literature review, impacts of variation on performance of paved road project were recognized through reviewing previous published research works and are summarized in Tables 2.4 -2.6.

Table 2. 4: Impacts of variation in relation to schedule delays

Impacts of variation	Identified Author(s)
Delays on project completion Logistics delays Reworking and demolition Increase unnecessary procurement delays Health and Safety Loss of productivity	Aftab (2014), Majed and Basim (2015), Fisk (1997), Ibrahim and Amund (2012), O'Brien (1998), Abdulmalik and Abdullahi (2017), Shibi (2018), Ghanim (2014), . Arain and Pheng (2006), Osman, Omran, & Foo (2009)

Table 2. 5: Impacts of variation in relation to project cost

Impacts of variation	Identified Author(s)
Logistics delays Delays on project completion Loss of productivity Increase in project cost Causes reworks and demolition	Aftab (2014), Majed and Basim (2015), Fisk (1997), Ibrahim and Amund (2012), O'Brien (1998), Abdulmalik and Abdullahi (2017), Shibi (2018), Ghanim (2014), Osman, Omran, & Foo (2009)

Table 2. 6: Impacts of variation in relation to quality of works

Impacts of variation	Identified Author(s)
Poor quality of works Health and Safety Reworking and demolition Loss of professional reputation	Aftab (2014), Majed and Basim (2015), Fisk (1997), CII (1995), O'Brien (1998), Abdulmalik and Abdullahi (2017), Shibi (2018), Ghanim (2014), Osman, Omran, & Foo (2009)

2.6 Variation Mitigation strategies and performance of paved road projects

Many factors inhibit professionals to effectively control projects cost and duration in road construction projects. In an attempt to harmonize consequences, Olawale and Sun (2010) comparatively identified over sixty factors from worldwide perspectives, and sorted out

twenty interrelated factors. The study revealed that, the five leading factors inhibiting cost control and time in construction practices are changes in design, risks and uncertainties, inaccuracies in evaluation of project duration, work complexities and non-performance of subcontractors. In addition, mitigation measures for those factors were developed basing on each factor.

In a bid to curtail the design change issues, several means of governing and mitigating their occurrences were developed by specialists and or professionals in practice. Through qualitative approach and interview of professionals, Olawale and Sun (2010) established eighteen design change mitigation measures. A critical investigation of the measures revealed that they could be categorized according to the broad function they perform leading to the following classification: Preventive measures: These are precautionary measures that are put in place as a defense to the inhibiting factors.

- **Predictive measures**: these may seem similar to preventive measures but they are not the same. Predictive measures enables identification of potential problems to the future control process to stop them from occurring or to be prepared for them in the event that they happen.
- **Corrective measures**: these are measures that are utilized to mitigate the effect of the project control inhibiting factors by acting as a remedy. These measures are reactive measures that only act after the event.
- **Organizational measures**: These measures generally encompass practices that go wider than the actual control process but have an effect on project control; they are normally in place because of the company's belief, orientation, management style or philosophy, they have a tendency of not being specific to one project but would normally affect all projects being undertaken by the company as they reflect how the wider organization works.

Mitigating factors of variation offer practical and informed judgments to professionals and therefore enhances effective strategic management of undesirable variation (Arain, 2005). Memon *et al*., (2014) stressed the importance of limiting variation to improve construction project performance. In the Indian construction industry, Subramani *et al*., (2014) established that, comprehensive site investigations and control of potential variation orders in contractual clauses are critical mitigation measures. In Malaysia, Memon *et al*., (2014) recognized four mitigation factors as collective effort by client, variation order controls by the contractor and consultant, clarity in design specification, involvement of client during construction, and timely written approval processes. However, findings from previous studies demonstrated similarities and differences relating to undesirable variation mitigation factors. This situation might be due to dissimilarities in methodologies and locations employed for the investigations. The literature review from seven previous published research works identified major mitigation strategy actions to control variation as summarized in Table 2.7 and Table 2.8.

Table 2. 7*:* Variation Mitigation strategies on paved road projects at pre-construction

Mitigation Strategy Actions	Identified Author(s)
Adequate planning and availability of fund before works start on site	Abdulmalik (2017), Shibi (2018), Andualem (2017), Majed and Basim (2015), Abdulkadir (2017), CII (1995), Singh (2016), Olawale and Sun (2010), Memon et. al., (2014)
Carry out detailed site investigation and consider it during design stage	Subramani (2014), Shibi (2018), Yusuph (2018),
Proper and restricted methods of procurement	Yusuph (2018),
The client should produce a conclusive design and contract documents	Abdulmalik (2017), Memon et. al., (2014)
Revise and update general contract clauses	Yusuph (2018),
Stakeholder's engagement to incorporate their demand.	Yusuph (2018),
Spend adequate time on pre-tender planning phase	Yusuph (2018), Memon et. al., (2014)

Table 2.7 Continued

Mitigation Strategy Actions	Identified Author(s)
Client should ensure that the design/specifications fall within the approved budget	Abdulmalik (2017), Yusuph (2018),
Clients should provide a clear brief of the scope of works	Majed and Basim (2015), Abdulmalik (2017), Andualem (2017)
Effective scheduling in relation to scope of works	Yusuph (2018), Andualem (2017)
Client's coordination in the design stage to spot the noncompliance owner's demand	Majed and Basim (2015), Abdulmalik (2017), Andualem (2017)
Objectivity and impartiality (the contract documents in a way that does not favour certain bidders)	Yusuph (2018), Andualem (2017)

Table 2. 8*:* Variation Mitigation strategies on paved road projects at construction stage of projects

Mitigation Strategy Actions	Identified Author(s)
Comprehensive design and financial reviews before **commencement** of physical works	Majed and Basim (2015), Andualem (2017), Abdulkadir (2017), CII (1995), Abdulmalik (2017), Singh (2016), Memon et. al., (2014)
Client expedite approvals and decision making	Yusuph (2018)
Enhance communication between all parties	Abdulmalik (2017), Andualem (2017)
Client should expedite payments to contractors and consultants	Abdulmalik (2017), Olawale & Sun (2010),
All parties should forecast unforeseen situations	Andualem (2017), Arain, (2005),
Construction and supervision of works should be done by experienced and dedicated teams	Andualem (2017)
Proper analysis of risks by all parties	Andualem (2017)

2.7 Construction Performance Dimensions

Ibbs (2012) identified good cost, schedule, and productivity performance as three dimensions of project performance delivery in the construction industry. Simpeh *et al.,* (2011) disclosed similar performance dimensions in the construction industry in South African. Alinaitwe (2008) identified productivity, profitability, quality, innovation, efficiency, quality of work life, and effectiveness as the seven construction performance dimensions.

Arain (2005) identified time, cost, quality and safety conditions as the main criteria of construction performance measurement. Besides, it is contended that in the modern construction project procurement, the goal is to inspire clients, consultants, contractors and suppliers to work collectively towards refining quality, reducing cost, mitigating disputes, improving innovativeness and sharing project risks (Jelodar *et. al.,* 2015). Several factors leading to project performance were identified from earlier studies. After the analysis, three factors and their sources are time, cost and quality. Yet, these dimensions are realizable through appropriate control of variation at all stages of project development, especially the construction stage. As a matter of fact, almost every client's interest is to obtain fully functional facilities completed in the planned time, quality, cost and scope.

Studies by Atkinson (1999), Bassioni *et al.,* (2004), Jin *et al.,* (2007), Cheung *et. al.,* (2004) agree that project performance can be evaluated and measured using a large number of performance indicators or criteria but time, quality and cost appear to be the three commonly preferred performance evaluation dimensions.

2.8 Modelling of variation and performance of paved roads

A model is a more abstracted way of schematizing a process, so that your strategy could be generalized to solve similar problems in other fields. A theory is a formalized model that is both generalizable and predictive, and therefore can be used prescriptively. Momme and Hvolby (2002) developed a model for contractor selection. It contains the following parameters: Competence analysis, Assessment and approval, Project execution and transfer, Contract negotiation, Relationship management, and Contract termination.

Elyamany, Ismail, and Tarek (2007) introduced a model for performance evaluation by construction companies to provide appropriate tool for the stakeholders to appraise the performance of construction companies in Egypt. The research introduced a performance appraisal model for construction companies to provide a proper tool for a company's managers, owners, shareholders, and funding agencies to evaluate the performance of construction companies. The model developed helps a company's management to make the right decisions. Five indices (models) were developed and these included company performance score, economy performance score, industry performance score, performance index, and performance grade.

Modeling change processes and management in the construction projects has been studied by a number of scholars. However, the studies mainly focused on addressing how changes affect various facets of construction projects delivery. Studies such as Motawa (2005) and Moghaddam (2012) considered cost and time overruns to be the main variation impact. Love *et al.,* (2004) advanced a rework reduction model for construction projects in Australia primarily consisting of the design development and production processes. He argued that it is ideal for the project facilitator to undertake an audit and sign off at the end of each design stage. He established that the model would ensure coherence between the specifications by the client and the actual implemented design. Ming *et al.,* (2004) defined the four stages of generic variation management process model as being start up, identify and evaluation, approval and implement and review. This study focused on developing a model to study how variation affect performance of paved road projects in Uganda.

2.9 Synthesis of Literature and Research Gap identification

The literature review above confirms that different scholars have conducted several studies on road construction projects variation. The research gaps are that no study has been done to establish to what extend the variation affect the performance of paved roads in Uganda, even the studies that were carried out in Uganda were not based on Rwenzori region and focus was not laid on the variables that are discussed in this study.

2.10 Chapter Summary

This chapter provides a review of literature on variation, causes of variation, impact of variation, measures to mitigate variation and the performance enhancement model of paved roads. From literature review, their emphasis has been on the project variation causes and impacts. Little has been done to show how variation affects the achievement of project success specifically paved road construction projects particularly in Rwenzori region and on what should be done to improve performance of paved road projects. The next chapter presents the methodology used to achieve the study objectives.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was adopted in collecting data for the research study. It discusses the research design, the population of the study, sample size and selection, sampling techniques, procedure of data collection, data collection methods and instruments, data analysis, reliability, validity and measurement of variables.

3.2 Research Design

Research design is the scheme, outline or plan that is used to generate answers to a research problem. The study used a case study design where both qualitative and quantitative approaches were used. A case study was adopted to narrow down the very broad field to a small specific and interesting researchable group to enable researcher gain an in-depth study of the particular situation. The researcher employed both approaches since some variables such as causes, impacts and mitigation measures of variation would better be measured using quantitative technique while performance of paved road would better be measured using qualitative techniques.

3.3. Study Area

The study was conducted at the campsites along the project roads, at UNRA station offices and UNRA headquarter in Kampala.

3.4 Study Population

According to Sekaran and Bougie (2013), population is the entire group of people, things or events the researcher desires to investigate and make inferences. The projects under study had three main groups of people executing different roles. These were the Contractor, the Consultant and the Client. Therefore, they were the target population. Table 3.1 shows the key

staff from each group and the final target population for each project. It shows that each project has a total of 24 technical people. The projects under study are four. This makes the target population to be 96(24*4) people. However, after completion of works, the client hands over the roads to UNRA stations for maintenance and therefore involves station managers during execution. This made them qualify to join the study population since they are also part of the team during execution. Rwenzori region has two UNRA stations each with a Station Manager thus a total of two Managers. This finally made the total target population to become 98 (96+2).

Table 3. 1: Study population per road

Contractor	Number	Consultant	Number	Client	Number
Project Manager	1	Resident Engineer	1	Head of Department : CST	1
Deputy project Manager	1	Deputy Resident Engineer	1	Contract Manager	1
Site Engineer	1	Materials Engineer	1	Project Engineer	1
Material Engineer	1	Surveyor	1		
Surveyor	1	Assistant surveyor	1		
CAD Engineer	1	Senior lab technician	1		
Foremen	2	Technicians	2		
Quantity Surveyor	1	Inspectors	3		
		CAD	1		
Total	**9**		**12**		**3**

3.5 Sample size

The sample size for this study was 79 consisting of the Contractor's, Consultant's, Client's technical staff and the Station Managers. This was obtained from Krejcie and Morgan (1970) Table in Appendix (III) and employing purposive sampling technique.

3.6 Sampling techniques

Sekaran and Bougie (2013) stated that sampling is the process of selecting an adequate number of elements from the population such that by studying the sample and understanding the

properties and characteristics of the sample objects, it would be possible to generalize the characteristics of the population elements. Sampling is divided into both probability and non-probability sampling techniques. However, this study used both sampling techniques.

3.6.1 Probability sampling

The study used purposive and simple random sampling techniques to sample the 79 from candidates from a population of 98 members consisting of contractor, Consultant, and client personnel. Station Managers were also included. Simple random sampling was use to select candidates from consultants and contractors team. This was obtained from Krejcie and Morgan (1970) Table appendix (III).

3.6.2 Non Probability Sampling

Purposive (expert) sampling was used to sample seven (7) people comprising of 1 Head Construction and Supervision team, 1 Resident Engineer, 1 Contract Manager,7 client team, 2 Station Managers and 1 Project Manager because it was necessary to obtain specific information from them since they are the people who had experience and knowledge about the topic under study by virtue of their positions and responsibilities. Palinkas *et al.,* (2015) affirms that purposive sampling is a useful technique broadly used in research for identification and selection of information-rich cases for the most effective use of limited resources. Expert sampling involves selecting a sample based on demonstrable experience, knowledge, or expertise of participants. This expertise may be a good way to compensate for a lack of observational evidence (Palinkas et al., 2015). The samples selected per population category and respective sampling techniques are shown in Table 3. 2

The other groups were considered based on their positions or participation in decision making or their physical participation in project implementation process. The sampling frame included higher positions such as; Resident Engineer, Deputy Resident Engineer, Project Engineer, Materials Engineer, Highway Engineer, Surveyor, CAD Engineer, Site Engineer, Site Foreman, Quantity Surveyor and Inspectors of Works while the lowly position staff included; Assistant Surveyor and Lab technicians. The Lowly position staff were considered due to the fact that they are part of the key quality management team on site who directly receive or experience feedbacks about project performance.

Table 3. 2: Categories of respondents

Category	Study population	Sample size	Sampling technique
Head of construction and supervision team	1	1	Purposive (Expert) sampling
Contract managers	1	1	Purposive (expert) sampling
Project Engineer	1	1	Purposive (Expert) sampling
Resident Engineer	1	1	Purposive(Expert) sampling
Project manager	1	1	Purposive (Expert) sampling
Consultants	12*4=48	36	Simple random sampling
Contractors	9*4=36	29	Simple random sampling
Client	7	7	Purposive (Expert) sampling
Station Managers	2	2	Purposive (Expert) sampling
Total	98	79	

3.7 Data collection methods

The data for this study (qualitative and quantitative) were obtained from both primary and secondary sources. Primary data was collected from the respondents through use of questionnaires and interviews. Secondary data was collected through reading policies,

textbooks, journals, reports and dissertations to review what other scholars have written about the study.

3.7.1 Questionnaire Survey

The study used the questionnaire method to collect data. The questionnaire was used because it can be used to collect data from a relatively large number of respondents from their natural settings. It is also economical and time saving (Amin, 2005). The questionnaire was also used because it allows busy respondents fill it at their convenient time. It also allows respondents express their views and opinions without fear of being victimized (Oso and Onen, 2008).

3.7.2 Interviews

Interviews were person-to- person verbal communication in which one person was interviewed at a time. Qualitative data from interviews was collected and reorganized in related themes with each of the variables under investigation being a theme title. The thematic categories and sub categories were integrated to make an analysis of the collected data in relation to the study objectives.

3.7.3. Document review

The study used document review in order to collect more secondary data to provide more in-depth information on the topic under investigation. The Secondary data were obtained from monthly project progress reports especially, Completion reports, Audit reports in project files. The data were used to provide in-depth qualitative information, which could not be possible to collect using closed ended questionnaire (Amin, 2005).

Archival documents were from projects under the study, in which contract documents, project

progress reports, audit reports, claims evaluation reports, correspondence letters and payment certificates were reviewed thoroughly and these were very important in identifying the factors affecting the performance of paved road construction projects.

The information obtained from document review were related to claims both cost and extension of time and their causations, project progress, quality concerns, change orders. Project challenges related to the topic of the study were obtained from monthly progress reports, project cost and time drivers as well as management issues raised by the Auditors were also obtained from review of Audit reports.

3.8 Data collection instruments

The instruments used in this study were the questionnaire, interview and document review checklist.

3.8.1. Questionnaire

A self-administered questionnaire was used for collecting primary data from the technical staff on the four projects under study who fall under the category of Contractor, Consultant and client. Station managers were also included. Detailed literature review was carried out on the parameters in the specific objectives.

The questionnaire consisted of both closed and open ended questions. Closed ended questions were developed to help respondents make quick decisions; in addition, closed-ended questions helped the researcher to code the information easily for subsequent analysis and narrow down the error gap while analyzing data as observed by (Sekaran, 2003).

The questionnaire was divided into two main parts. Section A was related to general information about the respondent's sex, age, education, employment, years of experience. Section B included statements/questions under the independent variables: causes of variation which are related to the client, Consultant and Contractor; impacts of variation in relation to completion time, increase in project cost, and quality of completed works; Mitigation strategy actions to minimize variation at pre-construction stage (conceptual and design stage) and construction stage.

It also included statements for use in developing the model. The parameters under the independent variable (variation) included a list of the identified causes, impacts of variation and mitigation measures. The combined effects of time performance, cost performance and quality performance of paved roads were used to determine the overall performance of paved roads.

3.8.2 Interview guide

Open-ended face-to-face interviews were conducted with key informants who were members of Client's, Consultant's and Contractor's technical staff. These included; 1 head of department, and 1 Resident Engineer. These were selected because they are policy makers and implementers of the project with very high level of experience, better understanding of the topic under study and in-depth information around the topic.

3.9 Research procedure

The researcher obtained an introduction letter from Kyambogo University introducing him to the road projects where data were collected. The research instruments (questionnaire) was self-administered and was designed and tailored to the objectives of the study. Open-ended

face-to-face interviews were conducted with key project informants at managerial level; one client's representative, one consultant's representative and one contractor's representative. Secondary data were obtained from review of project files at site offices and at UNRA head quarter and Audit reports accessed from UNRA head quarter.

3.10 Data quality control

3.10.1 Validity

Validity refers to the appropriateness of the instrument in collecting the data that is supposed to be collected, while reliability refers to its consistency in measuring whatever it is intended to measure (Amin, 2005). To ensure validity of the instrument, the questionnaire was developed and administered to eight (8) experts representing 10.8% to score the relevance of each questions in providing answers to the study. The experts included; Two (2) Contract Managers, two (2) Project Engineers, a Resident Engineer, a Deputy Resident Engineer, a Project Manager and a Materials Engineer. These were purposively selected because they were believed to be knowledgeable about the topic under investigation. After the respondents had scored the relevancy of the items in the research instrument, a content validity index (C.V.I) was computed using equation (3.1);

Content Validity Index = (Number of questions judged relevant) / (Total number of questions judged)…… (Equation 3.1)

Content Validity Index $= \frac{51}{57} = 0.895$

According to Polit, Beck, & Owen (2007), the closer to 1, the CVI, the more valid is the section of the research instrument or the entire instrument. A CVI of above 0.7 is acceptable as suggested by Amin (2005). The number of respondents pre-tested was smaller, 10.1% (8/79*100) of the sample size as suggested by Mugenda and Mugenda (1999). The researcher, therefore, used eight (8) respondents while pre-testing the instrument which represented 10%

of the sample size of 79 respondents of the study. In this case, the CVI was 0.895, it was considered to be good for the study.

3.10.2 Reliability

According to Koonin (2014), reliability is the credibility or consistency of a research instrument. A reliable research instrument enables a researcher to generalize the results. The reliability of the questionnaire was analysed to find out whether it was capable of yielding similar scores if respondents used it twice. Cronbach's alpha was used to measure the reliability of the questionnaire. Cronbach's alpha is usually computed from the following formula:

$$\alpha = \frac{N * \bar{C}}{\bar{v} + (N-1) * \bar{C}} \quad \text{.....(Equation 3.2)}$$

Where N = the number of items, $\bar{v}$ = the average variance and $\bar{C}$ = the average inter-item covariance. The closer the Cronbach's Alpha to one (1), the higher the reliability estimates of the instrument. The reliability coefficient (alpha) ranges from 0 to 1, with zero representing an instrument full of error and 1 representing total absence of error. According to Sekaran (2003), the alpha values of 0.7 and above are considered reliable and acceptable for the research instrument.

To check the reliability of questionnaire, pilot survey was conducted among 10% (8) respondents as suggested by Mugenda and Mugenda (1999). The reliability check was done using IBM SPSS software. The reliability coefficient Cronbach's alpha was found to be 0.976 for the 57 items. The score is in line with Amin (2005) who stressed that the reliability score of 0.7 and above shows how reliable, the instrument is. With reference to Sekaran (2003), the researcher concluded that the research findings using the instrument were reliable.

