KYAMBOGO UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

DEVELOPING A MODEL FOR COST PERFORMANCE IMPROVEMENT OF ROAD MAINTENANCE PROJECTS IN NORTHERN UGANDA – CASE STUDY OF UGANDA NATIONAL ROADS AUTHORITY

BY

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Kyambogo University a dissertation entitled: "**Developing a Model for Cost Performance Improvement of Road Maintenance Projects in Northern Uganda – Case study of Uganda National Roads Authority**", in partial fulfillment of the requirements for the award of a Degree of a Master of Science in Construction Technology and Management of Kyambogo University.

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DECLARATION

I, Abonga Alfred Alexis, 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.

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Abonga Alfred Alexis

ABSTRACT

Government has put in place plans for road development and maintenance and has improved on its budget allocations, in order to boost tourism, agriculture and mining, among others. However, road maintenance remains a challenge due to cost deviations, inflation of unit costs by contractors and delays in maintenance interventions. This has resulted into maintainable sections of the networks to slip into rehabilitation realm, therefore increasing maintenance backlog. This study examined Cost Performance Improvement of road maintenance projects in Northern Uganda considering Uganda National Roads Authority. The main objective of the study was to develop a model to improve cost performance in road maintenance projects. The study was conducted in four UNRA stations in Northern Uganda, namely Arua, Gulu, Kitgum and Moyo Stations using a simple random selection. Both qualitative and quantitative data were collected, using survey questionnaires and documentary reviews from a sample size of 60 elements. Data was analyzed using correlations, regression analysis and descriptive analysis. Wearing course & shoulder works experienced 64.3% negative cost deviations while drainage improvements experienced 21.4%. Material price fluctuations, with 80.9% of respondents, and equipment availability and failures, with 81% of respondents, were key factors, believed to have influence on cost deviations. A Cost Performance Improvement model, developed using a multivariate regression analysis of budgeted cost elements, is proposed to address inaccurate costing of the budget elements. The study concluded that road maintenance projects experience negative cost deviations due to problems related to Clients' Project management & contract administration, labor management, financial management, contractor's site management and design & documentation factors. The research recommends a study into the effect of different management styles on project cost deviations since it varies from one contract manager to another.

Key words: *Project costs, Cost deviations, Road maintenance, Predictive modeling and Northern Uganda.*

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LIST OF ABBREVIATIONS

ACWP	Actual Cost of Work Performed
BCAC	Budgeted Cost at Completion
BCWP	Budgeted cost of Work Performed
BMAU	Budget Monitoring and Accountability Unit
Bn	Billion
CPI	Cost Performance Index
CVI	Content Validity Index
FCAC	Forecast Cost at Completion
FCTC	Forecast Cost to Completion
FY	Financial Year
GDP	Gross Domestic Product
ICT	Information, Communication and Technology
KCCA	Kampala City Council Authority
LRA	Lord's Resistance Army
MoFPED	Ministry of Finance Planning and Economic Development
MoWT	Ministry of Works and Transport
NRN	National Road Network
OAG	Office of the Auditor General
PDE	Procurement and Disposal Entity
PMBOK	Project Management Book of Knowledge
PPDA	Public Procurement and Disposal of Asset authority

SPSS	Statistical Package for the Social Sciences
UNRA	National Roads Authority
USD	United States Dollars

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Investments in infrastructure are crucial drivers of economic growth and development (Sustainable Development Goal 9). Burningham and Stankevich (2005) noted that poor maintenance of roads constrain mobility, significantly raise vehicle operating costs. Besides, it increases accident rates and their human and property associated costs. Poor road maintenance is also known to aggravate isolation, poverty, poor health and illiteracy in rural communities. The importance of regular road maintenance was highlighted and the use of force account as a way of achieving sustainable road maintenance with scarce public resources, emphasizing the need to maintain existing roads before funding new ones was recommended. According to the Permanent International Association of Roads Congresses (PIARC) road maintenance handbook, maintenance of roads is an essential function which should be carried out on a timely basis (PIARC 1994). With competitive utilization of the scarce public resources by various sectors, there is need to improve on maintenance cost in order to do more maintenance work with savings realized

Cost deviations in construction projects have been established to be a widespread problem affecting construction industry globally. Studies have shown that cost underestimates, referred to as negative deviations, are more common in all construction

projects, irrespective of the value of the project (Mahamid and Amund, 2012). Cost deviations arise, among others, as a result of price escalations (Omoregie and Radford, 2006). Ahmed and Saad (2017) conducted a study and established that frequent change orders, lack of experience and lack of communication with suppliers were the major causes of cost deviations in highway construction projects in Bahrain.

On the other hand, the following are the five most significant causes of cost deviations affecting construction industry in Afghanistan (a country with a history of prolonged insurgencies due to terrorism similar to that of northern Uganda); corruption, delays in progress payments by clients, difficulties in financing projects by contractors, security, and change orders by clients (Abbas & Painting, 2017).

Cost variations appear to differ from one geographical location to another with significant statistics leading to cost overruns in the different locations (Cantarelli et. al., 2012). In addition, 26% of construction projects in Europe experienced cost overruns; 24% in North America and 65% in other areas It was therefore necessary to establish how the different road maintenance project costs varied from one station to another within the case study area in Uganda.

In Uganda, according to a sector report by ministry of works and transport (MoWT), there is a significant increase in unfunded backlog for roads in poor conditions from

USD629.7 million in 2013/2014 to USD802.4 million in 2014/2015. Unpaved National road network conditions in fair to good conditions decreased from 71% in FY 2015/2016 to 70% in FY 2016/2017 at 60.5%, below the target of 70%, for unpaved District road network in FY 2016/2017 (MoWT, 2017). Besides the deteriorating conditions of the unpaved roads network, a Budget Monitoring and Accountability Report (BMAU) noted that project cost overruns, have been consistently identified in multi-year road maintenance projects, mainly implemented by Uganda National Roads Authority (BMAU, 2011).

1.2 Problem statement

Every road is supposed to remain serviceable until the end of its design life without much degradation of the carriageway, siltation and erosion of the drainage systems. However, frequent use of the roads always lead to failures or road deterioration such as rutting, potholes and corrugations, among others, of the road surfaces. The failures make the road surfaces rough to motorist and sometimes impassable hence increasing costs of vehicle operations on the roads and blocking market access for agricultural products, among others. The deterioration always requires a maintenance intervention to prolong the life of the road. However, road maintenance faces the challenges of cost variations. The variations come, among other factors, as a result of underestimation of the road project cost which results into negative cost deviations after implementation. Cost variations lead to accumulation of institutional arrears which become part of government reconciled stock of arrears. Over accumulation of arrears by government suppresses

service deliveries to citizens. Cases of inflation of unit cost of work by contractors are also being registered leading to expensive road project costs. Expensive road projects lead to lower output coverage. This is resulting into an increase of roads in “poor” road conditions and an increase of unfunded road maintenance backlog. The increase in unfunded road maintenance backlog is likely to result into an increase in number of roads slipping away from lesser expensive maintenance interventions into a more costly rehabilitation or reconstruction interventions.

Developing a predictive model that informs about a probable way of reducing cost deviations during budgeting for maintenance works is envisaged to reduce cost deviations hence enhancing cost performance improvements through a realistic planning and implementation of unpaved road maintenance projects in UNRA. This is hoped to result into budgetary saving that can be used to increase maintenance outputs.

1.3 Objectives of the study

1.3.1 Main Objective

The main objective of the study was to develop a model to improve cost performance in unpaved road maintenance projects for Northern Uganda.

1.3.2 Specific objectives

The specific objectives of the research were:

i. To establish the current cost performances of road maintenance projects in UNRA;

ii. To establish the factors that influence cost performances of road maintenance projects in UNRA;

iii. To develop a predictive model for cost performance improvement of road maintenance in UNRA.

1.4 Research Questions

The research intended to answer the following questions:

i. What is the current situation on cost performances of road maintenance projects in UNRA?

ii. What are the factors that influence cost performances of road maintenance projects in UNRA?

iii. How can cost performance of road maintenance projects be improved in UNRA?

1.5 Research Justification

Although National Road Network (NRN) in Uganda is the most dominant form of transport network, carrying over 90% of passengers and freight traffic, its maintenance and operation faces competing financing demand from other sectors (Kagina, 2017). As a result, the same source reports that there was a budget shortfall of 280 billion Uganda Shillings in the budget for FY 2017/2018 towards NRN maintenance and operation.

Maintenance financing is also challenged by the problem that Uganda Government's obligation arrears that stand at 1,997 trillion Uganda shillings, representing13%, more

than the maximum allowable 3%, of the approved budgets (MoFPED, 2017). The Public sector management service annual report by MoFPED includes 363 billion Uganda shillings development arrears, inclusive of maintenance arrears for UNRA.

Apart from affecting financing of road maintenance budgets, continuous accumulation of government arrears leads to reduced economic growth as a result of reduced economic activities and increased unemployment; increased cost of service leading to inflation; halted service delivery as a result of delay of maintenance projects and increased interest rates as a result of the pressure created on the credit markets through borrowing from the commercial banks (Flyn & Pessoa, 2014). This study is to propose a model regarding the need to improve cost performance in the NRN maintenance through effective utilization of the appropriated budget to obtain more maintenance output.

1.6 Significance of the study

Uganda's total road network has an estimated maintenance value of USD 6.2bn, which is nearly 24% of the country's GDP (Odongo, 2017). In FY 2017/2018 and 2018/2019, government could only afford to budget Ushs 407bn and 607bn respectively for road maintenance. This was equivalent to USD 107 million and USD 160million, which was only about 22% of the overall estimated maintenance value of the total road network. There is therefore need to pay attention to proper planning for the utilization of the

meagre resource envelop available for road network maintenance in order to improve on cost performance in road maintenance projects and save funds to cover more road network.

The research would be useful in improving cost planning for road maintenance projects by UNRA and all the entities responsible for road maintenance, hence contributing to a reduction in the maintenance backlog. It would also contribute to the various discussions in future researches relating to cost performances in road maintenance projects.

1.7 Project scope

1.7.1 Content Scope

The research project studied cost performances in contracted term/ periodic maintenance of unpaved road projects only. The studied projects were contracted out to private construction firms by UNRA on 3-year maintenance contracts. Activities budgeted for the studied projects covered the areas of preliminary works, drainage works, wearing course and shoulder works.

1.7.2 Geographical scope

The research project studied only projects implemented within the northern region of Uganda under the different UNRA stations. The projects studied were from Kitgum,

Moyo, Arua and Gulu UNRA stations. Kitgum station covers the administrative districts of Kitgum, Lamwo, Agago and Pader. Moyo UNRA station covers the districts of Moyo, Adjumani and Yumbe. Whereas Arua station covers the districts of Nebbi, Maracha, Koboko, Zombo and Arua. Gulu station covers the districts of Omoro, Amuru, Nwoya and Gulu districts. Projects from the fifth station of Lira were not, however, studied due to difficulties in accessing data required for the study. Data from four, out of the five stations in northern Uganda, is believed to be representative of the entire region.

1.7.3 Financial scope

Projects studied were those with contract sum within the range of Ushs 1 to 10 Billion only.

1.7.4 Time scope

The projects studied were those implemented within the last five financial years beginning from FY 2012/2013 to 2016/2017 only.

1.8 Conceptual Framework

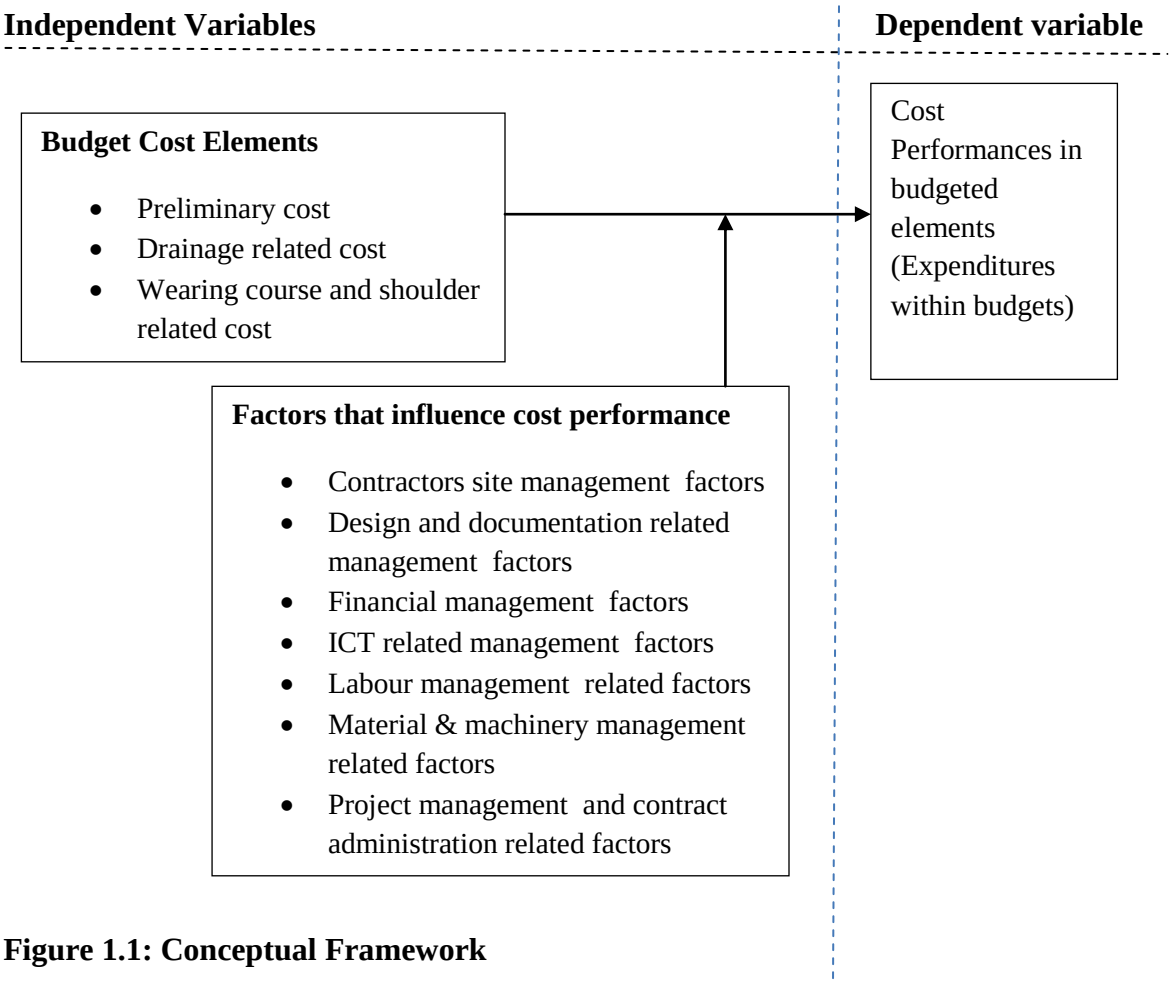


Figure 1.1: Conceptual Framework

Source: *Developed by the researcher, 2019*

In this concept, it is envisgaed that accurate costing of the budget cost elements, under each sub-element is expected to ensure that expenditures realised are within the budget (underspending), leading to improved cost performances. The costing should take into consideration control of the management factors during budgeting and implmentations. Whereas under-costing of the budgeted cost elements and lack of effective consideration

and control of the mangement factors may lead to over-spending on the budget cost elements resulting into bad cost performances.

Preliminary Budget Cost sub-element includes traffic management cost, quality control and material testing cost, overheads and profits and signboard cost. Accurate feasibility study and correct choice of profit and overhead percentage margin is expected to control preliminary cost. The drainage related budget cost sub-element considered include cost related to excavation of drains and culvert installations cost. Whereas wearing course and shoulder related budget cost sub-elements include road shaping cost and gravelling cost. Drainage and wearing course / shoulder related cost can be controlled through control of the management factors.

Contractors site management factors considered include poor site management & supervision, inadequate planning & scheduling, lack of experience, inadequate time and cost estimates, mistakes during construction and inadequate monitoring & control. Design and documentation related factors studied included frequent design changes, mistakes and errors in designs, incomplete designs at the time of tender, poor designs & delays in designs and delay in preparations and approval of drawings. On the other hand, financial management factors studied included; cash flows & financial difficulties by contractors, poor financial control on site, financial difficulties of owners, delays in progress payments by owners, delay in payment to supplier/contractor and contractual

claim. ICT related factors considered included lack of coordination between maintenance parties, slow information flow between the parties and lack of communication between the parties. Labour management related factors included low labour productivity, shortage of site workers, shortage of skilled labour, high cost of labour and labour absenteeism. Material and machinery related factors included fluctuation of price of materials, shortage of materials, late delivery of materials & equipment and equipment availability & failure. Finally Project management and contract administration related factors included poor project management, change in the scope of the project, delays in decision making and inaccurate quantity take-off. If these factors are carefully considered and controlled when road maintenance budgets are being prepared, then the budgeted cost elements' costs are controlled, leading to improved cost performance.

The concept adapted was a modified concept used for various major factors contributing to poor cost performances in road works in northern Kenya (Oguya & Muturi, 2016) as shown above.