Table 3. 3: Cronbach's Alpha (α) value of reliability test results of the study

Narrative Summary	Cronbach's Alpha coefficient	Number of items
Causes of variation related to the client	0.981	8
Causes of variation related to consultants	0.976	7
Causes of variation related to contractors	0.988	8
Impacts of variation in relation to time	0.977	6
Impacts of variation in relation to cost	0.958	5
Impacts of variation in relation to quality	0.956	4
Mitigation of variation at pre-construction Stage	0.987	12
Mitigation of variation at construction stage	0.984	7
Average	**0.976**	

3.11 Measurement of variables

Data on the views of respondents and their opinions about effect of variation on the performance of paved road projects was obtained using scaled variables from a self-developed questionnaire. A five-scale Likert scale was used in line with Anderson (1995) to rate the views of the respondents or study variables on the close ended questions. Using the scale; 5= Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1= Strongly Disagree was used to get respondents perception on the study variables.

3.11.1 Analysis of data

The data collected through questionnaires were analysed using Statistical Package for Social Sciences (SPSS) version 25 because this is the most recommendable package for analysing research data (Sekaran, 2013). The result is used to assess the causes of variation on performance of paved project, the impacts of variation on paved road project and to establish the mitigation measures of variation on paved road project in relation to cost, time and quality. The analysis relied on both descriptive and inferential statistics. The descriptive statistics used

were frequency counts, percentages as well as the mean and standard deviation. Correlation and regression analysis were used to determine the relationship and effect of the independent variables on the dependent variable (Kothari, 2004). Data were further analyzed using Pearson Product-Moment correlation analysis.

3.12 Achievement of specific objectives

3.12.1 Specific Objective (i): To establish the causes of variation on paved road projects in Uganda, Rwenzori region.

Variation arises for a variety of causes, of which some causes are foreseeable and others are not. The enormity of the various variation causes of variation over the years by various scholars indicates that variation will continue to exist as part of the construction projects and it cuts across various stakeholders. The causes of variation have been categorized into Consultant related, Client related and Contractor related variation. As a result of literature review, a total of 29 common causes were identified as listed in Tables 2.1, 2.2 and 2.3.

In order to analyze specific objective (i) above, a questionnaire listed with the researched causes of variation on paved road projects was developed, distributed to respondents, collected and information entered in SPSS software. Statistical methods were employed. These included obtaining the mean such that the causes are ranked. Inferential Statistics for determination of the relationship between causes and performance was also done. Results of the analysis are discussed in Chapter Four.

These causes of variation were responsible for the additional works, alterations, omissions or substitutions of original planned works, unnecessary costs incurred. The study established that these causes of variation were responsible for the cost escalation

over original project cost with time extension more than the original project duration.

3.12.2 Specific Objective (ii): To determine the impacts of variation on the performance of paved road projects in Uganda, Rwenzori region

From the literature review, fourteen major impacts of variation were identified by reviewing eight previously published research works as summarized in Tables 2.4, 2.5 and 2.6 in Chapter Two. Data were collected using a questionnaire and listed the impacts of variation on paved road projects and entered in SPSS software. Mean item score was used to rank results of respondents. These included obtaining of the mean and ranking the impacts. Inferential Statistics for determination of the relationship between impacts of variation and performance was also done. Results of the analysis are discussed in Chapter Four.

3.12.3 Specific Objective (iii): To establish the Variation mitigation Strategies to enhance performance of paved road projects in Uganda, Rwenzori region

Mitigating factors of detrimental variation provide hands-on informed decisions to professionals for effective strategic management of detrimental variation (Arain, 2005). Memon *et. al*., (2014) argue that in order to improve construction performance, it is very important to alleviate detrimental variation in construction projects. Other researchers have looked into factors that mitigate detrimental variation as listed in Table 2.7 and Table 2.8. Altogether, with the literature review, a total of 19 major mitigation strategies to minimize variation on road construction projects were identified by reviewing four previously published research works as summarized in Table 2.7 and Table 2.8.

List of mitigation strategies to control variation on paved road project were then obtained through literature review and questionnaire distributed to respondents, collected and

information entered in SPSS software. Mean item score was used to rank results of respondents. The highly ranked factors were then used in regression analysis to develop a model for improving performance of paved road projects at pre-construction stage and at construction stage. Results of the analysis are discussed in Chapter Four.

3.13 Employment of statistical methods

In order to achieve specific objectives (i), (ii) and (iii), the statistical methods below were employed.

Ranking; Mean item score was the technique used in assessing the information generated about the objectives of the study with the aid of statistical package for social sciences (SPSS). The objectives assessed were the causes of variation on paved road project, the impacts of variation and to establish mitigation strategy actions to minimize variation on paved road project. Mean item score was used to rank results of respondents. It can be used in calculating both the grouped and ungrouped data. It is mathematically represented as;

$$Mean\ Score, \mu = \frac{\sum(F*S)}{\sum F} \quad \text{(Equation 3.3)}$$

Where, $1 \leq \mu \leq 5$, S = Score given to each factor by the respondent and ranges depending on the ordinal scale of 1 to 5, F = frequency of respondent to each rating (1-5) for each factor.

The sample size of 79 was used, 74 questionnaires were retrieved and found reliable for analysis. The statistical analysis of data was applied with the aid of statistical package for social sciences (SPSS). The data collected were presented using tabular form while mean item score was applied appropriately and result were later discussed. The respondents' views on the variables (causes of variation, impacts of variation and mitigation strategy actions to minimize variation) were ranked by the measurement of the mean scores. The means < (less

than average mean) indicates variable with negligible influence on variation and that above > (greater than average mean) indicates variable with strong influence on variation.

Inferential Statistics: Correlation and regression analysis was used to determine the relationship and effect of the independent variables on the dependent variable as suggested by Kothari (2004). Data was analyzed using Pearson Product-Moment correlation analysis. Regression analysis was used to establish the relationship between study variables as suggested by Sekaran (2003). Regression analysis established the significance of the relationship between the independent variables; causes of variation, impacts of variation and mitigation strategy actions to control variation on the dependent variable performance of paved road projects.

Correlations Analysis: A correlation coefficient is a coefficient that illustrates a quantitative measure of some type of correlation and dependence, meaning statistical relationships between two or more random variables or observed data values (Mugenda and Mugenda, 1999). Pearson correlation was used to measure the degree of association between variables under consideration i.e. independent variables and the dependent variables. Pearson correlation coefficients range from -1 to +1. Negative values indicate negative correlation and positive values indicates positive correlation where Pearson coefficient $0 < r < 0.25$ indicates weak correlation, $0.25 \leq r < 0.75$ indicates moderate correlation, $0.75 \leq r < 1$ indicates strong correlation while r = l indicates perfect correlation.

Rank Correlation: Quantitative data obtained from questionnaires were analysed using SPSS software. The data manipulation generated descriptive statistics that were used to describe the study variables and their associated indicator items related to the objectives of

the study. Pearson correlation coefficient and regression analysis were used to measure the degree and strength of the relationship between the independent and dependent variables. The two methods above were applied to variables under each specific objectives from objective (i) to (iii) and their relationship with performance of paved road project was established.

3.14 Developing a model to enhance performance

Various studies have been carried out on modeling of change processes and change management in construction projects. However, the main focus of these studies was to address how changes affect various aspects of delivery of construction projects.

In this study, Multiple Linear Regression was employed. Linear regression attempts to model the relationship between two or more variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable (Draper and Smith, 1998).

A linear regression line has an equation of the form $Y = \beta_0 + \beta X$, where X is the explanatory (or independent) variable and Y is the dependent variable. The slope of the line is β, and intercept is β_0, (the value of y when $x = 0$). Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with a value of the dependent variable Y (Draper and Smith, 1998).

In developing the model to enhance performance of paved road projects, an average rating on a set of indicators in relation to the performance criteria was used. The researcher used equation (3.4) to analyze the effects of causes, impacts and mitigation strategy actions to

control variation on performance of paved road projects as explained in Chapter Four. The study considered causes with strong influence under client related, consultant related and contractor related. The cost related, time related and quality related with strong influence were the main impacts of variation considered under analysis of impacts of variation on performance whereas the input variables for mitigation strategy actions to control variation were considered under pre-construction and construction stages.

A relationship was established between the causes of variation, impacts of variation and mitigation strategy actions to minimize variation on paved road project indicators based on the model in form of a regression equation:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots \beta_n X_n, + e$……..……..(Equation 3.4)

Where; Y is the dependent variable (performance of paved road project), X_1, X_2, X_3… and X_n are the independent variables, and β_1, β_2, β_3… β_n represent the constants (weightings) obtained from the analyses while e, represents random error term. The mean of all the averages of each of indicators represented their overall averages or "weightings". Together, they represent the model of the indicators, in this case, cost, time and quality indicators, regarding their individual influences. The same relationship exists between the influencing factors and the active factors. In the case of the equations for the model, the dependent variables formed the "Objective Function" which the assessment seeks to minimize or maximize in order to achieve a project objective. The researcher used the model to establish the relationships between performance of paved road project (Y) and causes of variation (X_c), impacts of variation (Xt) and mitigation strategy actions to control variation (Xq).

3.14.1 Input variables for model development

A scoring system that adequately reflects the performance of a construction project being

assessed is the key to any evaluation system. Scoring the measurement implies the combination of quantitative and qualitative measurements to achieve an overall assessment of performance. This requires that all measurements are expressed in a common denominator. In this assessment system, all measurements were expressed in percentages to achieve these objectives. The process involves the use of the highly ranked mean score being most influential assessment measures (input variables); causes of variation, impacts of variation and mitigation strategy actions of variation on paved road project. The highly ranked input dependent variables on dependent variable (or sub-measures) are used to form performance measurement.

$PP = \beta_0 + \beta_1 Cv + \beta_2 Iv + \beta_3 Mv$ ……..……..(Equation 3.5)

$Cv = \beta_0 + \beta_1 Da + \beta_2 Dc + \beta_3 Sc + \beta_4 D_f + \beta_5 D_d + \beta_6 Pc + \beta_7 Sm$ ……..…(Equation 3.6)

$Iv = \beta_0 + \beta_1 Pct + \beta_2 Pcc + \beta_3 Qcw$ ……..…..……(Equation 3.7)

$Mv = \beta_0 + \beta_1 Ap + \beta_2 Di + \beta_3 Cdf + \beta_4 Cad + \beta_5 Ec$ ……..……..(Equation 3.8)

Where; Project Performance = PP, Causes of variation= Cv, Impacts of variation= Iv, Mitigation of variation =Mv, Delayed issuing of approval documents= Da, Changes in design = Dc, Changes in scope = Sc, Design flaws =Df, Delayed decision making =Dd, Poor coordination and project management =Pc, Shortage of skilled manpower =Sm, Project completion time =Pct, Project cost =Pcc, Quality of completed work =Qcw, Adequate planning and availability of fund before works start on site =Ap, Carry out detailed site investigation =Di, Comprehensive design and financial reviews before commencement of physical works =Cdf, Client expedite approvals and decision making =Cad and Enhance communication =Ec.

Analyzed results from the respondent represent the weightings for each of the measures and sub-measures. Together they represent the models of project performance. The weightings of each set of sub-measures that define the main measure add up to 100%, a relationships

between them were then established. The model is then used to establish whether there is perfect or superior performance.

3.14.2 Model Coefficients

The assessment is based on the linear additive model. According to this model, "if it can be proved or reasonably assumed, that the measures are preferentially independent of each other and if uncertainty is not formally built into the Multi-criteria analysis model, then the simple linear additive evaluation model is applicable" (DTLR multi-criteria analysis manual). This shows how an option's values on many criteria can be combined into an overall value. This is done by multiplying the value score on each criterion by the weight of that criterion and then adding all these weighted scores together (Gyadu. 2009). The relationship is represented as:

$PK = \sum_{i=1}^{n} W_i = 1\ or\ 100\%\ and\ 0 \leq W_i \leq 1$ ……(Equation 3.9)

and;

$PK = \sum_{i=1}^{n} W_i M_i \leq 1\ or\ 100\%$ ……...….(Equation 3.10)

Where,

P_K = is the performance measurement for overall performances;

w_i is the weight of a criteria, indicator or factor;

and m_i represents a score of an indicator or a weighted score of a criterion.

The general form of the equation (3.4) to predict performance from causes, impacts and mitigation strategy actions to control variation is predicted as:

$Y = a+\beta_1X_1 + \beta_2X_2+\beta_3X_3+\ldots\ldots\ldots\ldots\beta_nX_n$

Where: Y=Performance, β_1=variation coefficient, X_1=causes of variation, β_2=impacts coefficient, X_2=Impacts of variation, β_3= Mitigation strategy actions to control variation coefficient, X_3=mitigation strategy actions to control variation.

3.14.3 Relative Performance Scale

The scoring system that satisfactorily reflects the performance of a project being assessed is key to any evaluation system. Scoring the measurement implies the combination of monetary, quantitative and qualitative measurements to achieve an overall assessment of performance. This requires that all measurements are expressed in a common denominator. In this assessment system, all measurements are to be expressed in percentages to achieve this objective. A relative performance scale was used to assess performance of construction projects (DTLR, 2001). This is a scale whose main section is anchored at its ends with the least performance level (0) and the most performance level (100) in Figure 3.1.

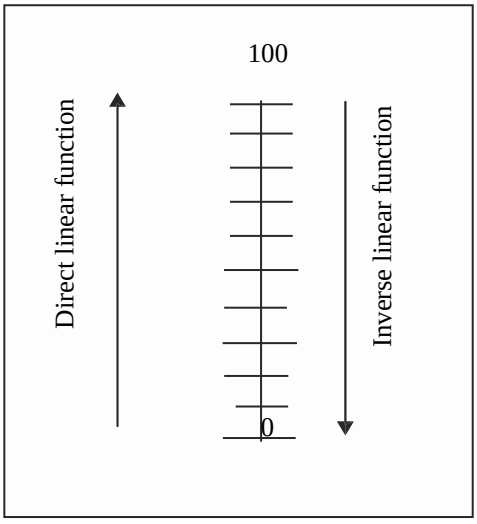

Figure 3. 1: The Relative Performance Scale

Source: DTLR (2001)

The scale in this research, however, uses planned or expected values of the project as the main pre-determined standards. This should be agreed as such at the beginning of the project for assessment purposes. Based on the direction of the relative strength or level of performance,

this scale may operate on either of the two functions as either Direct Linear Function in which the highest measurements scores towards 100 or Indirect Linear Function in which case the highest measurement scores towards 0. .

DTLR (2001) affirms that performance is scored against a pre-determined standard, target or benchmark. This could be represented by the estimated or planned performance i.e. planned cost, time or other activity level, or agreed previously recorded best practice (from similar projects undertaken or known to the different categories of project implementers).

The result of the overall performance scores are interpreted in light of:

i. 0% -20%: Extremely weak performance.
ii. 21% - 40%: Poor Performance.
iii. 41% – 60%: Good Performance.
iv. 61% - 80%: Very Good Performance.
v. 81%– 100%: Excellent or outstanding performance.

The analysis provides allowances for extra normal performances, i.e. 'perfect' or 'superior':

a. **Perfect Performance:** this is a situation when the measured indicator shows the same figures or values as the standard against which it is being compared. In such a situation, the relative performance scale will read 100%.
b. **Superior Performance:** this is a situation when the measured indicators show figures or values more than the standard against which it is being compared; for example when there is a cost savings or time savings etc. In such a situation, it would mean that the relative performance scale will naturally be expected to read more than 100%. However, because the scale is limited to 100, all superior performance will be given the maximum value just like

perfect ‘perfect’ performance. However, the exact values are recorded and documented as measured on the relevant measurement sheets for information and learning purposes. In a rare situation of superior performance in all the indicators, overall performance in all of the relevant criteria would be expected to exceed 1 or 100%. This should also be treated as perfect performance results, limiting everything to 100% and documenting the raw measurements. In all such situations, it should be necessary to investigate whether the result shows a superior performance or the standards of comparison were, in fact, erroneously low.

3.15 Ethical consideration

The researcher treated any information got from any individual confidentially without disclosing the respondents’ identity and was as open minded as possible and expressed opinions as they were given. The research process was guided by sound ethical principles which included the followings:-

Voluntarism: The researcher ensured that respondents were not pressed into participating in the study. Respondents were informed of the purpose of the study and their consent to participate in the study was sought.

Objectivity: The research team also ensured objectivity when carrying out the research, any attempt to bias results was considered unethical and was therefore avoided.

Confidentiality: The respondents were assured of confidentiality and anonymity. Their names were not written anywhere in the report and the information given was only to be used for academic purposes.

Respect: The researcher ensured respect for the respondents. Respect encompassed respecting the opinion of the respondents including the opinion to terminate the interview whenever they feel uncomfortable to continue.

3.16 Chapter Summary

The chapter highlighted how the research was designed and conducted. A clear description of the study area and sample size was discussed as well as techniques used for sampling. A discussion was made about the data collection tools including methods and instruments used and how their validity and reliability were tested. Achievement of specific objectives and development of model to enhance performance of paved road project were brought out. The chapter concluded with highlights of ethical considerations applied during the data collections. The collected data were then ready for presentation and analysis as presented in the next chapter.

CHAPTER FOUR

PRESENTATION ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter focuses on, analysis and discussion of the study findings arising from desk study, interviews and questionnaires. The collected data from questionnaires were tabulated and analyzed according to their ranking on mean item scores. The main objective of this chapter is to identify the highest ranked factors for discussion and correlation with findings from desk study, interviews and questionnaires. The data analysis was in line with specific objectives and application derived on them.

4.2 Analysis of data from desk study

The study analyzed data from four (4) projects which were under their final stage of construction in the Rwenzori region. From the four projects, approved variations were selected for analysis to fully understand the causes, impacts and determine the recommended strategy action to minimize variation. These projects were substantially completed and were selected as a representative of occurrence of variation on paved road projects in Uganda. Table 4.1, 4.2 & 4.3 show list of selected projects and data from desk study.

Desk study established that all the four projects experienced major design changes. Double bituminous Surface treatment (DBST) was changed to Asphalt Concrete for surfacing layer. This change logistic delay caused by need for new sets of plant and equipment and materials for asphalt works.

Project A suffered 611 days extension of time which is 111.70% time overrun and cost overrun of UGX. 48,412,573,497.18 which is 111.70% time overrun which is 67.70% cost overrun. These variations were caused by the introduction of Asphalt works and rock fill for swamp treatment. The project also experienced delay caused by Client in approval of change order, and delayed payment of contractor's interim payment certificates.

Project B experienced 153 days extension of time which is 24.29% time overrun and cost overrun of UGX. 13,846,433,222 which is 14.60% cost overrun. These were caused by the introduction of additional works on service lanes and walkways and delayed submission of design, delayed communication and approval by consultant.

Project C suffered 405 days extension of time which is 74.18% time overrun and cost overrun of UGX. 51,291,589,914 which is 61.61% cost overrun. These were caused by the introduction of Asphalt works and change order to include box culvert works. The project also experienced delay caused by Client in approval of change order, and delayed payment of contractor's interim payment certificates. Additional works of 4.5Km town road were included.

Project D suffered 603 days extension of time which is 110.24% time overrun and cost overrun of UGX. 14,954,780,339 which is 14.40% cost overrun. These were caused by the introduction of Asphalt works and rock fill for swamp treatment and additional 2.6Km access road. The project also experienced delay caused by Client in approval of change order, and delayed payment of contractor's interim payment certificates.

Table 4. 1: Project Cost Variation

Project Code	Projects	Original Contract Price (UGX)	Revised Contract Price (UGX)	Cost Variance (Overrun)	Planned Physical Progress	Actual Progress
A	Civil Works for Rehabilitation of Kyenjojo – Fort Portal (50km) Road	71,435,766,901	119,848,340,398.18	67.77%	100.00%	99.65%
B	Civil Works for Rehabilitation of Fort Portal – Hima (56km) Road	94,838,583,709	108,685,016,930.51	14.60%	98.81%	53.00%
C	Civil Works for Rehabilitation of Hima - Katunguru (58km) Road	83,258,595,474	134,550,185,388.21	61.61%	100.00%	76.00%
D	Civil Works for Rehabilitation of Katunguru - Ishaka (59km) Road	103,852,641,242	118,807,421,580.85	14.40%	100.00%	70.90%

Source: Project Report, (2020)

Table 4. 2: Project time variation

Project Code	Projects	Commencement Date	Original Completion Date	Revised Completion date	Time Variance (Overrun)	Planned Physical Progress	Actual Progress
A	Civil Works for Rehabilitation of Kyenjojo – Fort Portal (50km) Road	29-Jun-2016	28-Dec-2017	31-Aug-2019	111.70%	100.00%	99.65%
B	Civil Works for Rehabilitation of Fort Portal – Hima (56km) Road	3-Jan-2018	25-Sep-2019	25-Feb-2020	24.29%	98.81%	53.00%
C	Civil Works for Rehabilitation of Hima - Katunguru (58km) Road	13-Feb-2017	13-Aug-2018	22-Sep-2019	74.18%	100.00%	76.00%
D	Civil Works for Rehabilitation of Katunguru - Ishaka (58km) Road	30-Jun-2017	29-Dec-2018	23-Aug-2020	110.24%	100.00%	70.90%

Source: Project Report, (2020)

Table 4. 3: Summary of causes and impacts of variation data from desk study

Project	Causes of Variation	Impacts of Variation	Mitigation strategies proposed
A	Design Change Scope Change Lack of decision making by client Delayed approval by client Limited equipment Delayed issue working drawings Contractor's financial constraints	Increase in project cost Project schedule delay Logistic delay Rework and demolition Loss of productivity	Availability of fund to avoid interest and claims for extension of time. Detailed site investigation. Conclusive design and contract documents. Contractor mobilizes all the required equipment. Client expedite approvals and responses. Client ensure that detailed and comprehensive designs are made before the start of the procurement process. Timely and comprehensive design review.
B	Design Change Failure to issue design at commencement Scope Change Poor Workmanship Delayed approval by client Client's financial constraints Limited equipment Delayed issue working drawings	Project schedule delay Rework and demolition Increase in project cost Poor quality of works Loss of productivity	Client expedite approvals and responses. Detailed site investigation. Conclusive design and contract documents. Client ensure that detailed and comprehensive designs are made before the start of the procurement process.
C	Design Change Scope Change Lack of decision making by client Client's financial constraints Delayed approval by client Design omissions Limited equipment Poor Workmanship Delayed issue working drawings	Increase in project cost Project schedule delay Logistic delay Rework and demolition Loss of productivity	Detailed site investigation. Conclusive design and contract documents. Client expedite approvals and responses.
D	Design Change Scope Change Delayed approval by client Client's financial constraints Limited equipment	Project schedule delay Increase in project cost Logistic delay Loss of productivity	Detailed site investigation. Conclusive design and contract documents. Client expedite approvals and responses.