1.9 Chapter Summary

The chapter has covered what the research did to find solutions to issues of cost performances of road maintenance projects by addressing problems identified through the specific objectives stated. By addressing the specific objectives, the research

questions raised were then answered. The extent to which the research was handled was covered under the scope. Important issues were raised under the justification and significance of the research which raised the need to have the research undertaken. Finally, the conceptual framework proposed indicated the influence of factors for cost performance improvements in order to realize the desired research outcomes of reduced cost variations. The concept will further be understood by highlighting some key words, in the research topic as listed in the next chapter on literature review.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The research study was conceptualized by understanding some of the key words or phrases including, among others, Project cost, cost deviations, cost control, road maintenance and predictive models.

2.2 Project Cost

This is referred to as project budget and is a detailed time phased estimate of all resource costs for a project (Al-Agele and Al-Hassan, 2016). Project resources, which are in form of materials, machines, money and manpower, are not enough and have limited budget which must be allocated to all project activities in order to reduce project time or critical path (Scot and Jefferson, 2007). Project cost can either be in the form of direct cost, which is the cost of inputs such as cost of construction materials, tools and equipment and payment of staff wages or in the form of indirect costs, incurred to produce an output. Indirect costs include cost of renting an office, payment of utility bills and communication, among others. Project cost is best calculated at a time when little is known about a project (Atkinson, 1999). Many clients and financiers believe that project cost management and control requires the use of highly specialized experts in cost management.

2.3 Project Cost Management

Cost management includes processes involved in estimating, budgeting and controlling costs so that a project can be completed within the approved budget (PMBOK, 2013). Project managers are supposed to make sure that projects they approve are well defined, have accurate time and cost estimates and a realistic budget. Project cost management involves planning for the cost management, estimating costs, determining the budget and cost control.

2.3.1 Plan Cost Management

According to Project Management Body of Knowledge, plan cost management is the first step in cost management knowledge area meant for establishing policies, procedures and documentation. It is used for planning, managing, expending and controlling project costs. It describes how project cost shall be managed in terms of scope baseline, schedule baseline and risks information, such as inaccurate cost estimates and budget cuts, among others. It provides a guidance and direction on how the project cost will be managed throughout the project (PMBOK, 2013).

2.3.2 Estimating costs

This is a prediction of quantities, costs and or prices of resources required by the scope of a project (WSDOT, 2015). Cost estimate is also a process of developing approximate

likely costs of resources (labour, materials, equipment and facilities) necessary to complete project activities (PMBOK, 2013). Inflation allowance and contingency cost is also included in the estimates. As a prediction, it is emphasized that an estimate must address risks and uncertainties and therefore used in project cost control.

2.3.3 Determining a budget

This is a process of aggregating cost estimates of individual activities of work package to establish an authorized cost baseline for measuring and monitoring cost performance and estimating costs for each major project activity over a time period hence providing management with a foundation for project cost control (PMBOK, 2013).

2.3.4 Cost control

Cost control is ensuring that projects are implemented within their budgets on time and in correct quality (Al-Agele and Al-Hassan, 2016) or a process of monitoring the status of the project costs and managing the changes to the cost baseline (PMBOK, 2013). There are two control techniques established to control costs, namely; budgetary control, where a budget is used as a means of planning and controlling entire aspects of an organization activities and standard costing, which is a system of control aimed at establishing standards of performances and target costs to be achieved under a given set of working conditions (Chand, 2014). Cost control includes;

- Influencing the factors that cause cost deviations;

- Monitoring cost performances to detect variances from the plan;
- Ensuring that all approximate changes are recorded;
- Preventing incorrect, in appropriate or unauthorized changes;
- Informing appropriate stakeholders of authorized changes and;
- Analyzing positive and negative variances and how it affects other control processes.

Similarly, cost control entails, monitoring and controlling changes to a project budget through being concerned with key factors that cause the changes to the budget and actual controlling of cost changes as they occur (Guo-Li, 2010). The study explains further that actual cost changes are controlled through monitoring cost performances to detect variances, accurately recording appropriate changes in the cost baseline, preventing un authorized changes being included in the cost baseline, determining positive and negative variances and integrating it with all other control processes. Whereas in Uganda, the major cost control techniques proposed include accurate budgeting, inspection of works and monitoring and evaluation of works, among others (Otim et. al., 2011).

2.4 Cost deviations /variations

Cost deviation may be expressed as a percentage difference between the final cost of a project (actual cost) and the contract award amount (estimated cost) (Mahamid, 2011).

The cost estimation process should always be given a long time, during design stage, to give attention to all details (Ahmed et. al, 2014).

In addition, physical characteristics were established to have effects on cost deviations of road construction, where all road projects (100%) studied in West Bank in Palestine suffered an average cost deviation of 16.73% and that the deviation was mainly due to underestimation of initial project costs (Mahamid, 2012).

Other studies also established that 52 factors were the cause of cost variations for construction of waste water projects in Egypt where the factors were identified, ranked and grouped, in order of influence, under the following categories; owner originated category, designer originated category, contractor originated category and miscellaneous category (Aziz, 2013).

In addition, factors causing cost overruns in large construction projects in Malaysia were grouped and validated into 7 categories, namely contractor site management related factors, design and documentation related factors, financial management related factors, Information communication and technology related factors, labour management related factors, material and machinery related factors and project management and contract administration related factors (Rahman et. al, 2013). It has also been established that cost deviation above planned budgets is more predominant than costs saving; is more in

smaller projects compared to larger projects; increases with completion time up to medium sized projects and then decreases and lastly there are regional differences with respect to magnitude of cost deviations (Odeck, 2004).

Al-Agele and Al-Hassan, (2016) assessed 16 factors responsible for cost deviations in construction work in Iraq after a study of eight different completed projects. The factors included, among others, accepting lowest offers, inadequate planning and delayed cash flows by owners (Al-Agele and Al-Hassan, 2016). This was similar to the findings by Ahmed et. al., (2014).

Oguya and Muturi, (2016) established contractor's competency, construction parties financial management, timely availability of construction resources and conflicts, as the major factors affecting performances of road projects in arid and semi-arid areas of Kenya.

Alinaitwe et. al (2013) investigated and established that changes to the scope of work, delayed payments, poor monitoring and control, high cost of capital and political instability were the major factors contributing to construction delays and cost overruns in Uganda. In addition, Otim et. al., (2011) established that the following difficulties exist in controlling cost in construction projects; delays in paying contractors, delays in decision making and lack of materials and equipment, among others. However, major

causes of cost deviations in road projects have not yet been studied adequately in Uganda, although the sector is currently experiencing challenges in maintenance of unpaved roads countrywide.

Therefore, it is important to study the causes of cost deviations in maintenance of unpaved roads in Northern Uganda, use the above information to get a solution to it and compare it with findings from other different regions.

2.5 Cost Performance

Cost performance represents a measure of the amount of completed work for every unit of cost spent on the piece of work. It is affected by reluctance in timely decision and short bid preparation time, among others (Iyer and Jha, 2005). It is explained in terms of Cost Performance Index (CPI), which is a value that demonstrates the performance of the project cost to the planned cost. It relates to the work which is accomplished to the amount spent in accomplishing it, usually determined by dividing the value of the work performed (Earned Value) by the actual cost taken to accomplish the earned value (Christensen and Heise, 1993).

If the CPI ratio is less than 1, it means the cost of completing the work is higher than the planned cost, which is bad because it means a cost overrun; If the ratio is equal to 1, it

means the cost of completing the work is right on plan, which is good; whereas if the CPI ratio is more than 1, it means the cost of completing the work is less than the planned cost, which is good although it may also be due to inflation of budget estimates.

CPI is also used to project the Forecast Cost to Completion (FCTC) and the Forecast Cost at Completion (FCAC) using Budgeted Cost at Completion (BCAC) and the Actual Cost of work Performed (ACWP) as indicated in the equation (2.1);

$FCTC = \frac{(BCAC - BCWP)}{C \times I}$ ..... (Equation 2.1)

$FCAC = ACWP + FCT$ ..... (Equation 2.2)

Where; FCTC = Forecast cost to completion;

BCAC = Budgeted cost at completion;

BCWP = Budgeted cost of work performed;

CPI = Cost Performance Index;

FCAC = Forecast cost at completion and

ACWP = Actual Cost of work performed

If an organization is able to forecast accurately cost performances then it can confidently allocate capital, hence reducing financial risk (Pennypacker, 2005).

2.6 Road Maintenance

2.6.1 Road elements /structures

A road is a structure constructed to facilitate transport of people and goods with the aim of promoting development (Robinson and Thagesen, 2004). According to the road Technical Manual issued by the Ugandan Ministry of Works and Transport (MOWT) (2004), a road has the following elements;

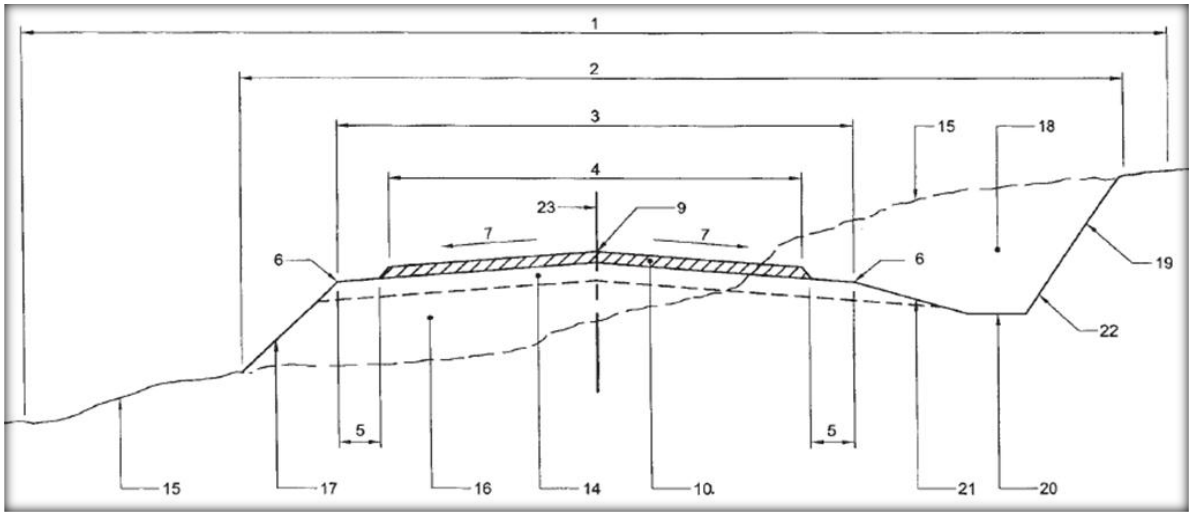


Figure 2.1: A typical cross section of an unpaved road.

Source: (MOWT, 2004)

Road reserve (coded 1): This is a strip of land legally awarded to a Road Authority (KCCA, UNRA, Districts or Municipal Councils) in which the road is or will be situated and where no other work or construction may take place without permission from the Road Authority. The width of the road reserved is measured at right angles to the centerline of the road and varies according to the classification of the road.

Formation width (coded 2): This is the full width of a road, including side drains, side cuts and embankments.

Road surface / roadway (coded 3): this is a top layer of the road which consist of a wearing course and sometimes a base course, usually constructed of gravels in unpaved roads.

Carriageway (coded 4): This is the width of the road which is normally used by traffic. It can be paved or unpaved.

Road shoulders (coded 5): This is a width of a road section between the edge of a carriageway and the shoulder break point, a point where the road way and the ditch inside slope meet along the sides of the road. The shoulder provides side support for a gravel surface and allows vehicle to stop or pass in an emergency.

Shoulder break point (coded 6): This is a point where a roadway and the ditch inside slope or embankment slope meet along the sides of the road.

Camber (coded 7): They are lateral slopes of the cross-section of a carriageway and shoulder, constructed to drain rainwater from the carriageway to the side drains.

Crown (coded 9): This is a peak or highest point of the cross-section of a cambered carriageway.

Gravel pavement (coded 10): This is part of a road designed to withstand the weight or loading by traffic.

Subgrade surface (coded 14): Constructed upper layer of the natural or imported soil (free from unsuitable material) which supports the pavement layer or gravel surface.

Original ground level (coded 15): It is the natural ground level prior to construction of the road.

Embankment (Coded 16): Constructed fill material below the pavement or gravel surface raising the road above the surrounding natural ground level.

Embankment slope (Coded 17): The constructed, inclined soil surface on the side of the embankment.

Cut (Coded 18): Excavation in the natural ground with graded slope to accommodate the road.

Road drains (coded 19, 20, 21 & 22): These are structures constructed to collect and drain surface runoff water from the carriage way and adjoining land away from the road way to a suitable point of disposal. It consists of side drains, running along the roadside, mitre drain, leading water away from the side drains and catchment water drains, constructed on the uphill side designed to intercept and drain away surface runoff flowing towards the roadside from the uphill side.

Other drainage structure includes scour checks and culverts. A scour check is a small structure placed across the drain or steep gradients, designed to slow down the flow of water to prevent erosion of drains and slopes while a culvert is a structure constructed under a road way and is designed to allow water from the drains and / or natural water course to safely cross under the road way.

A culvert has the following elements; headwalls, which is a retaining wall at the entry or exit to retain or protect embankment or retained gravels, wing walls, which is a retaining wall at the sides of the culverts to protect the embankment or retain soil, apron, which is a flat paved area at the culvert inlet or outlet to prevent erosion and cut off wall, which is a wall under the headwall meant to prevent water seeping under the structure and undermining it.

Road center line (Coded 23): This is an imaginary line running along the centre of the road.

This study focused on improvement of cost of road surfaces, road drains and drainage structures maintenance.

Saha and Ksaibati (2017) tried to address deterioration of unpaved roads leading to poor road conditions by developing a model for managing deterioration in unpaved roads within a limited budget for counties in Wyoming in the United States of America. They noted that deterioration of unpaved roads is always so rapid that it can drop from excellent conditions to failed conditions after only a short period of time. Therefore there is need to develop a maintenance management mechanism.

Tarimo (2017) put forward road maintenance sustainability by studying the engineering perspective of roads construction and maintenance in Serengeti National Park, assessing current practices, strengths and weaknesses of the current practices. Lack of financial resources was found to be one of the factors leading to poor performances of the studied road sections. More studies on the existing materials was proposed by Tarimo (2017) as an improvement measure for a sustainable road maintenance.

Burningham and Stankevich (2005) provide guiding information towards planning for road maintenance projects by noting the challenges many countries face in road maintenance and end up appropriating so little budget on maintenance of their road networks. However, cost calculations do not have to be precise at the planning stages but the major thing is to start planning with a simple rule of thumb on unit cost per kilometer (Burningham and Stankevich, 2005).

According to Hakan (2001) the main structure of a lifecycle for a road involves a construction phase; where the road and any related road furniture is constructed and the usage phase; which contains operating and maintaining the roads. Maintenance includes replacement of the wearing courses on the carriageway and road structures such drainage structures (culverts and headwalls).

A website publication of Pavement Interactive (Deighton, 1997), indicates that pavement deteriorates over time and the deterioration can only be treated through maintenance interventions by slowing down the rate of deterioration and correcting small defects that may arise before they worsen. If maintenance is not done and the defects worsen and become large, another intervention of rehabilitation phase sets in. If a pavement is allowed to deteriorate for 2-3 years beyond the optimum rehabilitation point, it will cost 4 to 5 times the maintenance cost. Maintenance needs to be undertaken in time because it costs more to change a pavement condition from "very poor" to "poor" than it does from "fair" to "good".

In Uganda, according to a report by Ministry of Finance Planning and Economic Development (MoFPED), there was a policy shift instituted for roads to be maintained through use of Force Account instead of contracting to prevent premature deterioration of newly constructed roads, extend the road's service life and save agencies high rehabilitation or reconstruction costs (MoFPED, 2017). This, however, has not been met yet as indicated by statistics, in a report by Ministry of Works and Transport (MoWT), on unpaved road conditions in fair to good conditions lowering from 65% in FY 2012//2013 to 47% in 2014/2015 (MoWT, 2015). Uganda National Roads Authority (UNRA) is a government agency mandated to develop and maintain the National Roads Network (NRN). They also advise government on general road policies (UNRA Website). UNRA maintains up to 20,544km National Road Network (NRN),

representing 15%, of the total network of 144,785km. Out of the NRN, 16,287km, representing 79.3%, are unpaved roads (Kagina, 2017). Other entities responsible for road maintenance are Kampala City Council Authority (2,110km), District Local governments (30,000km), Municipal Councils (3,800km), Town Councils (7,700km) and sub counties (75,890km).

Northern Uganda accounts for 35% of the total area of Uganda. It comprises the sub-regions of Acholi, Lango and West Nile. Maintenance of social infrastructures, including roads, was abandoned during the insurgencies caused by the Lord's Resistance Army (LRA) rebels which lasted from 1996 to 2006 in the region. As a result, there has been a rapid deterioration of roads which affected movements of agricultural products from the region to markets in South Sudan, which, by virtue of bordering the region, is better located to have positive impacts on agricultural exports because of geographical and distance advantages (MoWT, 2012).

2.6.2 Types of road maintenance

According to transport notes in the World Bank website (2005), road maintenance refers to interventions or works required to keep a road, its structures and property within the road margins as near as possible to their as-constructed or rehabilitated condition (World Bank, 2005). The interventions can be categorized as Routine, Periodic and Emergency maintenance based on ease of planning, organizational and funding arrangements.