4.2.1 Findings from desk study

The desk study was applied to four paved road rehabilitation projects. The projects documents reviewed were; contracts, bill of quantities and drawings, progress reports, claims and Audit reports. The documents were rich with data and information regarding the projects performance.

The desk study established that all the four projects experienced time and cost overrun. Kyenjojo – Fort Portal had the highest cost overrun (99.65%) and highest time overrun 99.63%).

The desk study finding identified twenty nine (29) causes of variation in answering the first objective. Due to repetition, it was filtered to eleven (11) least repetitive most common causes of variation to be used in questionnaire.

The causes identified were; design change, scope change, design omissions, lack of decision making by client, delayed approval by client, limited equipment, delayed issue working drawings, contractor's financial constraints, failure to issue design at commencement, poor workmanship, client's financial constraints.

From the desk study, twenty three (23) impacts of variation were identified. These variables were further synthesized to six (6) least repetitive most common impacts of variation which were to be used in the questionnaire. The impacts identified were; increase in project cost, project schedule delay, logistic delay, rework and demolition, loss of productivity and poor quality of works.

From desk study, sixteen (16) variation mitigation strategies were recommended. These variables were further synthesized to seven (7) least repetitive most common impacts of

variation. The variation mitigation strategies were; availability of fund to avoid interest and claims for extension of time, detailed site investigation, conclusive design and contract documents, contractor mobilizes all the required equipment, Client expedite approvals and responses, Client ensure that detailed and comprehensive designs are made before the start of the procurement process and timely and comprehensive design review.

4.3 Analysis of data from interviews

The interviews were conducted between selected experienced practitioners who are involved in paved road rehabilitation projects. Two interviews were conducted with 1 Resident Engineer from consultant and 1 Head of Department from Client as shown in Table 4.4.

4.3.1 Finding from interviews

From the interview, twenty (21) causes of variations in answering question one, six (6) impacts of variation in answering question two and ten (10) mitigation strategies to control variation were identified. These variables were checked in line with literatures in order to include them in the questionnaires. Most of the variables with the same meaning were the domain of the variables identified from literature review.

The finding from interview revealed that; Errors and omissions in design, delayed decision making, Change in specifications, Lack of stakeholders, I don't care attitude, Poor coordination and project management, Delayed acquisition of permits, Shortage of skilled manpower, Limited equipment, Poor Workmanship, Client's Financial constraints, Delayed Commencement of works, Failure to adhere to the supervisors advice, Delayed issuing of approval, Changes in scope, Changes in design, Poor scheduling, Delayed issue working drawings at commencement, Poor procurement process, Conflicting contract documents and

Contractor's Financial constraints were the causes which contributed to the occurrence of variation.

Table 4. 4 : Interview Results

Questions	Interviewee (1)	Interviewee (2)
What are the possible impacts of variation on road paved From your experience on road projects, causes of variation on paved road projects	Errors and omissions in design Delayed decision making Change in specifications Lack of stakeholders I don't care attitude Poor coordination and project management Delayed acquisition of permits Shortage of skilled manpower Limited equipment Delayed Commencement of works Failure to adhere to the supervisors advice Delayed issuing of approval Changes in scope Changes in design Poor scheduling Delayed issue working drawings at commencement Poor procurement process	Design Change Delayed communication Errors in design Change in scope/additional works Client's Financial constraints Lack of record of the original design Delayed acquisition of permits Poor Workmanship Contractor's Financial constraints Conflicting contract documents
	Disastrous logistic delays Increase in project cost Delays in project completion Loss of productivity Health and safety	Increase in project cost Delays in project completion Reworks and demolition Logistic delays

Questions	Interviewee (1)	Interviewee (2)
What strategy actions do you suggest to minimize variation on paved road projects	Adequate planning availability of fund detailed site investigation conclusive design and contract documents Stakeholder's engagement. Spend adequate time on pre-tender planning phase Design/specifications should fall within the approved budget Clear brief of the scope of works Effective scheduling in relation to scope of works coordination in the design stage to spot the noncompliance	Stakeholders engagement Detailed site investigation Clear scope definition Proper and restricted methods of procurement coordination in the design stage to spot the noncompliance conclusive design and contract documents

As identified in the interview, the common impacts of variation on paved road projects were; Increase in project cost, delays in project completion, reworks and demolition, logistic delays, loss of productivity and health and safety risk.

The interviewees suggested that variation on paved road projects can be mitigated by applying the following strategies; Effective scheduling in relation to scope of works, Clear brief of the scope of works, adequate planning, availability of fund, detailed site investigation, Proper and restricted methods of procurement, conclusive design and contract documents, Stakeholder's engagement, Spend adequate time on pre-tender planning phase, Design/specifications should fall within the approved budget and coordination in the design stage to spot the noncompliance

4.4 Response Rate from Questionnaires

The study quantitatively sampled 79 respondents from the target population of 97 in collecting data with regard to effect of variation on the performance of paved road projects in Uganda specifically the Rwenzori region. The seventy four (74) out of seventy nine (79) distributed

questionnaires were returned representing a response rate of 94%. The response rate was 93.67% (74). The results for the response rate are presented in Table 4.5.

Table 4. 5: Response rate

Response	Frequency	Percentage
Response	74	93.67%
Non response	5	6.33%
Total	**79**	**100%**

Source: *Primary data, (2020)*

From the study of 79 targeted respondents seventy four (74) respondents filled in and returned the questionnaire contributing to 93.67%. This commendable response rate was attributed to the data collection procedure, where the researcher engaged three Research Assistants to administer questionnaires and waited for respondents to fill in, while respondents who remained with the questionnaires were reminded to fill in the questionnaires through frequent phone calls and the questionnaires were picked once they were fully filled. Any clarifications sought by the respondents were attended to immediately. Based on Table 4.5, the response rate of 93.67% was in line with Amin (2005) who asserts that a response rate ≥ 0.5 (50%) is representative of a survey population. Therefore, the response rate of the study is a good representative of the study population.

4.5 Demographic Characteristics of the Respondents

The study targeted technical staff from UNRA headquarters and UNRA stations (Client), Consultants and Contractors at the different levels of management. The results on demographic characteristics of these respondents were established in the first section of the

questionnaire. They are presented in this section based on age, nature of employing organization, years of experience, position and level of education.

4.5.1 Respondents by age group

Table 4.6 presents summary results of respondents by age group. Majority of the respondents were in the age groups of 26-30 years (37.84%) and 31-35 years (32.43%). The categories targeted were of all technical staff and that is why the biggest percentage is between 26 and 35 years since this age group is too productive and strong to work. Positions for senior people are mostly limited to those who are 35 years and above represented by only 21.62%. It was important for the researcher to know the age of the respondents in order to ascertain reliability and accuracy of information obtained from them. From the findings, it can be inferred that the respondents were mature enough to provide reliable insights relevant to the study.

Table 4. 6: Respondents by age group

Age group(years)	Frequency	Percentage
(18-25)	6	8.11%
(26-30)	28	37.84%
(31-35)	24	32.43%
(36-45)	13	17.57%
(46 and above	3	4.05%
Total	**74**	**100.00**

Source: *Primary data, (2020)*

4.5.2 Categories of respondents

Figure 4.1 presents summary results of respondents by employment category. From the results, all the organizations that were targeted by the study were involved. Majority were from consultants with thirty seven respondents representing 50% followed by twenty six (26) from the contractors representing 35% and eleven (11) respondents were from the client

representing 15%. The responses from such a unbiased project team is reliable and represent a realistic project situation.

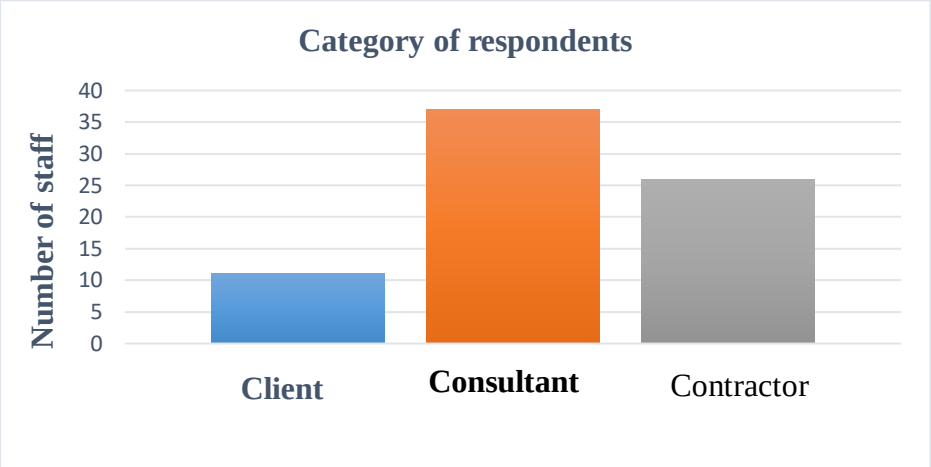

Figure 4. 1: Categories of respondents

Source: Primary data, (2020)

4.5.3 Respondents by level of Education

Table 4.7 presents summary results of respondents by their level of education. From the table of results, 35.1% of the respondents attained the diploma level, 45.9% are graduates, 17.6% are post graduates, and only 1.4% has certificate. From the responses in the questionnaires it was noted that majority of the respondents (45.9%) were graduates level. From the study findings, the researcher could generally infer that most respondents were well educated and knowledgeable and therefore had relevant information on the areas of researcher study.

Table 4. 7: Respondents by level of education

Education level	Field of Study	Frequency	Percentage
Certificate	Building and Concrete Practice	1	1.35%
Diploma	Civil Engineering	24	32.43%
	Water Engineering	2	2.70%
Degree	BSc in Civil Engineering	21	28.38%
	Construction Management	5	6.76%
	BSc. in Land and Surveying	4	5.41%
	BSc. In Quantity Surveying	4	5.41%
Post Graduate	MSc. Highways Engineering	5	6.76%
	MSc. Project Planning & Management	5	6.76%
	MSc in Transportation Engineering	1	1.35%
	PGD in Project Planning and Management	1	1.35%
Other	Vocational Studies	1	1.35%
Total		74	**100%**

Source: *Primary data, (2020)*

4.5.4 Distribution of respondents' years of experience in road construction projects

Data on the respondents' years of experience were obtained from the questionnaires responses. The data gave a reflection of the respondents' knowledge on the topic under study. The results were as indicated in Figure 4.2. The results in Figure 4.2 revealed that majority of respondents had experience in road construction. Fifty-one respondents representing 69% of the respondents had a working experience in road project of 1-9 years. Fourteen respondents representing 19% had a working experience which was between 10-15 years and five respondents representing 7% had experience in road construction between 16-20 years while four of them representing 5% had experience above 20 years. Therefore, the study findings are unbiased in regards to the years of experience of the respondents and since the respondents

had worked on paved road projects for some good years, therefore, they had a lot of authority over their responses. The findings from such a mature respondents is considered realistic.

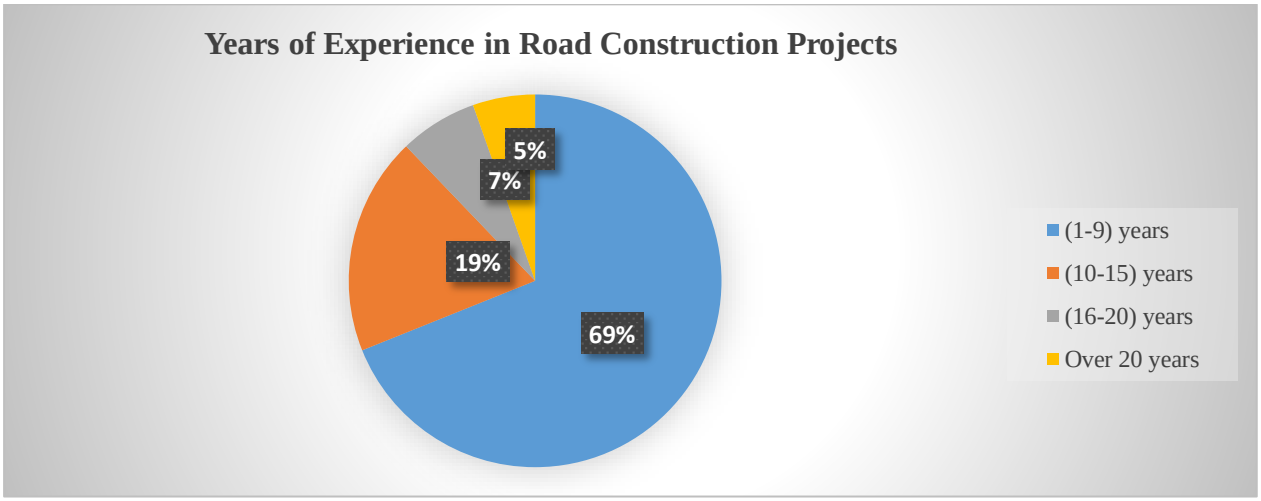

Figure 4. 2: Respondents' years of experience in road construction projects

Source: *Primary data, (2020)*

4.5.5 Position of respondents in Organization

Table 4.8 shows summary results of respondents by positions held. The results indicate that the technical staff from all the organizations answered the questionnaires. This indicates that the respondents had the skills and knowledge to perform their duties and therefore the responses to the questionnaires were considered to be technically reliable and would therefore lead to reliable and dependable findings.

Table 4. 8: Position of respondents in the Organization

Position	Frequency	Percent
Head of construction and supervision team	1	1.4%
Contract manager	1	1.4%
Project Manager	4	5.4%
Deputy Project Manager	4	5.4%
Site Engineer	4	5.4%
Materials Engineer	5	6.8%
Surveyor	4	5.4%
CAD Engineer	8	10.8%
Foreman	3	4.1%
Quantity Surveyor	3	4.1%
Resident Engineer	1	1.4%
Deputy Resident Engineer	1	1.4%
Assistant Surveyor	7	9.5%
Lab technicians	15	20.3%
Inspectors of Works	7	9.5%
Highway Engineer	2	2.7%
Project Engineer	2	2.7%
Station Manager	2	2.7%
Total	**74**	**100.00%**

Source: *Primary data, (2020)*

4.6 Empirical Findings from Questionnaires

4.6.1 Causes of variation on paved road projects

4.6.1.1 Causes of variation related to the client

According to Table 4.9, the means < 3.985 (less than 3.985) indicate causes with negligible influence on variation and that above >3.985 (greater than 3.985) indicate causes with strong influence on variation.

The results in Table 4.9 show univariate analysis of all variables under causes of variation. It summarizes these variables by giving the frequency and percentages indicating how respondents responded to the different questions in the questionnaire under the sub group of causes of variation. It also includes the mean and standard deviation of each statement. The

causes were ranked in descending order in relation to the mean.

For purposes of interpretation, it should be noted that scores for strongly disagree and disagree are grouped to represent negligible influence while agree and strongly agree scores are grouped to represent respondents who believe that the causes of variation strongly influence performance of paved road project. In addition, neutral represents respondents whose opinion was unclear whether the cause influences variation or not.

Table 4. 9: Descriptive statistics for causes of variation related to the client

Variables	SDA(1)	DA(2)	NE(3)	A(4)	SA(5)	Mean	S.D	Rank
Delayed issuing of approval documents	1 1.40%	2 2.70%	6 8.10%	33 44.60%	32 42.24%	4.26	0.886	1
Changes in scope	1 1.40%	4 5.40%	6 8.10%	33 44.60%	30 40.50%	4.18	0.897	2
Changes in design	3 4.10%	2 2.70%	4 5.40%	39 52.70%	26 35.10%	4.12	0.936	3
Financial constraints	1 1.40%	4 5.40%	6 8.10%	40 54.10%	23 31.10%	4.08	0.856	4
Poor scheduling	1 1.40%	9 12.20%	8 10.80%	27 36.50%	29 39.20%	4.00	1.06	5
Failure to issue working drawings at the start of the project	2 2.70%	7 9.50%	10 13.50%	31 41.90%	24 32.40%	3.92	1.044	6
Poor procurement process	2 2.70%	14 18.90%	12 16.20%	22 29.70%	24 32.40%	3.70	1.19	7
Conflicting contract documents and clauses	1 1.40%	16 21.60%	11 14.90%	28 37.80%	18 24.30%	3.62	1.119	8
						3.985		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree
S.D= Standard Deviation

Source: *Primary data, (2020)*

According to Table 4.9, three respondents representing 4.1% of the total number of respondents disagreed that there was influence of delayed issuing of approval documents by client while sixty-five respondents representing 86.84% of the total number of respondents agreed that there is a strong influence of delayed issuing of approval documents on variation. Six respondents representing 8.1% of the total number of respondents were not sure whether delayed issuing of approval documents had a great influence on variation on paved road projects.

The mean of 4.26 implied that majority of the respondents believed that delayed issuing of approval documents had a strong influence on variation on paved road projects and was ranked in 1st position. Review of monthly progress and claim evaluation reports established that there were a number of cases of delayed approval of documents and decision making by the client. For instance on Hima- Katunguru, the consultant submitted target quantities with cost breakdown to employer on 16th October 2018 but change order which revised the scope of works from 57km to 28km was issued by employer on 10th September, 2019 when the contract was scheduled to expire on 22nd September 2019. Similarly, on Kyenjojo –Fort Portal road change order which revised the wearing course from double bituminous surface treatment (DBST) to asphalt concrete (AC) for 50km was submitted to employer for action on 30th June 2018 and received employer's approval on 17th May, 2019 when the contract was expiring on 31st August 2019. Furthermore, on Ishaka – Katunguru, design and estimate for additional works was submitted to employer for action on 13th January 2020 but received approval on 12th May 2020 when the contract was scheduled to expire on 6th July 2020 and this caused a claim and resulted into award of 87 days extension of time. The finding agrees with previous findings by Gray and Hughes (2001) who observed that prompt decision making is an

important factor for project success. Failure to make the decision efficiently may result in the delay, causing the need for variation due to cost increments.

It was also established in Table 4.9 that five respondents representing 6.8% of the total number of respondents disagreed that there was influence of changes in scope by client on variation while sixty-three respondents representing 85.1% of the total number of respondents agreed that there is a strong influence of changes in scope on variation. Six respondents representing 8.1% of the total number of respondents were not sure whether changes in scope had influence on variation on paved road projects.

The mean of 4.18 implied that more respondents believed that changes in scope had a strong influence on variation on paved road projects and was ranked in 2nd position. Review of progress and claim evaluation reports established that there were a number of cases of change in scope caused by the client. For instance on Hima- Katunguru, the employer revised the scope of works from 57km to 28km and was approved by Employer on 10th September, 2019. The scope change was caused by change from double bituminous surface treatment to expensive Asphalt concrete and need for 6 double celled box culverts. Similarly, on Kyenjojo –Fort Portal road change order which revised the wearing course from double bituminous surface treatment (DBST) to asphalt concrete (AC) for 50km was approved on 17th May, 2019. Furthermore, on Ishaka – Katunguru, additional 2.6km of road to West Ankole diocese received approval on 12th May 2020 causing time variation of 87 days and cost variance of UShs. 14,996,949,801 on physical works representing 14.44% of original contract price excluding cost of claim. The finding agrees with Aftab (2014) who carried out a study on contractor perspective on time overrun factors in Malaysian construction projects, he found out that the major causative factors contributing to construction time overrun are frequent design changes, change in the scope of the project, financial difficulties of owner, delays in

decisions making and unforeseen ground condition. CII, (1990), established that change of plan or scope of the project is one of the most significant causes of variation in construction projects. Memon et. al., (2011) also pointed out that change of plan or scope of the project is a common issue faced by construction industry and is reported for affecting project time and cost performance. It is one of the extremely severe factors of variation in construction projects.

The findings further indicate that five (6.80%) of the total number of respondents disagreed that there was influence of changes in design on variation while fifty-five (74.3%) of the total number of respondents agreed that there is a strong influence of changes in design on variation and four respondents representing 5.40% of the total number of respondents were not sure whether changes in design had a great influence on variation on paved road projects.

The mean of 4.12 implied that many respondents believed that changes in design had a strong influence on variation on paved road projects and was ranked in 3rd position. Interview with consultant established that much of the design changes were bond to inadequate investigation and absence of records of the previous design of the rehabilitation and thus the details of previous investigation are missed out. It was also noted that the copy and paste approach made contributed to the change in design as ground conditions differs. He added that none involvement of stakeholders in the design contributed into the design change structures on Hima- Katunguru road. For instance, a proposed 1200mm diameter cross culvert was changed to a box culvert of 4m wide and 1.5m high at km 22+070 and inclusion of a new box culvert at km 33+520. Review of progress report of Kyenjojo - Fort Portal established that previous design did not include provision of approach slabs on all the bridges. The finding agrees with previous findings. Changes in design were frequent in projects where construction starts

before the design is finalized Aftab *et. al*., (2014). Such changes affect the project in various ways depending on the timing of the change (Alaghbari *et. al*., 2007).

Furthermore, the study also established that five respondents representing up to 6.80% of the total number of respondents strongly believed that there was negligible influence of financial constraints leading to interest on delayed payment on variation while sixty three respondents representing 85.20% of the total number of respondents believed that there is a strong influence of financial constraints leading to interest on delayed payment on variation. Six respondents representing 8.10% of the total number of respondents were not sure whether financial constraints leading to interest on delayed payment had a great influence on variation on paved road projects.

The mean of 4.08 implied that a good number of respondents believed financial constraints leading to interest on delayed payment had a strong influence on variation on paved road projects and was ranked in 4th position. Review of IPCs for the contractors established that all the four projects suffered effect of delayed payment. On Kyenjojo- Fort Portal interest charged by Contractor on delayed payment was UShs.. 1,635,383,648.71 representing 1.36% increase in project cost, Fort Portal – Hima project interest charged was UShs. 2,336,267,803 representing 2.46% increase in project cost while on Hima – Katunguru project interest on delayed payment amounted UShs. 1,227,488,01457 representing 1.47% increase in project cost and on Katunguru – Ishaka project interest charged by Contractor on delayed payment was UShs. 556,167,796 representing 0.54% increase in project cost. This in agreement with Auditor General's report (2020) which stated that the expenses of interest on delayed payment are considered nugatory and should have been avoided had payments been effected within the contractual period. The issue was attributed to inadequate funding leading to the entities'

inability to settle certificates of approved works within the contractual period, which makes contractors invoke the clause in the contract and claim interest on unpaid certificates. Financial problems of the owner affect severely the quality and progress of the project. This problem can lead to change in work schedules and specifications, affecting the quality of the construction Aftab et. al., (2014). Abdulmalik and Abdullahi (2017) recommends that clients should release fund whenever it is due to the contractors so that to avoid delays and subsequent cost overrun.

The study also established that nine (12.2%) of the total number of respondents strongly believed that there was negligible influence of failure to issue working drawings at the start of the project by client on variation while fifty five respondents representing 74.3% of the total number of respondents believed that there is a strong influence of failure to issue working drawings at the start of the project on variation and ten respondents representing 13.5% of the total number of respondents were not sure whether failure to issue working drawings at the start of the project had a great influence on variation on paved road projects.

The mean of 3.92 implied that a low number of the respondents believed that failure to issue working drawings at the start of the project had a strong influence on variation on paved road projects and was ranked in 6th position. Review of progress and claim evaluation reports established that there were a number of cases of failure to issue working drawings at the start of the project caused by the client. For instant, on Ishaka – Katunguru, works commence on 30th June 2017 and design was issued by the client on 15th December 2017. This delay caused seven months extension of time. On Kyenjojo –Fort Portal road final design was issued to the contractor on 9th August, 2017 when works commenced on 29th June 2016. Claim of extension

of time due to this late provision of design drawings and late provision of control points caused 154 days of extension of time with cost.

On the other hands, on Fort Portal - Hima project, the road design was reviewed by UNRA and some of the revised designs delayed to be issued to the contractor. Review of correspondences showed that the first batch of revised engineering drawings were submitted to the contractor on 11th October 2018 but certain details were pending some of which included the design of Fort Portal and Rwimi towns and the box culvert at km 44+472. It was noted that these outstanding revised designs were submitted on 23rd October 2019 implying that they delayed by more than one year from the date of submission of the first batch of the revised drawings.

Similarly, on Hima- Katunguru project, the absence of detailed design drawings after contract signing necessitated the Employer to conduct a detailed design of the project road that could be issued to the contractor for implementation. The reviewed design report indicated that the design process started in December 2016 and as per letter ref LASA/80020/Hima-Katunguru/2018/1210, the first drawing was issued on 28th July 2017 and the final on 23rd January 2018 as stated in letter ref LASA/80020/Hima-Katunguru/2019/239. This was contrary to section A9 Part A of the Scope of Works in the works contract which states that the contractor will be supplied with approved strip maps at contract commencement. Therefore, this delayed and long design process resulted in delay in issuance of these drawings by the Engineer. Consequently, this formed grounds for an award of 156 days as compensation in a claim for delay damages, disruptions and prolongation costs by the Contractor and increase in implementation costs in terms of time-related obligations. The finding agrees with previous findings by Aftab *et. al*., (2014) who observed that changes in design were frequent

in projects where construction starts before the design is finalized. Aftab *et. al.*, (2014) added that inadequate design can be a frequent cause of variation in construction projects. Inadequate working drawing details can result in misinterpretation of the actual requirements for the project causing variation in the project (Arain *et. al., 2004*).

It was further established in Table 4.9 that sixteen respondents representing 21.60% of the total number of respondents disagreed that there was influence of poor procurement process on variation while forty six respondents representing 62.10% of the total number of respondents agreed that there is a strong influence of poor procurement process on variation and twelve respondents representing 16.20% of the total number of respondents were not sure whether poor procurement process had a great influence on variation on paved road projects.

The mean of 3.7 implied that lower number of the respondents believed that poor procurement process had a strong influence on variation on paved road projects and was ranked in 7th position. Procurement delays have various adverse effect on other processes in the construction cycle (Fisk, 1997). Wang (2000) argued that other processes in the construction cycle are affected by poor procurement processes. Consequently, variation are required.

It was also established in Table 4.9 that, seventeen respondents representing 23.00% of the total number of respondents disagreed that there was influence of conflicting contract documents and clauses on variation while forty six respondents representing 62.10% of the total number of respondents agreed that there is a strong influence of conflicting contract documents and clauses

on variation and eleven respondents representing 14.90% of the total number of respondents were not sure whether conflicting contract documents and clauses had a great influence on variation on paved road projects.

The mean of 3.62 implied that the lowest number of the respondents believed that conflicting contract documents and clauses had a strong influence on variation on paved road projects and was ranked in 8th position. Conflict in contract documents can lead to misinterpretation of the actual project requirement (CII, 1986). It is important for the contract documents to be clear and precise. Inadequate details in the contract documents leads to project delays or variation in cost (CII, 1990a).

4.6.1.2 Causes of variation related to consultants

From Table 4.10, the means < 3.671 (less than 3.671) indicate causes with negligible influence on variation and that above >3.671 (greater than 3.671) indicate causes with strong influence on variation.

It was established in Table 4.10 that, three respondents representing 4.10% of the total number of respondents disagreed that there was influence of changes in design on variation while sixty-five respondents representing 87.90% of the total number of respondents with a mean of 4.16 agreed that there is a strong influence of changes in design on variation and six respondents representing 8.10% of the total number of respondents were not sure whether changes in design had a great influence on variation on paved road projects.

The mean of 4.16 implied that majority of the respondents believed that changes in design had a strong influence on variation on paved road projects and was ranked in 1st position. Review

of monthly progress reports established that on Hima- Katunguru road, pavement layer was changed to include rock fill from km 36+200 to km 37+600. Concrete line drain was changed to tunnel for half a kilometer in Hima town council. Change of access culverts on Kasese town roads sections from 600mm diameter to 1200mm diameter pipe culverts. On the other hands, on Kyenjojo – Fort Portal the pavement layers were changed from 225mm CRR base, 50mm asphalt to 150mm CRR base and 60mm asphalt. The finding agrees with previous findings by Arain *et al*., (2004) who observed that design changes by the consultant is a norm in modern professional practice. Design changes were frequent in projects commenced before the design were finalized (Aftab *et. al*., 2014). Such changes affect the project in numerous ways subject to the timing such change (Alaghbari *et al*., 2007).

Table 4. 10: Descriptive statistics of causes of variation related to Consultants

Variables	SDA (1)	DA (2)	NE (3)	A (4)	SA (5)	Mean	S.D	Rank
Changes in design	1 1.40%	2 2.70%	6 8.10%	40 54.10%	25 33.80%	4.16	0.794	1
Design flaws (errors and omissions in design)	1 1.40%	6 8.10%	9 12.20%	39 52.70%	19 25.70%	3.93	0.912	2
Delayed decision making	3 4.10%	6 8.10%	7 9.50%	37 50.00%	21 28.40%	3.91	1.036	3
Change in specifications	1 1.40%	12 16.20%	9 12.20%	31 41.90%	21 28.40%	3.8	1.072	4
Lack of stakeholders and the community Engagement during design implementation	6 8.10%	16 21.60%	4 5.40%	26 35.10%	22 29.70%	3.57	1.335	5
Lack of judgment and experience	4 5.40%	19 25.70%	16 21.60%	19 25.70%	16 21.60%	3.32	1.229	6
I don’t care attitude	8 10.80%	23 31.10%	16 21.60%	14 18.90%	13 17.60%	3.01	1.287	7
			Average Mean			**3.671**		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree
S.D= Standard Deviation

Source: *Primary data, (2020)*

It was also established in Table 4.10 that, seven respondents representing 9.50% of the total number of respondents disagreed that there was influence of design flaws (errors and omissions in design) on variation while fifty-eight respondents representing 78.40% of the total number of respondents agreed that there is a strong influence of design flaws on variation and nine respondents representing 12.20% of the total number of respondents were not sure whether design flaws had a great influence on variation on paved road projects.

The mean of 3.93 implied that a larger number of the respondents believed that design flaws had a strong influence on variation on paved road projects and was ranked in 2nd position. Review claim evaluation report for Ishaka – Katunguru project, it was established that there were errors in the design issued to the contractor between km 0+000 to 25+000 and was revised on 15th December 2017. On Hima – Katunguru project, the design of box culvert omitted provision of approach slab. This was discovered after defect had developed when the base had already been laid which interrupted asphalt works due to rework. Therefore, the impact of design errors is large, as Koskela (1992) suggests that it "sometimes seems that the wastes caused by design are larger than the cost of the design itself". A survey in Kuwait reported that defective design among the most significant risks to project delays (Kartam *et. al.*, 2001).

Furthermore, it was established that nine respondents representing 12.20% of the total number of respondents disagreed that there was negligible influence of delayed decision making on variation while fifty-eight respondents representing 78.40% of the total number of respondents agreed that there is a strong influence of delayed decision making on variation. Seven respondents representing 9.50% of the total number of respondents were not sure whether delayed decision making had a great influence on variation on paved road projects.

The mean of 3.91 implied that a large number of respondents believed that delayed decision-making had a strong influence on variation on paved road projects and was ranked in 3rd position. Document established that on Fort Portal – Hima project, delays in issuance of instructions and approvals by supervising consultants and UNRA were noted. These delays not only affect the smooth implementation of works but in some cases attract claims from the contractors. For example, on 10th December 2019, the consultant requested the contractor to submit a proposal to execute the additional works. The contractor then submitted his proposal on 20th January 2020; however, it was noted that the response to the contractor's proposal delayed by more than 3 months as seen in the letter dated 22nd May 2020. Prompt decision-making is an important factor for project success (Gray & Hughes, 2001). Failure to make efficient decision may result in delay, triggering the need for variation from cost increments.

According to Table 4.10, it was established that, twenty-two respondents representing 29.70% of the total number of respondents disagreed that there was influence of failure to engage the stakeholders on variation while forty-eight respondents representing 64.80% of the total number of respondents believed that there is a strong influence of failure to engage the stakeholders on variation. Four respondents representing 5.40% of the total number of respondents were not sure whether failure to engage the stakeholders had a great influence on variation on paved road projects.

The mean of 3.57 implied that a low number of respondents believed that failure to engage the stakeholders had a negligible influence on variation on paved road projects and was ranked in 5th position. An interview with the Resident Engineer who ranked stakeholders engagement second revealed that there was evident of lack of stakeholders Engagement on Hima-

Katunguru road where stakeholders were not involved in the design of drainage structures and therefore the built structures ended up under performing. He added that stakeholders especially the community and road users have history of the area and also understand the climate of the area. They are therefore very important in the design because information from them needs to be used to come up with proper structures. On the same road, it was observed that the client needed more space to implement the proposed designs and this called for land acquisition yet it was not budgeted for. However, because the different stakeholders were not fully brought on board it took a lot of time to acquire the land. The finding agrees with previous findings like Chinyio and Olomolaiye (2010) who stated that stakeholders can affect an organization's functioning, goals, development and even survival. The study further identified that, stakeholders are valuable when they aid to achieve goals and unfriendly when they oppose the mission. Stakeholders are pivotal to the successful completion of projects as their reluctance to continuously support the project vision or objectives leads project failure. Ayuso *et al.,* (2011*)* established that knowledge obtained from stakeholder engagement affects the sustainable innovation orientation of the firm.

According to Table 4.10, it was established that twenty three respondents representing 25.70% of the total number of respondents disagreed that there was influence of lack of judgment and experience on variation while thirty five respondents representing 47.30% of the total number of respondents believed that there is a strong influence of lack of judgment and experience on variation. Sixteen respondents representing 21.60% of the total number of respondents were not sure whether lack of judgment and experience had a great influence on variation on paved road projects. The mean of 3.32 implied that a less number of respondents believed that lack of judgment and experience had a negligible influence on variation on paved road projects and was ranked in 6^{th} position.

According to Table 4.10, it was established that thirty one respondents representing 41.90% of the total number of respondents disagreed that there was influence of i don't care attitude on variation while twenty seven respondents representing 36.50% of the total number of respondents believed that there is a strong influence of i don't care attitude on variation. Sixteen respondents representing 21.60% of the total number of respondents were not sure whether I don't care attitude had a great influence on variation on paved road projects. The mean of 3.01 implied that a least number of respondents believed that I don't care attitude had a negligible influence on variation on paved road projects and was ranked in 7th position.

4.6.1.3 *Causes of variation related to contractors*

The means < 3.678 (less than 3.678) indicate causes with negligible influence on variation and that above >3.678 (greater than 3.678) indicate causes with strong influence on variation.

According to Table 4.11, seven respondents representing 9.50% of the total number of respondents disagreed that poor coordination and project management practices had influence on variation on paved road project while fifty nine respondents representing 79.70% of the total number of respondents agreed that poor coordination and project management practices had a strong influence on variation and nine respondents representing 12.20% of the total number of respondents were not sure whether poor coordination and project management practices had a great influence on variation on paved road projects.

The mean of 4.03 implied that majority of the respondents believed that poor coordination and project management practices had a strong influence on variation on paved road projects and was ranked in 1st position. This is in agreement with findings by Shibi (2018); Aftab and

Ismail. (2014) who listed poor coordination and project management practices by contractors as one of the causes of variation on road construction projects. Lack of strategic planning is a pertinent cause of project variation where construction starts before the final design for example in design and build contracts (O'Brien, 1998). On Kyenjojo – Fort Portal review of claim evaluation report established that the contractor commenced with earthworks on 28th May 2018 without an approved and approved design was issued for section between km 25+200 – 54+300 between 13st October 2018 and 24th October 2018 via Engineer's Letter, Ref. No. CS/FHR/113-2018 and this caused an extension of time by 63 days.

Table 4. 11: Descriptive statistics of causes of variation related to Contractors

Variables	SDA (1)	DA (2)	NE(3)	A (4)	SA (5)	Mean	S.D	Rank
Poor coordination and project management	3 4.10%	4 5.40%	8 10.80%	32 43.20%	27 36.50%	4.03	1.033	1
Delayed acquisition of permits	4 5.40%	7 9.50%	9 12.20%	37 50.00%	17 23.00%	3.76	1.083	2
Shortage of skilled manpower	3 4.10%	6 8.10%	11 14.90%	42 56.80%	12 16.20%	3.73	0.969	3
Limited equipment to perform work	4 5.40%	12 16.20%	9 12.20%	25 33.80%	24 32.40%	3.72	1.233	4
Poor Workmanship	1 1.40%	16 21.60%	11 14.90%	28 37.80%	18 24.30%	3.62	1.119	5
Financial constraints	3 4.10%	13 17.60%	8 10.80%	36 48.60%	14 18.90%	3.61	1.108	6
Delayed Commencement of works	6 8.10%	11 14.90%	12 16.20%	27 36.50%	18 24.30%	3.54	1.241	7
Failure to adhere to the supervisors advice	3 4.10%	17 23.00%	16 21.60%	23 31.10%	15 20.30%	3.41	1.169	8
			Average Mean			**3.678**		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree

S.D= Standard Deviation

Source: *Primary data, (2020)*

It was also established in Table 4.11 that eleven respondents representing 14% of the total number of respondents disagreed that there was influence of delayed acquisition of legal documents especially permits on variation on paved road project while fifty four respondents representing 73% of the total number of respondents agreed that there is a strong influence of delayed acquisition of legal documents especially permits on variation and nine respondents representing 12.20% of the total number of respondents were not sure whether delayed acquisition of legal documents especially permits had a great influence on variation on paved road projects.

The mean of 3.76 implied that most respondents believed that delayed acquisition of legal documents especially permits had a strong influence on variation on paved road projects and was ranked in 2nd position. The finding agrees with previous finding by Shibi (2018) who listed delayed acquisition of legal documents by Contractor especially permits as one of the causes of variation in road construction projects.

Nine respondents representing 12.20% of the total number of respondents disagreed that there was negligible influence of shortage of skilled manpower on variation on paved road project while fifty four respondents representing 73.00% of the total number of respondents agreed that there is a strong influence of shortage of skilled manpower on variation. Eleven respondents representing 14.90% of the total number of respondents were not sure whether shortage of skilled manpower had a great influence on variation on paved road projects.

The mean of 3.73 implied that more respondents believed that shortage of skilled manpower had a strong influence on variation on paved road projects and was ranked in 3rd position. This is in agreement with findings by Aftab and Ismail (2014) who listed shortage of skilled

manpower as one of the causes of variation in road construction projects. Skilled manpower is one of the major resources required for technological projects (Arain *et. al*., 2004). Variation and delays may occur due to shortages of skilled labor (Aftab *et. al*., 2014).

The findings further indicate that seventeen respondents representing 23.00% of the total number of respondents disagreed that poor Workmanship had influence on variation while forty-six respondents representing 62.10% of the total number of respondents agreed that there was influence of poor Workmanship on variation. Eleven respondents representing 14.9% of the total number of respondents were not sure whether poor Workmanship had a great influence on variation on paved road projects.

The mean of 3.62 implied that less respondents believed that poor Workmanship had a strong influence on variation on paved road projects and was ranked in 5th position. The finding agrees with previous findings. Defective workmanship may lead to demolition and rework in construction projects and this results in delay and increased cost (Aftab *et. al*., 2014).

It was also established as seen in Table 4.11 that sixteen respondents representing 21.70% of the total number of respondents disagreed that there was negligible influence of financial constraints on variation while fifty respondents representing 67.50% of the total number of respondents agreed that there is a strong influence of financial constraints on variation. Eight respondents representing 10.80% of the total number of respondents were not sure whether financial constraints had a great influence on variation on paved road projects.

The mean of 3.61 implied that few respondents believed that financial constraints had a strong influence on variation on paved road projects and was ranked in 6th position. On Kyenjojo – Fort Portal Project, the Contractor on 23rd November 2018 notified the Consultant about their

intension to slow down works due to the Employer's flouting contract conditions of payment timelines in respect of IPCs 7, 8 and 9. The finding agrees with previous findings Aftab et. al., (2014) who stated that construction is a labor intensive industry. If a contractor encounters financial difficulties during the project implementation, it may result in lacking of resource availability. Consequently, project progress is affected which may necessitate variation and time extension.

It was also established in Table 4.11 that seventeen respondents representing 23.00% of the total number of respondents disagreed that there was negligible influence of delayed commencement of works on variation while forty five respondents representing 60.80% of the total number of respondents agreed that there is a strong influence of delayed commencement of works on variation and twelve respondents representing 16.20% of the total number of respondents were not sure whether delayed commencement of works had a great influence on variation on paved road projects. The mean of 3.54 implied that less number of respondents believed that delayed commencement of works had a strong influence on variation on paved road projects and was ranked in 7^{th} position.

It was also established in Table 4.11 that twenty respondents representing 27.10% of the total number of respondents disagreed that there was negligible influence of failure to adhere to the supervisors' advice on variation while thirty eight (51.40%) of the total number of respondents agreed that there is a strong influence of failure to adhere to the supervisors' advice on variation. Sixteen respondents representing 21.60% of the total number of respondents were not sure whether failure to adhere to the supervisors' advice had a great influence on variation on paved road projects. The mean of 3.41 implied that less number of respondents believed

that failure to adhere to the supervisors' advice had a strong influence on variation on paved road projects and was ranked in 8th position.