Routine maintenance is a frequent small scale operations applied to a road section mainly by labour and mechanized grading. It includes inspection and removal of obstacles, clearing drainage structures, repair of culvert structures, filling potholes, light re-shaping and grass cutting.

Periodic maintenance, on the other hand, is a scheduled set of activities regularly carried out on a road after about 2 – 7 years to improve the condition and operational status of the road. This is also referred to as Term maintenance. It depends on the type of pavement materials, rainfall and traffic volume, among others, and includes heavy re-shaping, construction or installation of drainage structures, spots improvement and re-gravelling.

Emergency maintenance refers to interventions that are carried out on a road section from time to time whenever sudden and unforeseen damage occurs. It is difficult to forecast activities under this maintenance during needs assessment and therefore they cannot be planned on. However, its budget can be provided as a percentage of the routine maintenance funds. Examples include repairs to damaged structures resulting from erosion and floods, clearing fallen trees, landslides or rock fall and repairs of damaged drainage as a result of siltation (MoWT Technical Manual, 2004).

The focus of this research was going to be on periodic maintenance of unpaved roads. The maintenance activities cover works on the road subgrade, gravel pavement and road drainages. Heavy re-grading of the road subgrade is undertaken using mechanical equipment for re-shaping the subgrade to appropriate slopes. The subgrade is then properly compacted ready to receive the wearing course and shoulder gravels of specified thickness and slopes. The formation width is adequately drained by cutting side drains, back slopes and culvert installations at specified road sections. Failure to carry out periodic maintenance activities on drainage structures, as described above, leads to draining of water into the subgrade. This will weaken the strength of the subgrade in carrying the traffic loads resulting into depressions which develop into potholes. The constant use of the road, over a period of time, wears out the gravel materials resulting into corrugation-like defects called ruts along the road lengths. There is, therefore, need to carry out periodic maintenance interventions on unpaved roads.

2.6.3 Methods of road maintenance

Road maintenance, according to the MOWT (2004), can be undertaken through the following three approaches:

- Use of contractors,
- Equipment
- Labour, depending on the efficiency and cost-effectiveness of the approach.

Preliminary observations show that the main method used is mechanized maintenance using equipment. In this research, it is hoped that mechanized periodic maintenance of unpaved / gravel roads shall be focused on.

2.7 Predictive Modeling

Predictive modeling is a collection of mathematical techniques aiming at finding a relationship between a target, response or dependent variable and various predictors or independent variables aimed at measuring future values of the predictors (David & Dickey, 2012). In the techniques when the future values of the predictors are inserted into the mathematical relationship, future values of the target variables are predicted. Predictive modeling can also be defined as a process of applying a statistical model to data sets for the purpose of predicting new or future observations (Shmueli, 2010). The prediction includes, among others, ranking of new observations.

A Predictive model therefore, refers to any method that produces predictions regardless of its underlying approach. Predictive model is in the form of data mining algorithm or statistical model. In this study, Pearson Correlation and Multiple linear regression were the inferential statistical methods used to model the relationship between the independent variables (i.e. Preliminary, Wearing and Drainage cost deviations) and total project cost deviation which was also the dependent variable. Whereas the various

predictors were the various budgeted cost elements in the Bills of Quantities (BOQs) of the road construction projects, also referred to as the independent variables.

2.7.1. Pearson Correlation

In statistics (Data Analysis, 2019), correlation is a technique for investigating the relationship between two quantitative, continuous variables. Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables.

Pearson's correlation coefficient (r) for continuous data ranges from -1 to +1:

r = -1 means data lies on a perfect straight line with a negative slope,

r = 0 means there is no linear relationship between the variables,

r = 1 means data lies on a perfect straight line with a positive slope.

Positive correlation indicates that both variables increase or decrease together, whereas negative correlation indicates that as one variable increases, so the other decreases, and vice versa.

2.7.2. Multiple Linear Regression

Linear regression attempts to model the relationship between two 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 (Linear Regression, 1998).

A linear regression line has an equation of the form **Y = a + bX**, where **X** is the explanatory (or independent) variable and **Y** is the dependent variable. The slope of the line is **b**, and **a**, is the intercept (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** (Multiple Linear Regression, 1998).

In regression analysis the $F_{statistic}$ is used to test if the means between two populations are significantly different (F Statistic / F Value, 2019).

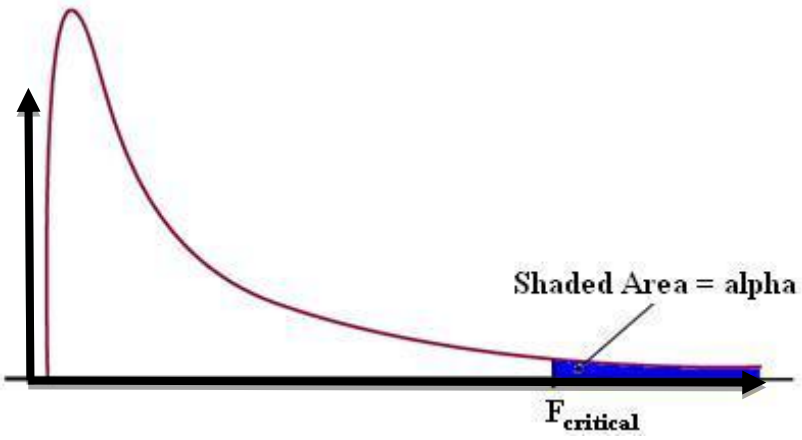


Figure 2.2: The F – statistic.

Source: (F Statistic / F Value, 2019)

Results from regression analysis will have both an F_{value} and an $F_{critical\ value}$.

The $F_{critical\ value}$ is also called the $F_{statistic}$.

The value calculated from a research data is called the F_{value}.

In general, if the calculated F_{value} in a test is larger than $F_{statistic}$, null hypothesis can be rejected.

i.e. If $F_{value} > F_{critical}$ = Reject Ho.

The F_{value} in regression is the result of a test where the null hypothesis is established that all of the regression coefficients are equal to zero. Basically, the F-test compares your model with zero predictor variables (the intercept only model), and decides whether an added coefficients improved the model. If we get a significant result, then whatever coefficients we included in our model improved the model's fit.

2.8 Chapter Summary

In conclusion, the chapter explained key literature on project cost management, road maintenance as well as statistical analysis methods to be applied in the next chapter.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was adopted during the study. It describes and discusses: the research design, research approach, sample size and selection, the data collection methods used and their corresponding data collection instruments, data management and analysis procedure as well as steps that were taken to ensure validity and reliability during the study and measurement of variables.

3.2 Research Design

The study adopted a case study design. The case study design was adopted because the study intended to conduct an intensive investigation on the variables under study in UNRA Stations in Northern Uganda specifically as suggested by Oso and Onen (2008). According to Zainal (2007), case study allows the use of both quantitative and qualitative data analysis. It also helps in explaining complexities of real life situations which may not be covered through experiment or survey research.

3.3 Research Approach

The study used both qualitative and quantitative approaches. The quantitative approach was adopted because the study intended to establish the factors that influence cost

performances of road maintenance projects at UNRA Stations in Northern Uganda. The quantitative approach is best suited for this study because it allows for collecting numeric data on observable individual behavior of samples, then subjecting this data to statistical analysis (Amin, 2005). The study also used a qualitative research approach in order to enable the researcher capture data that was left out by the quantitative approach. This was aimed at capturing more in-depth information on the topic under investigation.

3.4 Study Population

The study population comprised of 60 items: 15 completed projects and 45 documents. All the completed projects considered in the study were implemented through contracting. The contracts were awarded to different firms in Lots although some lots had more than one road section under maintenance. All the firms undertook periodic and termed maintenance, whose durations were ranging from 1- 3years.

3.5 Description of Study area

The study was based on all termed maintenance projects implemented to completion at the UNRA stations in Northern Uganda, with annual rainfall ranging from 1125mm in Kitgum to 1507mm in Gulu. The general topography is gentle sloping. Only contracted projects on maintenance of unpaved roads were studied. Each UNRA station covered a number of districts; Gulu UNRA station covers the districts of Omoro, Gulu, Nwoya and Amuru; Kitgum UNRA Station covers Kitgum, Pader, Agago and Lamwo districts;

Moyo UNRA station covers Moyo, Yumbe and Adjumani districts whereas Arua UNRA station covers Arua, Nebbi, Zombo, Maracha and Terego districts.

3.6 Study Sample

The study sample comprised of 15 completed projects and 45 documents for review. Three projects from each of the five stations in Northern Uganda and three documents for each of the 15 completed projects. The documents included completion certificates, measurement sheets and inspection reports. The sample size was arrived at by using the predetermined population table for determining sample size by Morgan and Krejcie (1970) as cited in Amin (2005).