4.6.1.4 *Comparison of Responses from Higher position Respondents and the lower position Respondents*

Based on the heterogeneous nature of the respondents which included up to twenty two (29.73%) of the total 74 respondents are of lower position staff in terms of decision making on project setting. The lower cadres consisted of Seven (9.46%) Assistant Surveyors and fifteen (20.27%) Laboratory Technician. The effect of their views on the study findings was assessed as in Table 4.12.

Table 4. 12: Comparisons of the different groups of Respondents by their qualification

Category		Combined Views		Lowly qualified Respondents		Highly qualified Respondents	
	Variable	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Consultant related	Changes in design	4.16	1	4.14	1	4.31	1
	Design flaws (errors and omissions in design)	3.93	2	3.82	2	3.98	4
	Delayed decision making	3.91	3	3.36	3	4.13	2
	Change in specifications	3.8	4	3.32	4	4	3
	Lack of stakeholders and the community Engagement during design implementation	3.57	5	3.18	6	3.73	5
	Lack of judgment and experience	3.32	6	3.23	5	3.37	6
	I don't care attitude	3.01	7	3.14	7	2.96	7
	Mean of Means	**3.671**		**3.455**		**3.783**	
Contractor Related	Poor coordination and project management	4.03	1	4.05	2	4.02	1
	Delayed acquisition of permits	3.76	2	3.91	4	3.69	2
	Shortage of skilled manpower	3.73	3	3.95	3	3.63	4
	Limited equipment to perform work	3.72	4	4.09	1	3.56	6
	Poor Workmanship	3.62	5	3.68	5	3.6	5
	Financial constraints	3.61	6	3.41	7	3.69	3
	Delayed Commencement of works	3.54	7	3.64	6	3.5	8
	Failure to adhere to the supervisor's advice	3.41	8	3.14	8	3.52	7
	Mean of Means	**3.678**		**3.733**		**3.651**	

Table 4.12 Continues

Categor		Combined Views		Lowly qualified Respondents		Highly qualified Respondents	
	Variable	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Client Related	Delayed issuing of approval documents	4.26	1	4.27	1	4.25	1
	Changes in scope	4.18	2	4.14	2	4.19	2
	Changes in design	4.12	3	4.05	4	4.15	3
	Financial constraints	4.08	4	4.09	3	4.08	4
	Poor scheduling	4	5	4	5	4	5
	Failure to issue working drawings at the start of the project	3.92	6	3.86	6	3.94	6
	Poor procurement process	3.7	7	3.82	7	3.65	8
	Conflicting contract documents and clauses	3.62	8	3.45	8	3.69	7
	Mean of Means	**3.985**		**3.96**		**3.994**	

According to Table 4.12, the lower cadres are in agreement with findings from higher cadres. However, a significant deviation was observed between responses from higher cadres regarding financial constraint which ranked third under contractor's related causes of variation and seventh by lower cadres which caused the combined view to rank sixth.

4.6.2 Descriptive statistics of Impacts of variation on Performance

From the study conducted using questionnaires, different opinions were received on the impacts of variation believed to be influencing performances of paved road rehabilitation projects. The opinions were ranked to establish their degree of influence as presented in subsequent sections.

For purposes of interpretation it should be noted that scores for strongly disagree and disagree were grouped to represent negligible influence, while agree and strongly agree scores were grouped to represent respondents who believe that the impacts of variation strongly influence performance of paved road project. In addition, neutral represents respondents whose opinion was unclear whether the impact influences variation or not. The means < 4.053 (less than 4.053) indicate impacts with negligible influence on variation and that above >4.053 (greater than 4.053) indicate impacts with strong influence on variation.

4.6.2.*1 Descriptive statistics of Impacts of variation in relation to time*

Impacts of variation as observed by many researchers and their occurrence have an adverse impact on project performance. Thomas *et. al*., (2002) suggest that variability generally impedes project performance.

According to Table 4.13, two respondents representing 2.70% of the total number of respondents disagreed that logistics delays had influence on project completion time while sixty-seven respondents representing 90.50% of the total number of respondents agreed that logistics delays had a strong influence on variation. Five respondents representing 6.80% of the total number of respondents were not sure whether logistics delays had a great influence on paved road projects completion time.

The mean of 4.41 implied that majority of the respondents believed that logistics delays had a strong influence on project completion time and was ranked in 1st position with a mean value of 4.41. Review of change order one for Kyenjojo- Fort Portal project which revised the design of surfacing materials from double bituminous surface treatment (DBST) to asphalt concrete (AC) required mobilization of different set of equipment such as an asphalt plant and a paver. There was also a change of bitumen from pengrade 80/100 to pengrade 50/70 and introduction of tack coat K1 60 cations emulsion which was completely a new material. Due to procurement regulation that allows variation in project cost not exceeding 15% caused a split in the contract into two contracts as rehabilitation contract and supply and lay tack coat and asphalt concrete. The procurement process delayed by over a year with the new supply and lay contract awarded for 9 months contract period. Similarly, in Hima – Katunguru the split of contract into phase 1 covering works from km 29+000 to km 57+080 and Phase 2 covering works from km 0+000 to km 29+000 resulted into a new procurement. The procurement which

commenced in December 2019 was not yet finalized by November 2020. This is in agreement with findings by Fisk (1997) and Hester *et. al.,* (1991) who observed that logistics delays may occur due to variation requiring new materials and equipment. Logistics delays were significant effects of variation in construction projects and are commonly experienced in construction projects where variation in the construction phase required new materials, tools and equipment Hester *et. al*., (1991).

Findings in Table 4.13 indicate that three respondents representing 4.10% of the total number of respondents strongly believed that variation was not the cause of delayed project completion while sixty two respondents representing 83.70% of the total number of respondents believed that variation was the cause of delayed project completion and nine respondents representing 12.20% of the total number of respondents were not sure whether variation was the cause of the delay on completion of the project.

Table 4. 13: Impacts of variation in relation to project completion time

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly

Variables	**SDA(1)**	**DA(2)**	**NE (3)**	**A (4)**	**SA (5)**	**Mean**	**S.D**	**Rank**
Logistics delays	0 0%	2 2.70%	5 6.80%	28 37.80%	39 52.70%	4.41	0.739	1
Delays on project completion	1 1.40%	2 2.70%	9 12.20%	34 45.90%	28 37.80%	4.16	0.844	2
Increase unnecessary procurement delays	4 5.40%	4 5.40%	3 4.10%	38 51.40%	25 33.80%	4.03	1.046	3
Reworking and demolition	0 0%	6 8.10%	10 13.50%	34 45.90%	24 32.40%	4.03	0.891	3
Health and Safety	0 0%	7 9.50%	11 14.90%	38 51.40%	18 24.30%	3.91	0.878	5
Loss of productivity	3 4.10%	6 8.10%	14 18.90%	32 43.20%	19 25.70%	3.78	1.05	6
						4.053		

Agree

S.D= Standard Deviation

Source: *Primary data, (2020)*

The mean of 4.16 implied that more respondents believed that variation had a strong influence on project completion time and was ranked in 2nd position. This is in agreement with findings by CII (1995) and Ibbs (1997) who observed that variation often hinder the project progress, leading to delay in achieving the targeted milestones during construction. Zeitoun and Oberlender (1993) established that variation may delay a project by 9% of the initial scheduled time of the project.

On the other hand, the study established that eight respondents representing 10.80% of the total number of respondents strongly believed that procurement delays had negligible influence on project completion time while sixty two respondents representing 85.20% of the total number of respondents believed that procurement delays had a strong influence on variation. Three respondents representing 4.10% of the total number of respondents were not sure whether procurement delays had a great influence on projects completion time.

The mean of 4.03 implied that many respondents believed that procurement delays had a strong influence on project completion time and was ranked in 3rd position. This is in agreement with findings by O'Brien (1998) who observed that variation which are imposed when construction is underway may require revised procurement requests. He added that procurement delays can be frequent due to variation that require new materials and specialized equipment. Hester *et. al.,* (1991) observed that procurement delays were common effects of variation related to new resources for construction projects.

It was also established in Table 4.13 that six respondents representing 8.1% of the total number of respondents strongly believed that reworking and demolition had negligible influence on project completion time while fifty-eight respondents representing 78.30% of the total number of respondents believed that reworking and demolition had a strong influence on project completion time. Ten respondents representing 13.50% of the total number of respondents were not sure whether reworking and demolition had a great influence on projects completion time.

The mean of 4.03 implied that many respondents believed that reworking and demolition was responsible for delayed project completion and was ranked in 3rd position. Review of documents for Kyenjojo - Fort Portal project established that due to variation in design of surfacing layer of pavement, 7km of subbase got deteriorated as decision to proceed with works delayed and contractor was instructed to rework subbase from km 20+300 to km 27+400. This disrupted contractor's work plan and caused a delay of 66 days. On Hima – Katunguru project, it was established that change in design of drainage structure at km 33+520 which required construction of an additional box culvert caused demolition of 40m of asphalt yet construction of a box culvert and reinstatement of pavement layers required over two months' extension of time. This is in agreement with findings by Clough and Sears, (1994) who observed that rework and demolition are frequent occurrences due to variation in construction projects. Variation imposed when construction is underway or even completed, usually lead to reworks and project completion delays (CII, 1990). The study established that rework and demolition are one of the potential impacts of variation in construction.

Findings in Table 4.13 that seven respondents representing 9.50% of the total number of respondents disagreed that there was negligible influence of variation on health and safety

while fifty-six respondents representing 75.70% of the total number of respondents agreed that there is a strong influence of variation on health and safety. Eleven respondents representing 14.90% of the total number of respondents were not sure whether variation had impact on health and safety on paved road projects. The mean of 3.91 implied that less number of respondents believed that variation had impacts on health and safety on paved road projects and was ranked in 5th position.

It was also established in Table 4.13 that nine respondents representing 12.20% of the total number of respondents disagreed that there was negligible influence of variation on loss of productivity while fifty-one respondents representing 68.90% of the total number of respondents agreed that there is a strong influence of loss of productivity on variation. Fourteen respondents representing 18.90% of the total number of respondents were not sure whether loss of productivity had a great influence on variation on paved road projects. The mean of 3.78 implied that least number of respondents believed that loss of productivity had a strong influence on variation on paved road projects and was ranked in 6th position.

4.6.2.2 *Descriptive statistics of Impacts of variation in relation to project cost*

The means < 4.02 (less than 4.02) indicate impacts with negligible influence on variation and that above >4.02 (greater than 4.02) indicate impacts with strong influence on variation.

Findings in Table 4.14 indicate that, three respondents representing 4.10% of the total number of respondents strongly believed that variation was not the cause of increase in project cost while sixty seven respondents representing 90.54% of the total number of respondents believed that variation was the cause of increase in project cost. Four respondents representing

5.40% of the total number of respondents were not sure whether variation was the cause of the increase in project cost.

The mean of 4.28 implied that majority of the respondents believed that variation had a strong influence on project completion time and was ranked in 1st position. Review of progress reports established that; Kyenjojo – Fort Portal project variation in pavement structure caused an increase in project cost by UShs.. 48,412,573,497.56 representing 67.77% increase in original project cost of UShs. 71,435,766,901,

On Fort Portal – Hima project, additional works on; Rehabilitation of Lugard Road (Two service lanes in Fort Portal City, 0.3 km), rehabilitation of Balya Road (0.22 km) within Fort Portal City, tarmacking of two service roads at Rwimi Town (0.84 km), a new roundabout at Rwimi Town, Yerya Catholic Church (0.32km); Curbing at sections of guardrails, bus bays and roadway edge protection (24891 m), paving raised footways with asphalt concrete (5692 m) caused increase in contract price by UShs. 24,072,692,607 representing 25.38% of original contract price. On Hima- Katunguru project change in design of drainage structures, additional works to include 4.5km town roads caused increase in contract price by UShs. 107,616,099,006 representing 129.26% of the original contract price. On Ishaka - Katunguru project, additional works which included 2.6km road to west ankole diocese caused an increase in contract price by UShs, 14,996,949,801 representing 14.44% of original contract price.

Table 4. 14: Descriptive statistics of impacts of variation in relation to project cost

Variables	SDA(1)	DA(2)	NE(3)	A(4)	SA (5)	Mean	S.D	Rank
Increase in project cost	0 0%	3 4.10%	4 5.40%	36 48.60%	31 41.90%	4.28	0.75	1
Delays on project completion	0 0.00%	2 2.70%	5 6.80%	46 62.20%	21 28.40%	4.16	0.663	2
Logistics delays	2 2.70%	5 6.80%	8 10.80%	37 50.00%	22 29.70%	3.97	0.965	3
Causes reworks and demolition	1 1.40%	4 5.40%	11 14.90%	45 60.80%	13 17.60%	3.88	0.81	4
Loss of productivity	0 0%	9 12.20%	12 16.20%	37 50.00%	16 21.60%	3.81	0.917	5
				Average Mean		**4.02**		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree
S.D= Standard Deviation

Source: *Primary data, (2020)*

This is in agreement with findings by CII (1990) who established that construction projects involve recognized phases of which two are particularly important, namely the pre-construction and construction phases. The most common impact of variation during the construction phase is the increase in project cost. However, not all variation orders increase the costs of construction. Omissions in most cases reduce costs while additions increase costs (Ssegawa *et. al.,* 2002). However, this was not the case with the projects under study. Variation experienced on all the four projects have caused increase in project cost. As Ruben (2008) found in his study variation orders adversely impact costs. In every construction project, a contingency sum is usually allocated to cater for possible variation in the project, while keeping the overall project cost intact. Arguably, the more the number of variation orders, the more they are likely to affect the overall construction delivery cost. This is agreed by Ijaola *et al.*, (2012) who concluded that changes occurring during constructions significantly impact on the project cost and time and in worst cases project abandonment and disputes.

On the other hand, the study established that two respondents representing 2.70% of the total number of respondents strongly believed that cost overrun was not due to delays on project completion caused by variation while sixty seven respondents representing 90.50% of the total number of respondents believed that cost overrun was due delays on project completion caused by variation. Five respondents representing 6.80% of the total number of respondents were not sure whether cost overrun was due delays on project completion caused by variation.

The mean of 4.16 implied that most of the respondents believed that cost overrun was due delays on project completion caused by variation and was ranked in 2nd position. Review of claim determination report established that on Kyenjojo – Fort Portal project, claim due to delay damages, disruption and prolongation costs compensation cost recommended for compensation to the Contractor was UShs.10,139,829,986.59. On Hima – Katunguru project, the Engineer recommended compensation cost of UShs. 11,060,703,067 as being prolongation of 406 days. This is in agreement with findings by CII (1995) and Ibbs (1997) who established that variation frequently hinder project progress, leading to delay in attaining the set milestones. In reducing the delay of a project, the contractor would try to accommodate the variation by utilizing the free floats in the construction schedules Aftab and Ismail (2014). It was established from review of claim evaluation reports that delayed completion of project is associated with prolongation cost. It should also be noted that direct time related cost under general items in the bill of quantities contributed to the increase in project cost. For instance, Kyenjojo – Fort Portal project revised duration was 43.8 months against 18 months of original contract duration, Fort Portal – Hima project revised duration was 44.2 months against 18 months of original contract duration, Hima- Katunguru revised duration of 45.3 months

against 18 months of original contract duration and Ishaka – Katunguru revised duration of 38.2 months against 18 months of original contract duration.

It was also established in Table 4.14 that, seven respondents representing 9.50% of the total number of respondents strongly believed that cost overrun was not due to logistics delays. Fifty nine respondents representing 79.70% of the total number of respondents believed that cost overrun was due logistics delays caused by variation and eight respondents representing 10.80% of the total number of respondents were not sure whether cost overrun was due logistics delays caused by variation.

The mean of 3.97 implied that some respondents believed that cost overrun was due logistics delays caused by variation and was ranked in 3rd position. Review of change order one for Kyenjojo- Fort Portal project which revised the design of surfacing materials from double bituminous surface treatment (DBST) to asphalt concrete (AC) required mobilization of different set of equipment such as an asphalt plant and a paver. There was also a change of bitumen from pengrade 80/100 to pengrade 50/70 and introduction of tack coat K1 60 cations emulsion which was completely a new material. Introduction of this new materials resulted into increase in project cost by UShs. 48,412,573,497.56 which is 67.77% of original contract price. Similarly, in Hima – Katunguru the split of contract into phase 1 covering works from km 29+000 to km 57+080 and Phase 2 covering works from km 0+000 to km 29+000 resulted into a new procurement. The procurement which commenced in December 2019 was not yet finalized by November 2020. This is in agreement with findings by Fisk (1997) who established that logistics delays may occur due to variation requiring new materials and equipment. Hester *et al.,* (1991) observed that, logistics delays were major effects of variation in construction projects. Logistics delays were experienced in construction projects where variation in construction phase required new materials, tools and equipment.

According to Table 4.14, five respondents representing 6.80% of the total number of respondents strongly believed that cost overrun was not due to reworking and demolition caused by variation while fifty eight respondents representing 78.40% of the total number of respondents believed that cost overrun was due reworking and demolition caused by variation. Eleven respondents representing 14.90% of the total number of respondents were not sure whether cost overrun was due reworking and demolition caused by variation.

The mean of 3.88 implied that less respondents believed that reworking and demolition was the cause of variation in project cost and was ranked in 4th position. Review of interim payment certificate (IPC) number 17 and 20 for Kyenjojo – Fort Portal established that UShs 479,091,046 and UShs 622,716,689 respectively was paid for reworking of subbase and base. On Hima – Katunguru project change in design of pavement structure at locations of problem soil at km 33+500 – 33+560 full width, km 36+200-36+500 RHS and 37+500 – 37+575 RHS which required provision of improved subgrade using rock fill and installation of new box culvert at 33+520 and new double lines of 900mm diameter pipe culverts at 38+300 which resulted in demolition reworking of all pavement layers at 33+500- 33+560 full width, 36+200 – 36+500 RHS, 37+500 – 37+570 RHS and 38+280 – 38+320 full width. This is in agreement with findings by Clough and Sears (1994) who observed that rework and demolition are frequent occurrences due to variation in construction projects. Variation which are imposed when construction is underway or even completed, usually lead to reworks and delays in project completion CII (1990). Rework and demolition are potential effect of variation in construction, depending on the timing of the occurrence of the variation.

On the other hand, nine respondents representing 12.20% of the total number of respondents strongly believed that loss of productivity had negligible influence on project cost while fifty three respondents representing 71.60% of the total number of respondents believed that loss of productivity had strong influence on project cost and twelve respondents representing 16.20% of the total number of respondents were not sure whether loss of productivity had influence on project cost.

The mean of 3.81 implied that least respondents believed that loss of productivity had strong influence on project cost and was ranked in 5th position. The study established that all the four projects experience change in design and delayed submission of design by the client and that physical works commenced without approved design as explained in Table 4.15. Such delays and changes were the cause of interruption of contractor's work programme. This is in agreement with findings by Ibbs, (1997) who observed that interruption, delays and redirection of work that are associated with variation orders have a negative impact on labor productivity. These in turn can be translated into labor cost or monetary value (Ibbs 1997). Hester *et. al.*, (1991) argued that the productivity of workers was expected to be greatly affected in cases where they were required to work overtime for prolonged periods to compensate for schedule delays. Thomas and Napolitan (1995) concluded that variation normally led to disruptions and these disruptions were responsible for labor productivity degradation. The most significant types of disruptions were due to the lack of materials and information as well as the work out of sequence. Lack of material was reported as the most serious disruption. Hence, to manage variation, one needed to manage these disruptions. However, the disruptive effects could not be avoided in many instances.

4.6.2.3 Descriptive statistics of impacts of variation in relation to quality

The means < 3.76 (less than 3.76) indicate impacts with negligible influence on variation and that above >3.76 (greater than 3.76) indicate impacts with strong influence on variation.

According to Table 4.15, it was established that, six respondents representing 8.10% of the total number of respondents strongly believed that variation had negligible influence on health and safety of workforce and persons affected by the project (PAPs) while fifty respondents representing 67.60% of the total number of respondents believed that variation strongly influence health and safety. Eighteen respondents representing 24.30% of the total number of respondents were not sure whether variation had an impact on health and safety of workforce and persons affected by the project (PAPs).

It was established in Table 4.15 that five respondents representing 6.80% of the total number of respondents strongly believed that variation was not the cause of reworks and demolition on a project while sixty two respondents representing 83.70% of the total number of respondents believed that variation causes reworks and demolition on a project and seven respondents representing 9.50% of the total number of respondents were not sure whether variation causes reworks and demolition.

The mean of 4.09 implied that majority of the respondents strongly believed that variation causes reworks and demolition on a project and was ranked in 1st position. The demolition and reworking of completed sections of asphalt on Hima- Katunguru road from; km 22+060-22+080, km 33+520- 33+560, km 38+280 – 38+320 due to change in design which introduced new box culverts and from several locations between km 36+200 – 37+580 RHS to introduce rock fills.

Table 4. 15: Descriptive statistics of impacts of variation in relation to quality

Variables	SDA (1)	DA (2)	NE(3)	A(4)	SA (5)	Mean	S.D	Rank
Reworking and demolition	2 2.70%	3 4.10%	7 9.50%	36 48.60%	26 35.10%	4.09	0.924	1
Loss of professional reputation	1 1.40%	9 12.20%	7 9.50%	44 59.50%	13 17.60%	3.8	0.921	2
Health and Safety	0 0%	6 8.10%	18 24.30%	37 50.00%	13 17.60%	3.77	0.837	3
Poor quality of works	3 4.10%	18 24.30%	14 18.90%	26 35.10%	13 17.60%	3.38	1.155	4
			Average Mean			**3.76**		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree

S.D= Standard Deviation

Source: *Primary data, (2020)*

Change in design which revised surfacing layer from DBST to asphalt concrete caused reworking of over 7km of subbase on Kyenjojo –Fort portal project and a split of contract on Hima- Katunguru projects. This is in agreement with the findings by Ruben (2008) who established that variation in construction often results in rework and demolition if the variation are occurred when the construction is underway or even completed. This effect is to be expected due to variation during the construction phase while variation during the design phase do not require any rework or demolition on construction sites.

On the other hand, ten respondents representing 13.6% of the total number of respondents strongly believed that variation had negligible influence on professional reputation of parties to the contract while fifty seven respondents representing 77.10% of the total number of respondents believed that variation can lead to loss of professional reputation and seven respondents representing 9.50% of the total number of respondents were not sure whether variation had an impact on professional reputation of the parties to the contract.

The mean of 3.80 implied that more respondents believed that variation strongly influence professional reputation and was ranked in 2nd position. The delayed finalization of variation orders and its associated impacts were viewed as incompetency of the parties to the contract. Delayed completion encountered by all the four projects is judged and inability of the parties to the contract irrespective of the causations. The demolition of completed sections of asphalt on Hima- Katunguru road from; km 22+060-22+080, km 33+520- 33+560, km 38+280 – 38+320 to introduce new box culverts and from several locations between km 36+200 – 37+580 RHS to introduce rock fills. Reworking of over 7km of subbase on Kyenjojo –Fort portal project were all viewed by the public as incompetency. This is in agreement with the findings by Bower (2000) who opined that each successfully completed project adds experience to members and builds up their reputation. Disagreements may come up when contractors are not contented with the determination of the value of variation by the client's consultant. Contract parties are left to argue over the cost, time effects and due payment of variation. This aligns with Ssegawa *et al.,* (2002) who reported that over a third of disputes related determination of losses stem from variation orders. The extreme existence of variation due to errors in design or omission may weaken the designer's expertise. Workers are disheartened when they have to demolish already completed. Charoenngam *et al*., (2003) remarked that disputes between client and contractor can happen if orders of variation are not carefully managed. Finsec (2005) established that a large percentage of present arbitrations related to claims for additional time and expenses.

The mean of 3.77 implied that lower number of respondents believed that variation strongly influence health and safety and was ranked in 3rd position. Variation which occur at construction phase may cause delayed activity or stoppage of an activity and introduction of such new work requires revision of health and safety considerations which most contractor tend to response slowly. The study established that variation from DBST to asphalt concrete

caused a change from bitumen spray work to hot mix asphalt which requires unique protection equipment to workers. On the other hands, the PAPs were affected by prolonged exposure to the effects of construction activities such as noise and dust pollution due to logistics delays. This is in agreement with other literatures and the views of other researchers. The OHS (2003) clause 5.3 (e) specifies that where changes are required, satisfactory health and safety information and suitable resources should be made available to the contractor to execute the work. Change in construction methods, equipment and materials may require extra health and safety measures (Arain & Pheng, 2005). Furthermore, the OHS (2003) clause 5.14 requires that the contractor should provide the principal contractor with any information which might lead to health and safety of any person at work.

It was also established in Table 4.15 that twenty one respondents representing 28.40% of the total number of respondents strongly believed that variation had negligible influence on quality of works while thirty nine respondents representing 52.60% of the total number of respondents believed that variation strongly influence quality of works and fourteen respondents representing 18.90% of the total number of respondents were not sure whether variation had an impact on quality of works.

The mean of 3.38 implied that less number of respondents believed that variation strongly influence quality of works and was ranked in 4^{th} position. This is in agreement with the findings by different researchers. The quality of work is adversely affected by variation (Fisk, 1997). CII (1995) stated that variation frequently affect the quality of work as contractors have to compensate for losses by cutting corners. However, in views of other project beneficiaries, asphalt concrete is considered an improved superior quality over DBST. On the other hands,

technocrats argued that the prolongation cost and the high cost of the semi-structural asphalt concrete outweighs the benefits and disagree with the justification for the variation.

4.6.2.4 Comparison of responses from respondents of higher cadres and those of lower cadres

Further assessment of the responses from the lowly position respondents were compared with those from the highly positioned respondent. The responses were ranked as in Table 4.16.

Table 4. 16: Comparison of responses from higher position respondents and lower position respondents

		Combined		Higher Position		Lower Position (Lab. Tech & Ass. Surveyors)	
	Variables	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
On Completion Time	Logistics delays	4.41	1	4.52	1	4.14	1
	Delays on project completion	4.16	2	4.27	2	3.91	3
	Increase unnecessary procurement delays	4.03	3	4.06	4	3.95	2
	Reworking and demolition	4.03	3	4.15	3	3.73	5
	Health and Safety	3.91	5	3.96	5	3.77	4
	Loss of productivity	3.78	6	3.87	6	3.59	6
	MoMs	**4.053**		**4.138**		**3.848**	
On Project Cost	Increase in project cost	4.28	1	4.31	1	4.23	1
	Delays on project completion	4.16	2	4.17	2	4.14	2
	Logistics delays	3.97	3	4.00	3	3.91	3
	Causes reworks and demolition	3.88	4	3.92	4	3.77	5
	Loss of productivity	3.81	5	3.81	5	3.82	4
	MoMs	**4.02**		**4.042**		**3.973**	
Quality of	Reworking and demolition	4.09	1	4.12	1	4.05	1
	Loss of professional reputation	3.8	2	3.77	2	3.86	3
	Health and Safety	3.77	3	3.67	3	4.00	2
	Poor quality of works	3.38	4	3.27	4	3.64	4
	MoMs	**3.76**		**3.707**		**3.886**	

According to Table 4.16, the lower cadres are in agreement with findings from higher cadres. It is therefore observed that the responses from lowly positioned respondents had no significant deviation from the overall study findings.

4.6.3 Descriptive statistics of mitigation strategy actions to control variation

4.6.3.1 Mitigation measures applied at pre-Construction stage

The means < 3.78 (less than 3.78) indicates mitigation measures with negligible influence on impacts of variation and that above >3.78 (greater than 3.78) indicates mitigation measures with strong influence on impacts of variation.

It was also established from Table 4.17 that four respondents representing 5.40% of the total number of respondents strongly believed that there was negligible influence of adequate planning by all parties in the contract before works start on site in mitigation against variation while sixty-nine respondents representing 93.20% of the total number of respondents believed that there is a strong influence of adequate planning by all parties in the contract before works start on site in mitigation against variation and one respondent representing 1.40% of the total number of respondents was not sure whether adequate planning by all parties in the contract before works start on site had a great influence on mitigation against variation on paved road projects.

The mean of 4.57 implied that majority of the respondents believed that adequate planning by all parties in the contract before works start on site had a strong influence on variation and was ranked 1st. Review of the contract document established that all the four projects demonstrated lack of adequate planning at inception stage. Quantities appears to have been generated for the purpose of bidding only since contractors' interim payment certificates indicated definite quantities for pavement layers being exceeded by over 20%.

Table 4. 17 : Descriptive statistics of mitigation of variation at pre-construction stage

Variables	SDA(1)	DA (2)	NE (3)	A (4)	SA(5)	Mean	S.D	Rank
Adequate planning and availability of fund before works start on site	2	2	1	16	53	4.57	0.877	1
	2.70%	2.70%	1.40%	21.60%	71.60%			
Carry out detailed site investigation and consider it during design stage	5	3	1	32	33	4.15	1.106	2
	6.80%	4.10%	1.40%	43.20%	44.60%			
Proper and restricted methods of procurement	6	8	3	19	38	4.01	1.319	3
	8.10%	10.80%	4.10%	25.70%	51.40%			
The client should produce a conclusive design and contract documents	13	2	1	24	34	3.86	1.474	4
	17.60%	2.70%	1.40%	32.40%	45.90%			
Revise and update general contract clauses	9	6	3	29	27	3.8	1.344	5
	12.20%	8.10%	4.10%	39.20%	36.50%			
Stakeholder's engagement to incorporate their demand.	11	9	3	15	36	3.76	1.524	6
	14.90%	12.20%	4.10%	20.30%	48.60%			
Spend adequate time on pre-tender planning phase	12	10	0	21	31	3.66	1.529	7
	16.20%	13.50%	0%	28.40%	41.90%			
Client should ensure that the design/specifications fall within the approved budget	12	4	1	38	19	3.65	1.359	8
	16.20%	5.40%	1.40%	51.40%	25.70%			
Clients should provide a clear brief of the scope of works	6	9	13	28	18	3.58	1.216	9
	8.10%	12.20%	17.60%	37.80%	24.30%			
Effective scheduling in relation to scope of works	4	11	19	27	13	3.46	1.113	10
	5.40%	14.90%	25.70%	36.50%	17.60%			
Client's coordination in the design stage to spot the noncompliance owner's demand	7	13	12	26	16	3.42	1.271	11
	9.50%	17.60%	16.20%	35.10%	21.60%			
Objectivity and impartiality (the contract documents in a way that does not favour certain bidders)	10	8	20	16	20	3.38	1.352	12
	13.50%	10.80%	27.00%	21.60%	27.00%			
			Average Mean			**3.78**		

Key SDA= Strongly Disagree,DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree
S.D= Standard Deviation.

Source: *Primary data, (2020)*

The interim payment certificates reviewed showed that interests accrued on delayed payments were; Kyenjojo – Fort Portal UShs. 1,635,383,649 representing 1.36% of original contract price, Fort Portal – Hima project UShs. 2,336,267,803 representing 2.46% and Hima-Katunguru project UShs. 1,227,488,015 representing 1.47% of the original contract price. These are clear evidences that the projects were let out when the employer was ready but the funds were not available.

Both the head of the Construction and Supervision department of UNRA and the Resident Engineer interviewed believe that there is too much pressure from external forces mainly from politicians making projects being let out for procurement prematurely. They believe that adequate planning by all parties in the contract before works start on site would actually control adverse impacts of variation. Andualem (2017) in his strategies to minimize variation recommended that all parties need adequate planning before commencement of site works.

It was also established in Table 4.17 that eight respondents representing 10.90% of the total number of respondents strongly believed that there was negligible influence of carrying out detail site investigation and considering it at design stage to mitigate against variation while sixty-five respondents representing 87.80% of the total number of respondents believed that there is a strong influence of carrying out detail site investigation and considering it at design stage in mitigation against variation and one respondent representing 1.40% of the total number of respondents was not sure whether carrying out detail site investigation and considering it at design stage had a great influence on mitigation against variation on paved road projects.

The mean of 4.15 implied that more respondents believed that carrying out detail site investigation and considering it at design stage had a strong influence on variation and was ranked 2nd. It was established that most projects were rolled out for implementation without detailed site investigation and detailed design. Review of change orders on Kyenjojo-Fort Portal project and Hima – Katunguru revised the original scope to include rock fill quantities for treatment of water logged areas and change of DBST to asphalt concrete for surfacing layer. The finding was in agreement with the view of one of the interviewee who believes that carrying out detail site investigation and considering it at design stage would actually reduce variation by over 90%. Review of the contract document and consultants' monthly progress report established that all the four projects were procured using schematic designs. Delayed design was experienced in all the projects. Piecemeal submission of design when works had commenced on site were the cause of extension of time (EOT) granted to all the four projects and this EOT causation was with cost. As Baharuddin (2005) concluded, variation orders can be minimized if all the parties involved in projects are aware that preliminary work before tendering must be carried out, for example detailed site and soil investigations. Ibrahim *et al*., (2012) recommended that detailed and all-inclusive site investigation should be carried out at the design stage to avoid variation and late changes during the construction phase of road construction projects.

On the other hand, fourteen respondents representing 18.90% of the total number of respondents strongly believed that there was negligible influence of proper and restricted methods of procurement in mitigation against variation while fifty seven (77.10%) of the total number of respondents believed that there is a strong influence of proper and restricted methods of procurement in mitigation against variation. Three respondents representing

4.10% of the total number of respondents were not sure whether proper and restricted methods of procurement had a great influence on mitigation against variation on paved road projects.

The mean of 4.01 implied that many respondents believed that proper and restricted methods of procurement had a strong influence on variation and was ranked 3rd. The multifaceted nature of procurement selection and their consequent management poses great problems to clients and any failure to live up to this challenge has often resulted in poor project performance. Such consequence has long been recognized by a number of researchers such as Mohsini and Davidson, (1991); Molenaar *et. al*., (2009). Delays in procurement have various adverse effects on other processes in the construction cycle (Fisk, 1997). Poor processes in procurement affect other processes in the construction cycle and as such variation become necessary (Aftab, 2014).

Furthermore, it was also established that fifteen respondents representing 20.30% of the total number of respondents strongly believed that there was negligible influence of producing a conclusive design and contract documents in mitigation against variation while fifty eight respondents representing 78.30% of the total number of respondents believed that there is a strong influence of producing a conclusive design and contract documents in mitigation against variation. One respondent representing 1.40% of the total number of respondents was not sure whether producing a conclusive design and contract documents had a great influence on mitigation against variation on paved road projects.

The mean of 3.86 implied that some of the respondents believed that producing a conclusive design and contract documents had a strong influence on variation and was ranked 4th. Hwang and Low (2012) stated that, conflict over changes in project can be lessened when the problem

is identified at the earlier project phase. Therefore, one of project management best practices is to implement design change management to construction projects. As Arain (2005) suggested, variation can be reduced with due diligence during the design stages. Jeffrey *et al*., (2015) concluded that to mitigate the impacts of design changes, the dynamics that influence design changes need to be identified and attended to immediately. They need to be addressed as early as possible in the project life cycle or immediately upon detection. Clients are required to provide detailed project briefs to the design teams to aid designers in arriving at conclusive designs so that frequent variation to original plans or material type will be minimized or eliminated during the construction phase. This should be preceded by comprehensive planning and thorough identification of needs by clients before embarking on any developmental project. The scope of work should properly define the works to be carried out by the contractor without ambiguity. Specifications should be comprehensive enough to assist contractors to deliver the quality that is expected of them by clients.

On the other hand, twenty (27.10%) of the total number of respondents strongly believed that there was negligible influence of Client's coordination in the design stage to spot the noncompliance owner's demand in mitigation against variation while forty two respondents representing 56.70% of the total number of respondents believed that there is a strong influence of Client's coordination in the design stage to spot the noncompliance owner's demand in mitigation against variation and twelve respondents representing 16.20% of the total number of respondents were not sure whether Client's coordination in the design stage to spot the noncompliance owner's demand had a great influence on mitigation against variation on paved road projects.

The mean of 3.42 implied that less respondents believed that Client's coordination in the design stage to spot the noncompliance owner's demand had a strong influence on variation and was ranked 11th. Alaghbari et al., (2007) argued that such changes affect the project in numerous ways depending on the timing of such change. Before any contractual agreement, there should be an open line of communication between all the principle project parties in order to mitigate design errors (Musa 2016).

It was also established in Table 4.17 that eighteen respondents representing 24.30% of the total number of respondents strongly believed that there was negligible influence of objectivity and impartiality of contract document in mitigation against variation while thirty six respondents representing 48.60% of the total number of respondents believed that there is a strong influence of objectivity and impartiality of contract document in mitigation against variation. Twenty respondents representing 27.00% of the total number of respondents were not sure whether objectivity and impartiality of contract document had a great influence on mitigation against variation on paved road projects.

The mean of 3.38 implied that least number of respondents believed that objectivity and impartiality of contract document had a strong influence on variation and was ranked 12th. This is in agreement with findings by Alia et, al. (2014) who established that checking contract document is one of the measures of controlling variation in construction project. Conflict between contract documents can result in misinterpretation of the actual requirement of a project. It is essential that the contract documents are clear and precise. Inadequate details in the contract documents may result in project delays or cause variation in cost (Aftab et al., 2014).

4.6.3.2 Descriptive statistics of mitigation measures applied at Construction stage

The means < 3.92 (less than 3.92) indicate mitigation measures with negligible influence on impacts of variation and that above >3.92 (greater than 3.92) indicate mitigation measures with strong influence on impacts of variation.

According to Table 4.18, nine respondents representing 12.2% of the total number of respondents strongly believed that there was negligible influence of lack of Comprehensive design and financial reviews before commencement of physical works while sixty-four respondents representing 86.50% of the total number of respondents believed that there is a strong influence of client Comprehensive design and financial reviews before commencement of physical works on variation. One respondent representing 1.40% of the total number of respondents was not sure whether Comprehensive design and financial reviews before commencement of physical works had a great influence on variation on paved road projects. The mean of 4.22 implied that majority of the respondents believed that comprehensive design and financial reviews before commencement of physical works had a strong influence on variation on paved road projects and was ranked in 1st position. The finding agrees with findings of document review.

It was established that design review on Kyenjojo – Fort portal which recommended change of DBST to AC surfacing was concluded and submitted to employer for action on 30th June 2018 two years after commencement of works on 29th June 2016. This aligns with findings by Majed and Basim (2015) who listed comprehensive design and financial reviews before commencement of physical works as one of the factors for controlling variation.

Table 4. 18 : Descriptive statistics of mitigation of variation at construction stage

Variables	SDA(1)	DA (2)	NE (3)	A (4)	SA(5)	Mean	*S.D*	*Rank*
Comprehensive design and financial reviews before commencement of physical works	8 10.80%	1 1.40%	1 1.40%	21 28.40%	43 58.10%	4.22	1.264	1
Client expedite approvals and decision making	8 10.80%	1 1.40%	2 2.70%	20 27.00%	43 58.11%	4.2	1.382	2
Enhance communication between all parties	6 8.10%	5 6.80%	2 2.70%	31 41.90%	30 40.50%	4	1.205	3
Client should expedite payments to contractors and consultants	10 13.50%	3 4.10%	1 1.40%	25 33.80%	35 47.30%	3.97	1.375	4
All parties should forecast unforeseen situations	5 6.80%	5 6.80%	12 16.20%	27 36.50%	25 33.80%	3.84	1.171	5
Construction and supervision of works should be done by experienced and dedicated teams	14 18.90%	2 2.70%	0 0%	34 45.90%	24 32.40%	3.7	1.44	6
Proper analysis of risks by all parties	11 14.90%	3 4.10%	14 18.90%	27 36.50%	19 25.70%	3.54	1.326	7
	Average Mean					**3.92**		

Key SDA= Strongly Disagree, DA = Disagree, NE= Neutral, A= Agree, SA= Strongly Agree

S.D= Standard Deviation

Source: *Primary data, (2020)*

It was also established from Table 4.18 that nine respondents representing 12.2% of the total number of respondents strongly believed that there was negligible influence of client expedite approvals and decision making while sixty-three respondents representing 85.11% of the total number of respondents believed that there is a strong influence of client expedite approvals and decision making on variation. Two respondents representing 2.70% of the total number of respondents were not sure whether client expedite approvals and decision making had a great influence on variation on paved road projects.

The mean of 4.20 implied that more respondents believed that to expedite approvals and decision making by client had a strong influence as a mitigation measure on variation and was ranked 2nd. Review of progress and claim evaluation reports established that there were a number of cases of delayed approval of documents and decision making by the client. For instant, change order which revised the scope of the works from 57km to 28km on Hima - Katunguru was issued on 10th September, 2019 when the contract was scheduled to expire on 22nd September 2019. Similarly, on Kyenjojo –Fort Portal road change order which revised the wearing course from double bituminous surface treatment (DBST) to asphalt concrete (AC) for 50km was issued on 17th May, 2019 when the contract was expiring on 31st August 2019. The finding agrees with previous findings by Jaffari (2019) who observed that clients are the project owner, when they do not make decisions on time regarding project matters, they slow down on site project activities. Jaffari (2019) argued that slow decision-making could be caused by an organization's internal bureaucracy or wrong channel of communication in building projects. Prompt decision-making is an important factor for project success (Gray and Hughes, 2001). Failure to make the decision efficiently may result in the delay, causing the need for the change order due to cost increments.

According to Table 4.18, eleven respondents representing 14.90% of the total number of respondents strongly believed that there was negligible influence of enhancing communication between all parties in contract in mitigation against variation while sixty-one respondents representing 82.40% of the total number of respondents believed that there is a strong influence of enhancing communication between all parties in contract in mitigation against variation. Two respondents representing 2.70% of the total number of respondents were not sure whether enhancing communication between all parties in contract had a great influence on mitigation against variation on paved road projects.

The mean of 4.00 implied that many respondents believed that enhancing communication between all contract parties had a strong influence on mitigation against variation and was ranked in 3rd position. Award (2001) argued that although no one can ensure that variation orders can be avoided completely, their occurrence and subsequent waste can be eliminated if their origin and causes are clearly determined. Ineffective communication, lack of integration, ambiguity, fluctuating environment, and rising project complexity are the key drivers of variation in projects (Arain *et. al*., 2004). Abdulmalik and Abdullahi (2017) recommended that **h**eightened communication and co-ordination is needed at the design stage and that all parties should be proactive all times. Direct communication and continuous coordination is important as it provides professionals with an opportunity to review contract documents and help in eliminating variation arising because of contradictory contract documents and also eliminate design inconsistencies and errors as well as omissions in design.