Table 3.1: Sample Size Determination

Category	**Target Population**	**Sample Size**	**Sampling Technique**
Projects	3 * 5 = 15	15	Simple Random Selection
Documents	3 * 15 = 45	45	Simple Random Selection
Total	60	60	

Source: *Primary data (2019)*

3.7 Sampling Techniques and Procedure

Simple Random Selection technique was used to select the projects for study. Simple random sampling was used because it ensures generalizability of findings and minimizes

bias (Sekaran, 2003). The road projects studied were, however selected based on the type of maintenance interventions contracted out. Only roads under periodic and term maintenance were studied because of proper documentation of the project costs. Each project had defined scope of work on standard templates of Bill of quantities covering preliminary costs, wearing course and shoulder costs and drainage costs.

The region of Northern Uganda was purposely selected because there is a lot of focus on infrastructural development and maintenance in the region after the two decades of insurgencies in the region forced authorities to abandon maintenance of most road network infrastructures. UNRA was as well purposely selected based on the fact that they are the responsible authority for maintenance of NRN, which is the most dominant means of transport, carrying up to 90% of passengers and freight traffic (Kagina, 2017). The selection of UNRA was also based on published report of the Budget Monitoring and Accountability Unit, on consistent increase of cost variations in multi-year projects they implemented. The report recommended that UNRA should invest more in research on the various ways of maintaining unpaved roads and choose a more economical, yet efficient, method of road maintenance (BMAU, 2011 & 2014). The road projects studied were, however selected based on the type of maintenance interventions contracted out. Only roads under periodic and term maintenance were studied because of proper documentation of project costs. Each project had defined scope of work in terms of cost

and quantities. Measurement sheets for payment for the physical work executed were raised for each completed project.

3.8 Data Collection Methods

3.8.1 Questionnaire Survey Method

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 cheap and saves time as suggested by 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 & Onen, 2008:18).

3.8.2 Document Review Method

The researcher reviewed documents in order to obtain recorded information that is related to the issue under investigation. This method was used because it enabled the researcher access data at his convenient time, obtain data that are thoughtful in that the informants have given attention in obtaining them and enables the researcher obtain data in the language of the respondent (Amin, 2005).

3.9 Data Collection Instruments

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

3.9.1 Self-Administered Questionnaire

The study employed a questionnaire as a tool of primary data collection. 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).

3.9.2 Document Review Checklist

The study used a document review checklist in order to collect more in-depth secondary data on the topic under investigation. Secondary data was obtained from project records especially from Final Completion Certificates and progress reports in project files. The checklist was used to provide in-depth qualitative information which may not be possible to collect with the closed ended questionnaire as suggested by (Amin, 2005).

3.10 Data Quality Control

3.10.1 Validity

To ensure validity, the questionnaire was developed and given to three (3) experts to score the relevance of each questions in providing answers to the study. The experts included two (2) Station Managers and a Maintenance Engineer. These were purposively selected because they were believed to be knowledgeable about the topic under investigation. After the experts had scored the relevancy of the items in the research instrument, a content validity index (C.V.I) was computed using the equation;

$$Content\ Validity\ Index = \frac{\text{Number of items declared relevant}}{\text{Total Number of items}} \quad \text{..... (Equation 3.1)}$$

$$Content\ Validity\ Index = \frac{25}{32} = 0.78$$

A CVI of above 0.7 is acceptable as suggested by Amin (2005). The number of respondents pre-tested was smaller, 10% of the sample size as suggested by Mugenda and Mugenda (1991). The researcher therefore used 3 respondents while pre-testing the instrument which represented 10% of the sample size of 32 respondents of the study. In this case, the CVI was 0.78, it was considered to be good.

3.10.2 Reliability

To ensure reliability, a pre-test was done as a final study on 10% (3) of the respondents, as suggested by Mugenda and Mugenda (1999). Data was coded and entered into the

computer. Cronbach's Alpha Reliability Coefficients were generated using the statistical package for social scientists (SPSS) computer program to estimate the reliability of the questionnaire. The Cronbach's alpha reliability coefficient of above 0.6 is acceptable (Sekaran, 2003). When Cronbach α is less than 0.3 it means the reliability is at low level. The data is therefore not reliable and cannot be accepted. Whereas a Cronbach α greater than 0.7 indicates reliability is at high level (Rahman et. al., 2013).

In this case reliability was computed using SPSS and determined using the Cronbach's Alpha. The response results were confirmed to be reliable as reflected in table 3.2. Sekaran (2003) asserts that Cronbach Alpha Coefficient that ranges between 0.6 – 0.8 is acceptable. From the table 3.2, the Cronbach Alpha Coefficient was 0.7485 implying that the findings of the pilot study reflected that the study instruments were reliable. On the contrary, Santos (1999) further argued that there is no commonly agreed cut-off for the Cronbach Alpha Coefficient and that even lower values are sometimes taken as acceptable and used in the literature. Table 3.2 is a presentation of the pre-test results of this study.

Table 3.2: The reliability test results of the study

Narrative Summary	Cronbach Alpha coefficient	Number of items
Contractors site management factors	0.7134	6
Design and documentation related factors	0.7803	5
Financial Management factors	0.7358	6
Information and Communication Technology (ICT) related factors	0.7451	3
Labour management related factors	0.7762	5
Material and machinery related factors	0.7242	4
Project management and contract Administration related factors	0.7249	4
Average	**0.7490**	**5**

Source: Primary Data, (2019)

3.11 Data Collection Procedure

The researcher obtained a letter of introduction from Kyambogo University which was presented to the authorities at UNRA. The researcher randomly selected respondents on a simple random selection to participate in the study. A self-administered questionnaire was used to collect information from staff.

3.12 Data Analysis

3.12.1 Analysis of Quantitative Data

The data collected through questionnaires was analyzed using Statistical Package for Social Sciences (SPSS) version 21 because this is the most recommendable package for analyzing research data (Sekaran, 2013). The analysis relied on both descriptive and inferential statistics. The descriptive statistics used was frequency counts, percentages as well as the mean and standard deviation. 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).

3.12.2 Analysis of Qualitative Data

Qualitative analysis involved categorizing data and then attaching it to the appropriate categories. The researcher used thematic analysis to analyze the qualitative data.

3.13 Measurement of Variables

Data on the respondent's views and opinions about factors affecting cost performances was obtained using scaled variables from a self-developed questionnaire. A five point-Likert scale of 1= Not at all, 2= Small extent, 3= Moderate extent, 4= Large extent and 5= Very Large extent was used to tap respondents perception on the study variables.

3.14 Ethical Considerations

The research process was guided by sound ethical principles which include the followings:-

Voluntarism: the researcher ensured that respondents are not coerced or manipulated into participating in the study. Respondents were told 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.

3.15 Chapter summary

The chapter highlighted how the research was designed and approached. A clear description of the study area and sample size was brought out including techniques used in sampling. A lot was also brought out about the data collected including methods and instruments used and how their validity and reliability was tested. The summary

concludes with highlights of ethical considerations applied during the data collections. The collected data was then ready for presentations and analysis in the next chapter.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter analyzes and interprets the study findings arising from the field information collected from respondents on Developing a Model for Cost Performance Improvement of roads maintenance projects in Uganda considering a case of Uganda National Roads Authority. The first section presents the response rate, followed by presentation and analysis of the study findings in relation to the specific objectives of the study.

4.2 Response Rate

A total of 45 documents for 15 projects were expected to be reviewed. 42 documents were reviewed for 14 projects which were at least 95% complete. One project from Gulu station was however terminated due to delays by the contractor to complete the work when progress was standing at about 70%. Only two documents, i.e measurement sheet and payment certificates, were reviewed for the terminated project. The number of projects studied helps in determining accuracy of the study through the calculation of response rate as reflected in the table below:

Table 4.1: Response rate

Particulars	Sample	Reviewed item	Percentages
Projects	15	14	93.3%
Documents Reviewed *(Payment Certificates per project, Inspection reports and Measurement sheets)*	3*15=45	(3*13) + (2*1) = 41	91.1%
Overall			**92.2%**
The Overall Response Rate			**92.2%**

Source: Primary Data, (2019)

The Table 4.1 above shows a response rate of 92.2% suggesting that the results contain adequate information. The results were representative of the survey on current Cost Performances of road maintenance projects in Uganda considering a case of Uganda National Roads Authority. The response rate of 92.2% suggested an accurate results (Amin, 2005).

4.3 Cost performances of road maintenance projects

The data presented below were obtained from measurement sheets of the projects reviewed. It gives a reflection of whether there has been any deviation (positively or negatively) in the project budgets after implementation. Understanding the deviations

give us knowledge about the current cost performances of road maintenance projects in UNRA.