This study further established that sixteen respondents representing 21.60% of the total number of respondents strongly believed that there was negligible influence of construction and supervision of works should be done by experienced and dedicated teams in mitigation against variation while fifty eight respondents representing 78.30% of the total number of respondents believed that there is a strong influence of construction and supervision of works should be done by experienced and dedicated teams in mitigation against variation. The mean of 3.70 implied that less respondents believed that construction and supervision of works should be done by experienced and dedicated teams had a strong influence on variation and was ranked 6th.

It was also established in Table 4.18 that fourteen respondents representing 19.00% of the total number of respondents strongly believed that there was negligible influence of proper

analysis of risks by all contract parties in mitigation against variation while forty six respondents representing 62.20% of the total number of respondents believed that there is a strong influence of proper analysis of risks by all contract parties in mitigation against variation and fourteen respondents representing 18.90% of the total number of respondents were not sure whether proper analysis of risks by all contract parties had a great influence on mitigation against variation on paved road projects. The mean of 3.38 implied that least respondents believed that proper analysis of risks by all contract parties had a strong influence on variation and was ranked 7th.

4.6.4 Multiple Regression Analysis

4.6.4.1 Determination of model coefficients

The assessment is centered on the linear additive model. According to this model, "if it can be proven or reasonably assumed, that the measures are preferentially independent of each other and if uncertainty is not formally built into the Multi-criteria analysis model, then the simple linear additive evaluation model is applicable" (DTLR multi-criteria analysis manual). This shows how an option's values on many criteria can be combined into an overall value. This is done by multiplying the value score on each criterion by the weight of that criterion and then adding all these weighted scores together. The relationship is represented in equations (3.9) and (3.10).

$PK = \sum_{i=1}^{n} W_i = 1 \; or \; 100\% \; and \; 0 \leq W_i \leq 1$ ……(Equation 3.9)

and;

$PK = \sum_{i=1}^{n} W_i M_i \leq 1 \; or \; 100\%$ ……...….(Equation 3.10)

Where,

P_K = is the performance measurement for overall performances;

w_i is the weight of a criteria (causes of variation, impacts of variation and mitigation strategy actions to control variation) and indicator or factor; highly ranked variables under causes of variation, impacts of variation and mitigation strategy actions to control variation at pre-construction and construction stages).

m_i represents a score of an indicator or a weighted score of a criterion.

The general form of the equation (3.4) to predict performance from causes of variation, impacts of variation and mitigation strategy actions to control variation is predicted as:

$$Y = a+\beta_1X_1 + \beta_2X_2+\beta_3X_3+\ldots\ldots\ldots\ldots\ldots\beta_nX_n$$

Where: Y=Performance, β_1=variation coefficient, X_1=causes of variation, β_2=impacts coefficient, X_2=Impacts of variation, β_3= Mitigation strategy of variation coefficient, X_3=mitigation strategy to control variation. The weighted coefficient is obtained from equation (3.9) and equation (3.10).

4.6.4.2 Variation and Project performance enhancement measurement

Table 4. 19: Weighted scores of factor groups on assessment criteria

Measure.	No.	Sub-Measure	Overall Weighting		
			μ_T	σ_T	WT(%)
Performance	1	Causes of variation	3.778	1.071	32.65
	2	Impacts of variation	3.944	0.896	34.08
	3	Mitigation of variation	3.85	1.30	33.27
Causes of Variation	1	Delayed issuing of approval documents	4.26	0.886	15.13
	2	Changes in design	4.12	0.936	14.63
	3	Changes in scope	4.18	0.897	14.84
	4	Design flaws	3.93	0.912	13.96
	5	Delayed decision making	3.91	1.036	13.88
	6	Poor coordination and project management	4.03	1.033	14.31
	7	Shortage of skilled manpower	3.73	0.969	13.25
Impacts of Variation	1	Project completion time	4.053	0.908	34.25
	2	Project cost	4.02	0.821	33.97
	3	Quality of completed work	3.76	0.959	31.78
Measures to minimize variation	1	Adequate planning and availability of fund before works start on site	4.57	0.877	12.43
	2	Comprehensive design and financial reviews before commencement of physical works	4.22	1.264	11.47
	3	Client expedite approvals and decision making	4.2	1.382	11.42
	4	Carry out detail site investigation and consider it during design stage	4.15	1.106	11.28
	5	Proper and restricted methods of procurement	4.01	1.319	10.90
	6	Enhance communication between all parties	4	1.205	10.88
	7	Client should expedite payments to contractors and consultants	3.97	1.375	10.79
	8	The client should produce a conclusive design and contract documents	3.86	1.474	10.49
	9	Revise and update general contract clauses	3.8	1.344	10.33

Table 4. 20: Abbreviations for the Assessment Measures and sub-measures

ayFactors	**Key**
Causes of variation	Cv
Impacts of variation	Iv
Variation Mitigation strategies	Mv
Delayed issuing of approval documents	Da
Changes in design	Dc
Changes in scope	Sc
Design flaws	Df
Delayed decision making	Dd
Poor coordination and project management	Pc
Shortage of skilled manpower	Sm
Project completion time	Pct
Project cost	Pcc
Quality of completed work	Qcw
Adequate planning and availability of fund before works start on site	Ap
Detailed site investigation	Di
Comprehensive design and financial reviews before commencement of physical works	Cdf
Client expedite approvals and decision making	Cad
Enhance communication	Ec
Mitigation Strategy Action at Pre-Construction Stage	MPr
Mitigation Strategy Action at Construction Stage	MCo
Client should expedite payments to contractors and consultants	Pay
Proper and restricted methods of procurement	Rmp
Client produce a conclusive design and contract documents	Cod
Revise and update general contract clauses	Coc

Table 4. 21 : Mitigation Strategy Actions at Pre-Construction Stage

Variables	**Mean**	**SD**	**Weighted, W_T (%)**
Adequate planning and availability of fund before works start on site	4.57	0.877	22.41
Carry out detail site investigation and consider it during design stage	4.15	1.106	20.35
Proper and restricted methods of procurement	4.01	1.319	19.67
The client should produce a conclusive design and contract documents	3.86	1.474	18.93
Revise and update general contract clauses	3.8	1.344	18.64

Table 4. 22: Mitigation Strategy Actions at Construction Stage

Variables	Mean	SD	Weighted, W_T (%)
Comprehensive design and financial reviews before commencement of physical works	4.22	1.264	25.75
Client expedite approvals and decision making	4.2	1.382	25.63
Enhance communication between all parties	4	1.205	24.41
Client should expedite payments to contractors and consultants	3.97	1.375	24.22

4.6.4.3 Models and Summary of Relationships

The analyzed results from the respondents represent the weightings for each of the measures and sub-measures used to assess project performance. Together they represent the models of respondents' perspective of variation and project performance. Since the measures are preferentially independent of each other, the simple linear additive evaluation model is applicable. Because the weightings of each set of sub-measures that define the main measure add up to 100%, the following relationships are established between them.

Summary 1: Criteria –indicators Relationships

PP = 32.65Cv + 34.08 Iv + 33.27 Mv ……..……..(Equation 4.3)

Cv = 15.13 Da +14.63Dc +14.84Sc +13.96Df +13.88Dd +14.31Pc +13.25Sm….(Equation4.4)

Iv = 34.25 Pct + 33.97Pcc + 31.78Qcw ……..……..……(Equation 4.5)

M_V = 12.43Ap + 11.47Cdf + 11.42Cad + 11.28Di + 10.9Rmp + 10.88Ec + 10.79Pay + 10.49Cod + 10.33Coc……..……..……..……. (Equation 4.6)

MPr= 22.41Ap + 20.35Di + 19.67Rmp + 18.93Cod + 18.64Coc……..…..(Equation 4.7)

MCo = 25.75Cdf + 25.63Cad + 24.41 Ec + 24.22Pay…….(Equation 4.8)

4.6.4.4 Explanation of the Models

The summary above represents models on the various facets of project performance assessment in Uganda. The summary describes the relationships between:

i. Project performance and the criteria by which performance could be assessed equation (4.3). The relationship shows that in assessing project performance (PP) in the perspective of practitioners on relative performance scale, impacts of the variation (Iv) on project cost, completion time and quality must be given the highest priority with 34.08%, followed by mitigation strategy to control variation (Mv): 33.27%, then causes of variation (Cv): 32.65%. This relationship provides information as to which criterion is playing what role in any level of project performance at any stage of the assessment. Using the general performance scale, a performance of a project can be explained from extremely weak performance 0-20% to excellent or outstanding performance 81-100%.

ii. Equations (4.4 - 4.6) show each criterion and its indicators. The relationships show the weighting of each indicator among the set of indicators within the set in the criterion. For example, equation (4.4) shows the assessment criterion causes of variation (Cv) with indicators Delayed issuing of approval documents (Da) with a weighting of 15.13%; 14.63% for design change (Dc); 14.84% for Scope change (Sc); 13.96% for design flaws; 13.88% of delay decision making (Dd); 14.31 for poor coordination and management (Pc) and 13.25% for shortage of skilled manpower (Sm).

The same holds for the other criteria for example impacts of variation (Iv). The relationships show that the criterion impacts of variation is influenced by the factors related to: the project completion time (Pct) 34.25%; 33.97% for project completion cost (Pcc) and 31.78 for quality of completed works (Qcw).

On the other hand, mitigation of variation (Mv), the relationships show that the criterion mitigation of variation is influenced by the factors related to adequate planning and availability of fund before works start on site (Ap) representing 12.43%; whereas 11.47% Comprehensive design and financial reviews before commencement of physical works (Cdf), 11.42% for Client expedite approvals and decision making (Cad), 11.28% for detailed site investigation (Di); 10.90% for proper and restricted methods of procurement (Pmp), 10.88% for enhance communication between all parties (Ec), 10.79% for Client should expedite payments to contractors and consultants (Pay),10.49% for Client should produce a conclusive design and contract documents (Cod) and 10.33% for revise and update general contract clauses.

4.6.5 Proposed management strategy actions to control variation

4.6.5.1 Conceptual and design stages (Pre-construction stage)

Conceptual stage is the initial phase of a construction project which primarily includes exploring thoughts and deliverables of the project. This stage is considered as a foundation of a construction project and a set of steps must take place through this stage to prevent any changes in the following project stages. Adequate planning and clear scope definition by client are required at this stage. Availability of fund before commencement of construction works should be guaranteed, stakeholders' engagement during feasibility study to enable real life situation is captured.

Design stage consists mainly of design works and generation of contract files. The design consultant and the owner share the responsibility in which the design consultant prepares the design works, while the owner reviews the design. The proposed minimization strategy actions to control variation are; detailed site investigation and consider it during design stage,

ensure that the design specification fall within the accepted budget, revise and update general contract clauses, stakeholders' engagement at design stage, effective scheduling in relation to scope of works, proper and restricted methods of procurement and clear contract document which does not favour any party should be employed at this stage to minimize variation and the impacts at construction stage.

The performance Management framework in Figure 4.3 is meant to enhance performance of paved road construction projects by early prediction and minimization of variation leading to accurate estimations of project cost, completion time and quality meeting required standards. The findings from the study have been employed as groundwork for proposing management strategy actions that could reduce variation and, as a result, their impacts when they occur. The application of the minimization strategies in Figure 4.3 should protect all project stages (conceptual, design and construction).

4.6.5.2 -Construction Stage

This stage of the project lifecycle consists principally of executing the shop drawings. The parties involved in this stage are; the client; the consultant and the contractor. The proposed minimization strategy actions to control variation are; Comprehensive design and financial reviews before commencement of physical works, Client expedite approvals and decision making, enhance communication between all parties, Client should expedite payments to contractors and consultants, all parties should forecast unforeseen situations, Construction and supervision of works should be done by experienced and dedicated teams and Proper analysis of risks by all parties should be employed in case variation is encountered at this stage. The application of the minimization strategies in Figure 4.4 clear define the roles of each project party in mitigating variation which is envisaged to protect projects at construction stage against the adverse effect of variation thereby improving project performance.

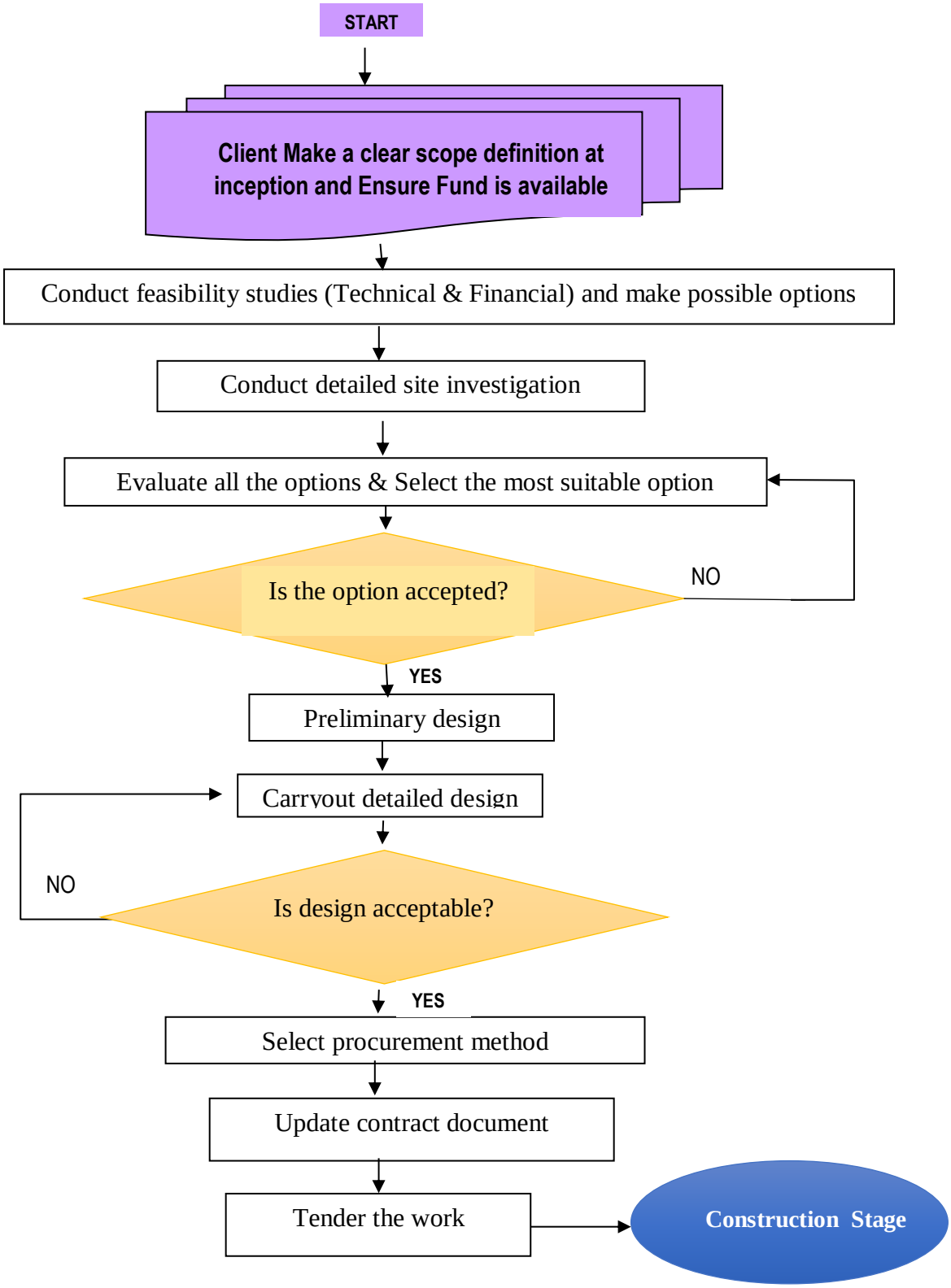

Figure 4. 3: Proposed Construction Project Performance enhancement Framework at pre-construction stage

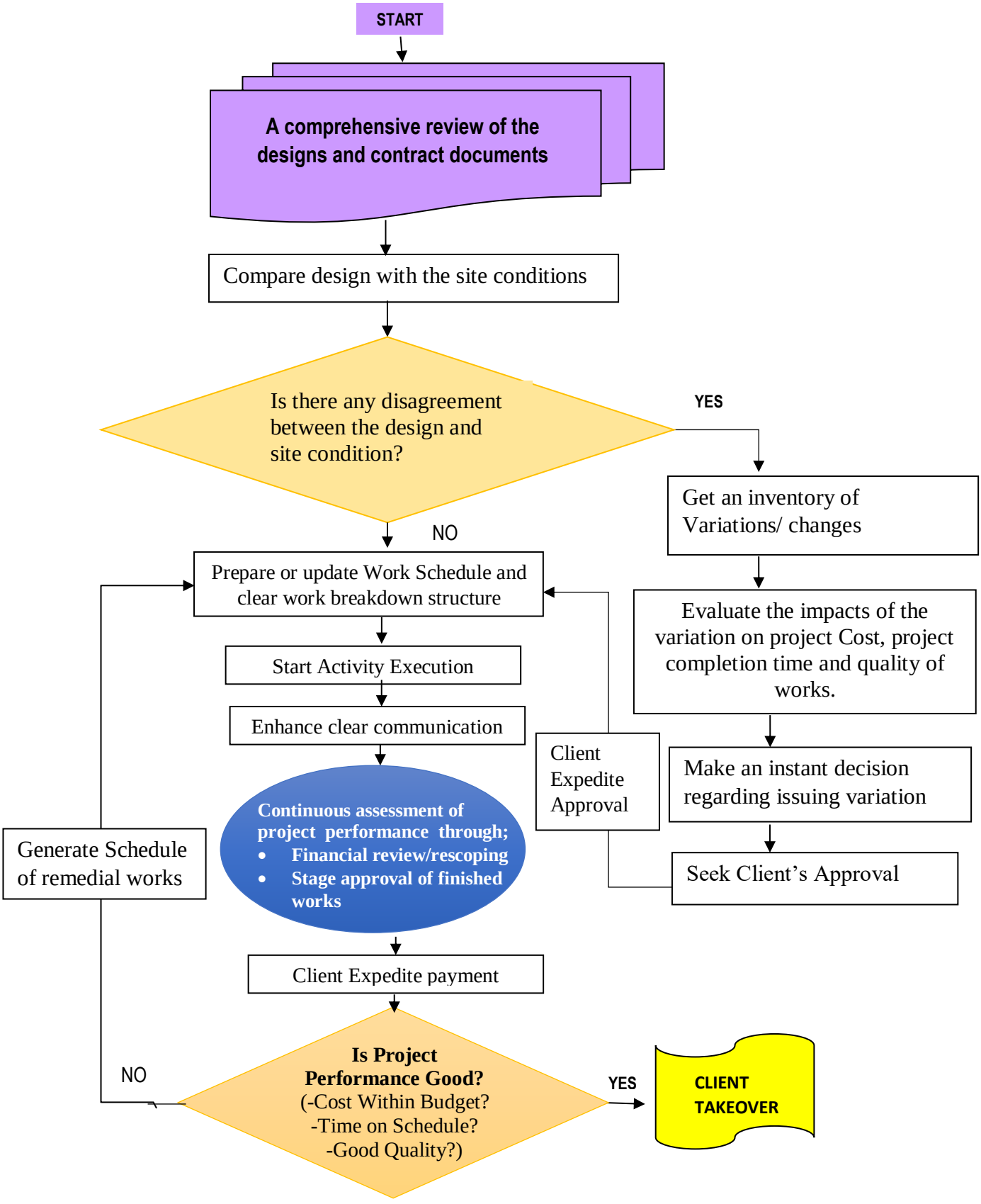

Figure 4. 4 : Proposed Construction Project Performance enhancement Framework at construction stage

4.7 Chapter summary

In summary, the following were the key findings of the study:

- The data were collected from respondents with high level of education good experience on road construction works. The views of such experienced respondents is considered acceptable.
- All the four projects under the study have experienced variation which were caused by client, consultant and Contractors and this resulted in to cost and time overruns. Although the variation which led to change of surfacing layer from DBST to Asphalt Concrete was intended to improve quality, its delayed formalization of the change orders impacted negatively on performance of the projects. However, the increase in cost and delayed completion was traded-off the quality of completed works.
- Numerous additional works and extensions of time whose causations were not contractor's fault affected project completion time and this culminated into cost claim and eventually led to increase in project cost.
- All the four projects experience time and cost overrun and quality issues due to variation. The variation were caused by client, consultant as well as contractor. Eight causes which were identified to be related to client includes; delayed issuing of approval documents, changes in scope, changes in design, financial constraints, failure to issue working drawings at the start of the project, poor procurement process, and conflicting contract documents and clauses. Seven causes which were identified to be consulted related includes; Changes in design, Design flaws, delayed decision making, change in specifications, failure to engage the stakeholders and the community during design, lack of judgment and experience, and I don't care attitude of consultant. While eight causes which were identified to be consulted related includes; poor coordination and project management practices, delayed acquisition of legal documents especially permits, shortage of skilled manpower, limited equipment to perform

work, poor Workmanship, financial constraints, delayed commencement of works, and failure to adhere to the supervisors' instruction.

- All the four projects suffered the direct impacts of variation on the scheduled completion time, cost and quality. Six impacts identified to be on related to time includes; logistics delays, delays on project completion, increase unnecessary procurement delays, reworking and demolition, health and Safety, and loss of productivity. Six impacts in relation to cost includes; increase in project cost, delays on project completion, logistics delays, Causes reworks and demolition, and loss of productivity. While four impacts which were identified to be in relation to quality includes; reworking and demolition, loss of professional reputation, health and Safety, and poor quality of works.
- The study established that the effect of variation on project performance were more at construction stage due to unmitigated causes at pre-construction stage. Twelve mitigation strategy actions identified to minimize variation at pre-construction stage includes; adequate planning and availability of fund before works start on site, detail site investigation and consider it during design stage were high on the list. While the seven mitigation strategy actions to minimize variation identified includes; comprehensive design and financial reviews before commencement of physical works, Client expedite approvals and decision making, enhance communication between all parties ranked high on the list

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study aimed at developing a model to enhance performance of paved road projects in Uganda focusing on paved road projects in Rwenzori Sub-region. It was conducted on four projects which included Kyenjojo- Fort Portal road (50km), Fort Portal –Hima (55km) road, Hima – Katunguru road (58km) and Katunguru – Ishaka road (58km). This chapter presents the conclusions made by the researcher and the recommendations to user entities organized in line with specific objectives of the study and finally the chapter areas for further research.

5.2 Conclusion of the study

This research assessed the causes of variation, the impacts and mitigation strategy actions to control variation in paved road construction projects in Rwenzori region, Uganda. Through the questionnaire survey, it was concluded that the most influencing causes of variation are; delayed issuing of approval documents which ranked highest followed by design change, Scope change, design flaws, delayed decision making, poor coordination and management and shortage of skilled manpower respectively.

This research further concluded that the impacts of variation were; delays on project completion, increase in project cost, logistics delays, increase unnecessary procurement delays, reworking and demolition, health and safety and loss of productivity, loss of professional reputation, poor quality of works.

Although variation cannot be completely avoided in a project, strategies to minimize its occurrence are necessary. The research concluded that mitigation strategies at pre-

construction stage are; adequate planning and availability of fund before works start on site, detail site investigation, proper and restricted methods of procurement and client produce a conclusive design and contract documents. Whereas mitigation strategies to minimize variation at construction stage are; comprehensive design and financial reviews before commencement of physical works, client expedite approvals and decision making, enhance communication between all parties and client should expedite payments to contractors and consultants.

In summary, variation affect performance of paved road projects. It is therefore envisage that the mathematical model and performance enhancement framework which were developed in this research can enhance performance of paved road projects when employed at pre-construction and construction stages of projects.

5.3. Recommendations

5.3.1 Recommendations on Specific Objective (i): To establish the causes of variation on paved road projects in Uganda, Rwenzori region

The study recommends that, delayed approval of document by client severely affect project cost, quality and progress of the project, therefore client should set up project document review and approval timelines to expedite approvals. Clients should provide detailed project briefs to the design teams to aid in arriving at conclusive designs so that recurrent variation to original plans or material type will be minimized or eliminated during the construction phase. This should be preceded by comprehensive planning and thorough identification of needs by clients and ensure availability of fund before embarking on any road developmental project. There should be proper definition of the scope of work to be carried out by the contractor without ambiguity. Specifications should be all-inclusive enough to assist contractors to deliver the

quality that is expected of them by clients. A detailed design should be in place to prevent any unnecessary interference from consultants and beneficiaries.

5.3.2 Recommendations on Specific Objective (ii): To determine the impacts of variation on the performance of paved road projects in Uganda, Rwenzori region

The following recommendations will serve as means of minimizing the impacts of variation on project performance. In order to advance performance of road construction projects in Uganda, the contributions of each project stakeholder must be improved. The occurrence of variation that causes poor performance is about the expertise of the client team and construction professionals regardless of the factors influencing variation. The general commentaries by the study respondents indicated that issues related to management skills cause variation in various ways. Hence, performance improvement in road construction projects necessitates the improvement of the competence of the client and entire construction team involved in a project.

5.3.3 Recommendations on Objective (iii): To establish the variation mitigation strategies to enhance performance of paved road projects in Uganda, Rwenzori region

5.3.3.1 Recommended strategy actions to Government/ Donors

The government or donors should make fund readily available to UNRA to minimize interest on delayed payment, suspension of works by contractors due to effect of delayed payment. This leads to extension of time with cost. The contractual claims related to delayed payment is a double financial loss in terms of interest and cost claim.

5.3.3.2 Recommended strategy actions to the Employer /Client (UNRA) and Consultants

i) Adequate planning is required before letting out projects for implementation. Lack of adequate planning translates into major design changes during implementation and it has been established to be one of the major causes of erroneous scope of works and schedules. This results in variation in quantities during implementation causing insufficiency of budget to complete the works and multiple extensions of time.

ii) Detailed site investigation should be conducted. Risks envisaged within the ground are accredited to significant cost and time overruns on construction projects. There is need to address such risks through a comprehensive site investigation, instead of ignoring them as an unnecessary cost. It is essential to conduct a thorough site investigation prior to any construction. They will help identify any risks of constructing at the site, which can help in finding the best solution. This solution may require the use of a specific design, materials or treatments, or it may mean finding a more suitable alternative location or route.

iii) The Client should produce a conclusive design and contract documents. Nearly all the projects went through assorted changes at construction. These various changes have considerably impacted on the performance of the project, which was minor or major according to the result of the change. Design changes in construction projects inevitably led to cost overrun or schedule delay or affected quality of work. To mitigate the impacts, the dynamics that influence design needs to be identified and attended to as early as possible and a conclusive design that meets required standards and specifications and fall within the approved budget is provided to minimize detrimental design changes.

iv) Comprehensive design and financial reviews before commencement of physical works. This is a process by which a design is assessed against its necessities in order to verify the outcomes of previous activities and identify any issues prior to commencement. Designers should take full control of the review process, both in-house and out-of-house. Adequate time should be

given to complete the design reviews, field investigations and greater involvement in the inspection process to produce a comprehensive design review document that will eliminate design errors.

v) Client expedite approvals and decision making. Early approval of design and response to key contractual matters on site and fast decision making process by the client avoid unnecessary delays in project.

vi) Clients and their consultants should try as much as possible to avoid single and multiple variation that require new procurement or contract split on road projects since they have greater influence on the outcome of the final completion time and cost of projects.

5.3.3.3 Recommended strategy actions to Contractors

i) Enhance communication between all parties. Fast and effective communication transfer among managers and participants speed up the road construction process and performance of contractors

ii) Improve on planning and daily scheduling of work so that materials and equipment are timely delivered to work fronts.

iii) Hire skilled and experience manpower. Skilled manpower enables the construction company to achieve overall goals of the company as skilled employees delivered quality work.

iv) Adhere to supervisor's instruction and specifications in order to achieve the required standards

v) Prepare program of work and share work breakdown structures with project team for proper scope management and monitoring.

vi) Improve on monitoring and supervision of work at project sites

vii) Get actively involved in financial and design reviews.

5.3.4 Performance enhancement model of paved road projects in Uganda

Equation (4.1) can be used by the owners of paved road projects, donors, consultants and contractors and they will be in position to determine the effect of variation on performance and then minimize detrimental variation on paved road projects hence improving performance of paved road projects.

5.4 Contribution of the study

This study identified mitigation strategy actions necessary to minimize variation on paved road construction projects. A mathematical performance enhancement model was developed based on mitigated cause of variation and mitigation strategy action to minimize variation. Using the performance enhancement model and a performance enhancement framework proposed by the researcher, the Employers/ Clients, Donors, Consultants and Contractors of paved road projects will be in position to identify causes and mitigation strategy actions to minimize variation in paved road projects.

5.5 Areas for further studies

The researcher recommends that further research be conducted on developing an appropriate approach of capturing data with regard to variation in paved road rehabilitation projects.

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APPENDICES

APPENDIX 1: RESEARCH QUESTIONNAIRE

Dear Sir/Madam/Eng./Dr./Prof,

I am **Lukala Justine** conducting a study on the Assessment of the Effects of Variation on the Performance of Paved Road Projects in Uganda. A Case of Uganda National Roads Maintenance Program-Rwenzori region as part of my study program for Master of Science in Construction Technology and Management at Kyambogo University. Your opinion and experience is of great importance to this study and the information you provide shall only be used for academic purposes. I therefore kindly request that based on your experience and knowledge, you help me complete this questionnaire.

SECTION A: GENERAL BACKGROUND INFORMATION

1.1 About respondent

1.1.1 Gender

[1] Male [2] female

1.1.2 What is your age group?

[1) 20-25 [2] 25-30 [3] 30-35 [4] 35-45 [5] 45-50 [6] Above 50

1.2 About Your Organization (*Please select/fill as appropriate*)

1.2.1. Nature of the employing Organization.

(1) Client (2) Consultant (3) Contractor

1.2.2 For how long have you been supervising, managing or constructing paved roads in Uganda?

(1) 1-4 years (2) 5-9 years (3) 10-15 years (4) 15-20 years (5) Over 20 years

1.2.3 Please indicate your current position in the organization (Please tick appropriate).

Contractor	√	**Consultant**	√	**Client**	√
1)Project Manager		10)Resident Engineer		19)Contract Manager	
2)Deputy Project 3)Manager		11)Deputy Resident Engineer		20)Project Engineer	
4)Site Engineer		Materials Engineer		21)Station Manager	
5)Material Engineer		Surveyor			
6)Surveyor		Assistant surveyor			
7)CAD Engineer		Senior lab technician			
8)Foremen		Technicians			
9)Quantity Surveyor		Inspectors			
		Highway Engineer/CAD			

1.2.2. Please kindly indicate your level of education? (Please tick appropriate)

(1) Certificate (2) Diploma (3) Degree (4) Post Graduate (6) Other

SECTION B:

The purpose of this section and all subsequent sub-sections is to give you a chance to indicate the degree to which you agree with the statements. Tick the number that best describes your opinion on each of the statements. Using the scale below the highest score is Strongly Agree and the least score is Strongly Disagree. Use the Likert scale below to complete the questions.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

If you strongly disagree, tick 1, where you disagree, tick 2, where you are neutral tick 3, in case you agree, tick 4 and where you believe you strongly agree, tick 5.

1. CAUSES OF VARIATION

No.		**Strongly disagree ((1)**	**Disagree(2)**	**Neutral (3)**	**Agree (4)**	**Strongly agree (5)**
The following causes of variations are related to the client						
1a	Poor scheduling					
1b	Poor procurement process					
1c	Delayed issuing of approval documents					
1d	Conflicting contract documents and clauses					
1e	Changes in design					
1f	Financial constraints leading to interest on delayed payment					
1g	Changes in scope					
1h	Failure to issue working drawings at the start of the project					

No.		Strongly disagree ((1)	Disagree(2)	Neutral (3)	Agree (4)	Strongly agree (5)
The following causes of variations are related to the consultant						
1i	Changes in design Changes in design					
1j	Design flaws (errors and omissions in design)					
1k	Lack of judgment and experience					
1l	Delayed decision making					
1m	Change in specifications					
1n	I don't care attitude					
1o	Lack of stakeholders and the community Engagement during design implementation					
The following causes of variations are related to the contractor						
1p	Failure to adhere to the supervisors advice					
1q	Poor Workmanship					
1r	Limited equipment to perform work					
1s	Shortage of skilled manpower					
1t	Delayed acquisition of permits					
1u	Delayed Commencement of works					
1v	Financial constraints					
1w	Poor coordination and project management					

2. IMPACTS OF VARIATION

No.		Strongly disagree (1)	Disagree(2)	Neutral (3)	Agree (4)	Strongly agree (5)
	Impacts of variation in relation to time					
2a	Logistics delays					
2b	Delays on project completion					
2c	Increase unnecessary procurement delays					
2d	Reworking and demolition					
2e	Health and Safety					
2f	Loss of productivity					
	Impacts of variation in relation to cost					
2g	Delays on project completion					
2h	Increase in project cost					
2i	Logistics delays					
2j	Loss of productivity					
2k	Causes reworks and demolition					
	Impacts of variation in relation to quality					
2l	Poor quality of works					
2m	Reworking and demolition					
2n	Health and Safety					
2q	Loss of professional reputation					

3. MITIGATION STRATEGY ACRIONS TO CONTROL VARIATION

(a) Mitigation measures at pre-construction stage

No.		Not Important(1)	Less Important(2)	Neutral (3)	Important(4)	Very Important(5)
3a	The client should produce a conclusive design and contract documents					
3b	Clients should provide a clear brief of the scope of works					
3c	Adequate planning and availability of fund before works start on site					
3d	Carry out detail site investigation and consider it during design stage					
3e	Client should ensure that the design/specifications fall within the approved budget					
3f	Client's coordination in the design stage should be practiced to help spot the noncompliance of owner's demand					
3g	Effective scheduling in relation to scope of works					
3h	Stakeholder's engagement to incorporate their demand.					
3i	Spend adequate time on pre-tender planning phase					
3j	Proper and restricted methods of procurement					
3k	Objectivity and impartiality (the contract documents in a way that does not favour certain bidders)					
3l	Revise and update general contract clauses					

(b) Mitigation measures at construction stage

No.		Not Important(1)	Less Important(2)	Neutral (3)	Important(4)	Very Important(5)
3m	Construction and supervision of works should be done by experienced and dedicated teams					
3n	Client expedite approvals and decision making					
3o	Enhance communication between all parties					
3q	All parties should forecast unforeseen situations					
3r	Proper analysis of risks by all parties					
3s	Comprehensive design and financial reviews before commencement of physical works					
3t	Client should expedite payments to contractors and consultants					

END OF QUESTIONNAIRE

THANK YOU FOR YOUR PARTICIPATION AND COOPERATION

APPENDIX II: INTERVIEW GUIDE FOR THE SURVEY

A. CAUSES OF VARIATION

1. Has the project you are implementing experienced any variation? Yes / No

2. If yes, specify;

(a) Client related causes

……

……

……

(b) Consultant related causes

……

……

……

(c) Contractors' related causes

……

……

……

B. IMPACTS OF VARIATION

1. How has variation affected your project in relation to:-

(a) Project completion time

……

……

(b) Project cost

……

……

(c) Quality of completed works

……

……

C. MITIGATATION MEASURES TO MINIMIZE VARIATIONS ON PAVED ROAD PROJECT

1. What Mitigation strategy actions should be put in place to minimize variations on paved road projects?

……

……

2. In order of priorities, which areas in project cycle (Pre-construction/design and construction) requires more attention in order to reduce on variations

……

……

END OF INTERVIEW GUIDE

APPENDIX III: KREJCIE AND MORGAN TABLE

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Krejcie and Morgan Table 1970

APPENDIX IV: REVIEWED PROJECT DOCUMENTS

(a) PROJECTS DETAILS

KYENJOJO –FORT PORTAL ROAD

Contract Title		Civil Works for Rehabilitation of Kyenjojo –Fort Portal Road (50km)
Employer		Uganda National Roads Authority (UNRA)
Contractor Address		M/S China Wu Yi Co Ltd, P O BOX 37825 Kampala, Tel : +256 776327623 Email: chinawuyifortportal@outlook.com/ chinawuyiuganda@hotmail.com
Procurement Reference No.		UNRA/WORKS/2014-15/00005
Letter of Bid Acceptance		2nd December 2015
Contract Signing Date		30th December 2015
Site Possession Date		1st June 2016
Commencement Date		29th June 2016
Original Revised		Eighteen (18) months Thirty Eight (38) months
Original 1stRevision 2nd Revision 3rd Revision		28th December 2017 30th April 2018 31st December 2018 31st August 2019
Extension of Time		30 Months (611 days)
Original Revised		USHS. 71,435,766,901/= (including VAT) NA
Construction Supervisor	Original	MS MBW Consulting Ltd/Infrastructure Projects Ltd JV
	Current	UNRA Construction Supervision Team

Table 6b: Contract Data for Supply and Lay tack Contract

Contract Title	Supply and Lay tack Coat and Asphalt Concrete on Kyenjojo – Fort Portal road (40km) Contract
Employer	Uganda National Roads Authority (UNRA)
Contractor Address	M/S China Wu Yi Company Ltd, Plot No. 89, Wu Si Road, Fuzhou City, Fujian Province, China Tel +256 776327623 Email: chinawuyiuganda@hotmail.com
Procurement Reference No.	UNRA/WORKS/2018-2019/00004

Letter of Bid Acceptance	29th April 2019
Contract Signing Date	17th May 2019
Site Possession Date	24th May 2019
Commencement Date	24th May 2019
Original	Nine (9) months
Original	23rd February 2020
Extension of Time	None
Original Revised	USHS. 48,412,573,498/= (including VAT) NA
Construction Supervisor	UNRA Construction Supervision Team

FORT PORTAL – HIMA ROAD

Contract Title	Civil Works for Rehabilitation of Fort Portal - Hima Road (55km)
Procurement Reference No.	UNRA/SERVICES/2014-15/00042
Employer	Uganda National Roads Authority (UNRA)
Contractor Address	M/S China Wu Yi Co Ltd, P O BOX 37825 Kampala, Tel : +256 776327623 Email: chinawuyifortportal@outlook.com/ chinawuyiuganda@hotmail.com
Commencement Date	26th March 2018
Original Revised	Eighteen (18) months Thirty six (36) months
Original Revision	25th September 2019 2nd January 2021
Original Contract Completion Date	25th September 2019
Latest Programme Completion Date	30th November 2020
Projected Completion Date (Consultant)	2nd January 2021
Projected Overrun (Consultant)	577 days
Original Contract Amount	USHS. 94,838,583,709
Latest Approved Contract Amount	USHS. 98,396,183,393
Projected Final Contract Amount (Consultant)	USHS. 118,911,276,316
Projected Overrun (Consultant)	USHS. 12,515,877,954

HIMA - KATUNGURU

Phase 1 km 29+000 to km 57+080

Contract Title		Civil Works for Rehabilitation of Hima - Katunguru Road (58km)
Employer		Uganda National Roads Authority (UNRA)
Contractor Address		M/S China Railway No. 3 Engineering Group Co. Ltd
Procurement Reference No.		UNRA/WORKS/2014-15/00019
Letter of Bid Acceptance		2nd December 2015
Contract Signing Date		6th May 2016
Site Possession Date		1st June 2016
Commencement Date		13th February 2017
Original Revised		Eighteen (18) months Thirty one (31) months
Original Revision		13th August 2018 22st September 2019
Extension of Time		405 days
Original Revised		USHS. 83,258,595,474.44/= (including VAT) NA
Construction Supervisor	Original	MS Lea Associates South Asia in association with KOM Consult Uganda Limited
	Current	UNRA Construction Supervision Team

Phase II km 0+000 to km 29+000

Contract Title	Civil Works for Rehabilitation of Hima - Katunguru Road Phase II km 0+000 to km 29+000
Employer	Uganda National Roads Authority (UNRA)
Contractor Address	M/S China Railway No. 3 Engineering Group Co. Ltd
Procurement Reference No.	UNRA/WORKS/2019-20/00028
Contract Signing Date	22nd January 2021
Site Possession Date	2nd January 2020 (under pre-financing)

Commencement Date	2nd January 2020(under pre-financing)
Original Revised	Eighteen (9) months Seventeen (17) months
Original Revision	1st October 2020 17th June 2021
Extension of Time	259 days
Original Revised	USHS. 107,616,099,006/= (including VAT) NA
Construction Supervisor Original	UNRA Construction Supervision Team

KATUNGURU – ISHAKA

Contract Title	Civil works and rehabilitation of Ishaka-Katunguru road (58km).
Employer	Uganda National Roads Authority Plot 3-5 New Portbell road UAP Nakawa Business Park, Block C&D
Contractor	M/S Mota-Engil Africa 66 Wierda Road East, Sandton 2146, Johannesburg Southafrica *Local représentative* Plot 2, Park Lane Kololo,
Procurement Reference No.	UNRA/WORKS/2015-16/00058
Letter of Bid Acceptance	28th December 2015
Contract Signing Date	12th April2017
Commencement Date	30th June 2017
Period of Performance	Eighteen (18) months
Revised period of performance	38.2 Months.
Original Completion Date	31st December 2018
Original Contract Price	UShs. 103,852,641,242.00/=
Total Extension of Time	20.2 months
Revised Completion Date	23 August 2020

Revised Contract Amount	118,849,591,043
Amount of Advance Payment	15% of Original Contract Price
Amount of Retention Money	10% of the Accepted Contract Amount
Amount of Liquidated Damages	0.05% of the Contract Price per day
Limit of Liquidated Damages	10% of the Final Contract Price
Defects Liability Period	365 Calendar Days
Construction Supervisor	UNRA In House Construction Supervision Team

(b) DOCUMENTARY EVIDENCE

Project Roads	**Project Documents Reviewed**					
	Change Orders	payment certificates	Claims	Progress report	Audit report	Status
Kyenjojo – Fort Portal						
Fort Portal - Hima						
Hima- Katunguru						
Katunguru - Ishaka						

APPENDIX V:TURNITIN PLAGIARISM CHECK REPORT