Table 4.2: Data on completed projects

DATA ON COMPLETED TERM ROAD MAINTENANCE PROJECTS - LAST 5 Fys												
Station / Road Sectio	Preliminaries x 000				Drainage x 000				Wearing course and Shoulder x 000			
Kitgum Station	Planned	Actual	Devia	% Dev	Planned	Actual	Dev.	% Dev	Planned	Actual	Dev	% Dev
Pajule - Pader - Kwonki	22,800	11,700	11,100	49	154,570	38,372	116,198	75	1,515,725	1,915,256	(399,531)	-26.4
Naamokora - Adilang	22,800	15,150	7,650	34	286,010	63,669	222,341	78	4,156,950	4512524.14	(355,574)	-8.55
Kilak - Adilang	43,056	16,560	26,496	62	256,174	245,263	10,911	4	3,752,496	4159142.48	(406,646)	-10.8
Ngomoromo - Bibia	10,000	7,000	3,000	30	276,950	207,712	69,238	25	1,595,600	1286571.21	309,029	19.37
Palabek - Atiak	14,700	10,900	3,800	26	156,740	120,311	36,429	23	3,762,000	3670984.71	91,015	2.419
Kitgum- Orom	700,000	11,400	688,600	98	212,671	214,175	(1,504)	(1)	4,520,256	5344185.7	(823,930)	-18.2
MOYO STATION												
Adjumani - Amuru	14,700	11,400	3,300	22	271,360	202,022	69,338	26	4,650,800	5259018.74	(608,219)	-13.1
Moyo - Obongi	10,200	6,900	3,300	32	78,586	19,317	59,269	75	1,179,000	1148078.63	30,921	2.623
Moyo - Yumbe	76,400	23,600	52,800	69	180,000	109,108	70,892	39	5,833,080	5952271.6	(119,192)	-2.04
ARUA STATION												
Wandi - Yumbe	47,200	19,500	27,700	59	267,460	116,770	150,690	56	2,992,000	3159457	(167,457)	-5.6
Wandi - Rhino camp	21,100	17,800	3,300	16	428,091	296,274	131,817	31	2,238,390	2520927	(282,537)	-12.6
Koboko - Yumbe	21,100	17,800	3,300	16	322,175	367,671	(45,496)	(14)	1,805,760	2149368.4	(343,608)	-19
GULU STATION			-									
Gulu- Rackoko	36,800	13,000	23,800	65	145,600	67,250	78,351	54	4,086,000	2878851.8	1,207,148	29.54
Aber-Anyeke-Ngai-Aron	15,300	12,300	3,000	20	220,288	269,418	(49,130)	(22)	3,207,980	3061538.9	146,441	4.565

Fys = Financial years. Dev. = Deviations

Source: *Primary data, (2019).*

From Table 4.2, all the 14 projects studied experienced positive deviations in budgeted preliminary costs items, with the least cost deviation of 16% and highest cost deviation of 98% of the planned budget. This implies that too much cost was attached to traffic management, quality control & material testing, overheads and profits and signboard yet very little was spent on these items. This confirms the identified problem of cases of inflation of unit cost of work by contractors leading to expensive road project costs.

Three (3) projects out of the 14 projects, representing 21.4%, had negative cost deviations in drainage cost items implying that very little budget was estimated to do excavation of drains and culvert installations, while 78.6% experienced positive deviations in drainage cost items. This implies that too much cost was attached to drainage and culvert installations, confirming the problem of inflation of unit cost of work.

Nine out of the 14 projects, representing 64.3%, experienced negative cost deviations in wearing course and shoulder cost items implemented. It implies that there was very little estimates provided for road shaping and gravelling or re-gravelling, confirming the problem of underestimates of projects. Only 35.7% had positive deviations in the Wearing Course and Shoulder (WCS) cost items implemented.

Generally, only four projects out of the 14 projects had positive cost deviations in all the budget elements, representing only 28.6% (Kitgum=14.3%, Moyo = 7.15%, Gulu = 7.15%). The remaining 10 projects, representing 71.4% (Kitgum = 28.56%, Moyo = 14.28%, Arua = 21.42, Gulu = 7.14%) had negative cost deviations in some or all of the budget elements implemented. Each of the stations had an average negative cost deviation of 17.85%. This is consistent with a previous study conducted by Mahamid on road projects in West bank in Palestine, which indicated that 16.73% suffered deviations (Mahamid and Amund, 2012). The different values of deviations in different stations are

in line with an earlier study conducted on variability of cost deviations from one location to another (Cantarelli et. al., 2012).

4.4 Description of Respondents

4.4.1 Distribution of respondents by Stations

The number of respondents from every station was obtained from the questionnaires returned and reflected as in the bar graph below. The data helps us in establishing the distribution of factors that influence cost performances in the entire region under study for inferences.

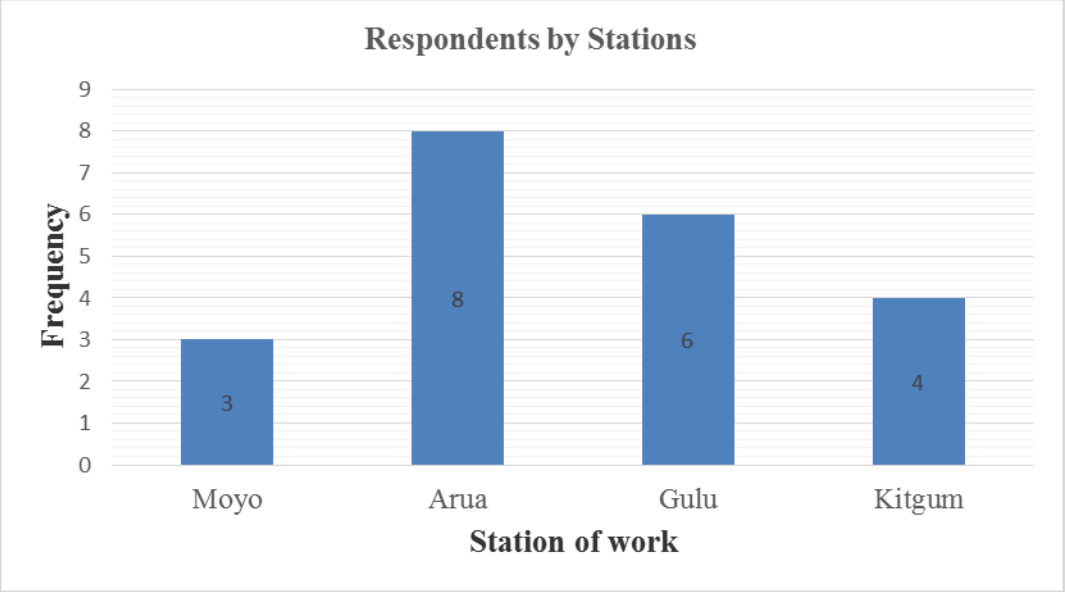


Figure 4.1: Bar graph of the respondent's work stations

Source: *Primary Data, (2019)*

The illustration in Figure 4.1 above reflects the respondents' station of work. The bar graph shows that the highest bar represents respondents whose station of work was Arua (8 respondents representing 38.1% of the total respondents were from Arua station). The

second highest bar represents respondents whose station of work was Gulu, (6 respondents representing 28.6% of the total respondents were from Gulu station). This was followed by respondents whose station of work was Kitgum, (4 respondents representing 19% of the total respondents were from Kitgum station). Lastly the shortest bar represents respondents whose station of work was Moyo, (3 respondents representing 14.3% of the total respondents were from Moyo station).

Therefore, the study findings are unbiased with regards to the distribution of respondent's duty station of work.

4.4.2 Title of the respondent

Respondents had different contributions to make on cost performance of maintenance projects based on their titles. Whereas station managers were mainly office based and responsible for critical decision making on projects cost control, maintenance technicians were partly office based and field based. They obtained data from the field and developed them into plans. Maintenance technicians were field based and well versed with problems affecting implementations from sites. It was important to obtain views from the respondents of different titles in order to accurately capture factors that influence cost performances from the sites to offices. Their data was obtained from the questionnaires returned. .

Table 4.3: Respondents title

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Station Manager	3	14.3	14.3	14.3
	Maintenance Engineers	7	33.3	33.3	47.6
	Maintenance Technicians	11	52.4	52.4	100.0
	Total	21	100.0	100.0	

Source: *Primary Data, (2019)*

According to the results in Table 4.3, it's shown that majority of the respondents were Maintenance Technicians who were 11 respondents representing 52.4% of the total number of respondents, followed by Maintenance Engineers who were 7 respondents representing 33.3% of the total number of respondents and the remaining respondents were Station Managers who totaled to only 3 respondents representing 14.3% of the total number of respondents. Therefore, the study findings have reliable data with regards to the type of study being conducted.

4.4.3 Distribution of respondents by years of experience

Data on the respondent's years of experience was obtained from the questionnaires returned. The data gives a reflection of the respondent's knowledge on the subject matter under study. The results were as indicated below.

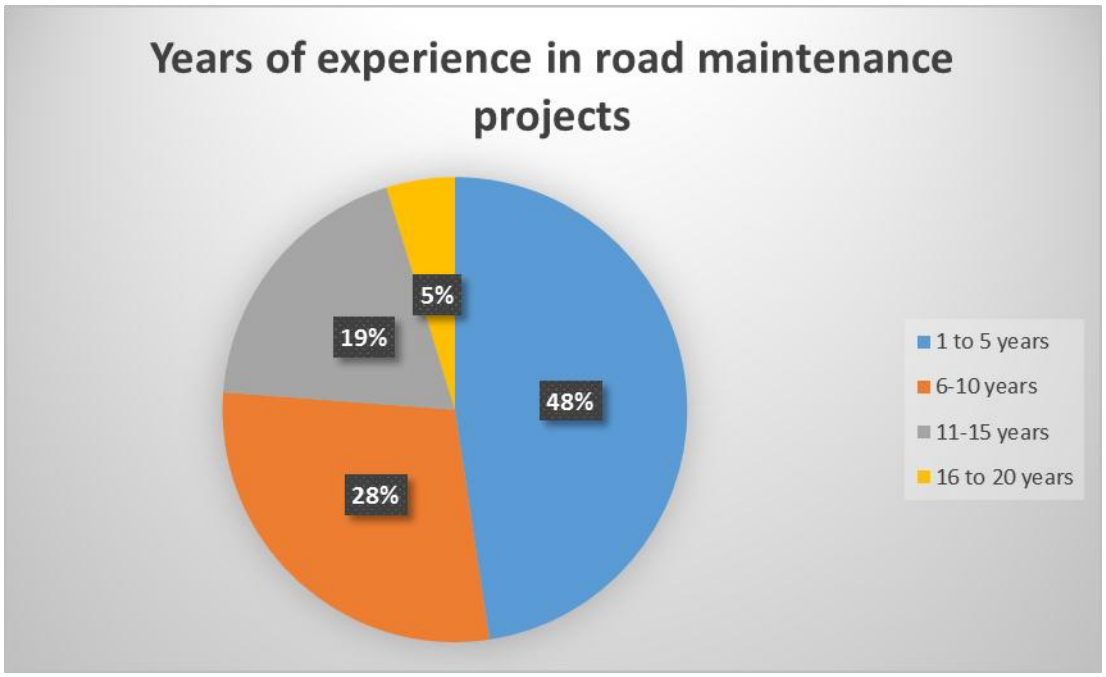


Figure 4.2: Respondents years of experience

Source: *Primary Data, (2019)*

The results of the pie chart above, reflect that majority of the respondents had worked for the organization for the period between 1 to 5 years (the blue slice) and these were 10 respondents representing 48% of the total number of respondents, followed by those who have a working experience of 6 to 10 years (the brown slice) who were 6 respondents representing 28% of the total number of respondents, followed by respondents with a working experience of between 11 to 15 years (the grey slice) who were 4 respondents representing 19% of the total number of respondents and the remaining only 1 respondent representing 5% of the total number of respondents represents respondents with 16 to 20 years of experience (the yellow slice). Therefore, the study findings are unbiased with regards to the years of experience of the

respondents and since the respondents had worked with road maintenance for some good time, therefore they had a lot of authority over their responses.

4.5 Descriptive statistics of Factors of Cost deviations

From the questionnaires, different opinions were received on the factors believed to be influencing cost performances in road maintenance projects. The opinions were ranked to establish their degree of influence as presented in subsequent sections.

4.5.1 Contractors site management factors

Table 4.4: Descriptive statistics of Contractors Site Management

No.	Details	NA(1)	SE(2)	ME(3)	LE(4)	VLE(5)	Total	Mean	Ranking
1	Inadequate monitoring and control	**0** 0%	**7** 33.3 %	**4** 19%	**8** 38.1 %	**2** 9.5%	**21** 100%	3.24	1
2	Inadequate time and cost estimate	**1** 4.8%	**3** 14.3 %	**9** 42.9%	**7** 33.3 %	**1** 4.8%	**21** 100%	3.19	2
3	Inadequate planning and scheduling	**0** 0%	**6** 28.6 %	**7** 33.3%	**8** 38.1 %	**0** 0%	**21** 100%	3.10	3
4	Mistake during construction	**2** 9.5%	**5** 23.8 %	**6** 28.6%	**8** 38.1 %	**0** 0%	**21** 100%	2.95	4
5	Poor site management and supervision	**2** 9.5%	**7** 33.3 %	**4** 19%	**8** 38.1 %	**0** 0%	**21** 100%	2.86	5
6	Lack of experience	**3** 14.3%	**6** 28.6 %	**5** 23.8%	**6** 28.6 %	**1** 4.8%	**21** 100%	2.81	6

Average Means: 3.025

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and
VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation note that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores are grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) represents scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) represents scores of factors with strong influence on cost deviation.

According to Table 4.4, six respondents representing 28.6% of the total number of respondents believed that there was a negligible influence of Inadequate planning and scheduling on cost deviation while as eight respondents representing 38.1% of the total number of respondents believed that there is a strong influence of Inadequate planning and scheduling on cost deviation and only seven respondents representing 33.3% of the total number of respondents were not sure whether Inadequate planning and scheduling had a great influence or not on cost deviations.

The mean of 3.10 implied that majority of the respondents believed that inadequate planning and scheduling had a strong influence on cost deviation and was ranked in 3rd position. This is in agreement with findings by Al-Agele and Al-Hassan (2016) and

Otim and Alinaitwe (2013), who listed inadequate planning as one of the factors with influence on cost deviations.

It was also established from Table 4.4 that, four respondents representing 19.1% of the total number of respondents believed that there was a negligible influence of Inadequate time and cost estimate on cost deviation while as eight respondents representing 38.1% of the total number of respondents believed that there is a strong influence of Inadequate time and cost estimate on cost deviation and only nine respondents representing 42.9% of the total number of respondents were not sure whether Inadequate time and cost estimate had a great influence or not on cost deviations.

The mean of 3.19 implied that majority of the respondents believed that inadequate time and cost estimate had a strong influence on cost deviation with a ranking of 2. Most contractors were established to have made a lot of inaccurate cost estimates. Records from their BOQs show that more money was estimated on preliminary costs on all projects studied and drainage costs for most projects except on Kitgum–Orom, Koboko-Yumbe and Aber-Anyeke-Ngai-Aromo road projects which were underestimated. On the contrary there was under estimation of wearing course and shoulder cost in most projects except in Ngomoromo-Biabia, Palabek-Atiak, Moyo-Obongi and Aber-Anyeke-Ngai-Aromo road projects. The finding is in agreement with findings of Amhed et. al., (2014), Al-Agele and Al-Hassan (2016), Aziz (2013) and Omoregie & Radford (2016)

who established inadequate time and cost estimate as one of the factors causing cost escalations.

Finally, seven respondents representing 33.3% of the total number of respondents believed that there was a negligible influence of Inadequate monitoring and control on cost deviation while as ten respondents representing 47.6% of the total number of respondents believed that there is a strong influence of Inadequate monitoring and control on cost deviation and only four respondents representing 19% of the total number of respondents were not sure whether Inadequate monitoring and control had a great influence or not on cost deviations.

The mean of 3.24 implied that majority of the respondents believed that inadequate monitoring and control had a strong influence on cost deviation and was ranked first. It was established that most contractors are not adequately monitoring and controlling activities at the sites. As a result, there is low worker's and equipment's productivity, leading to increase in labour payment and equipment hire cost, with associated fuel and lubricant costs. .This agrees with previous findings by Alinaitwe et. al., (2013) who established that lack of monitoring was one of the causes of delays and cost overruns in public sector construction projects in Uganda.

Generally, the overall Average Means was 3.025 implying that majority of the respondents believed that the factor “Contractors Site Management” is one of the major factors that influence cost deviation within Road Maintenance Projects within Uganda National Roads Authority. Contractor’s site management is contributed mainly by inadequate monitoring and control, inadequate time and cost estimate and inadequate planning and scheduling of work. This finding is consistent with the finding in specific objective one that there was under budgeting of the project cost elements. This is probably due to inadequate time and cost estimate and inadequate monitoring and control leading to negative deviations experienced.

4.5.2 Design and documentation related factors

Table 4.5: Descriptive statistics of Design and Documentation

No.	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Incomplete design	**2** 9.5%	**5** 23.8%	**6** 28.6%	**5** 23.8%	**3** 14.3%	**21** 100%	3.10	1
2	Frequent design changes	**1** 4.8%	**8** 38.1%	**4** 19%	**5** 23.8%	**3** 14.3%	**21** 100%	3.05	2
3	Mistakes and errors in designs	**0** 0%	**9** 42.9%	**5** 23.8%	**5** 23.8%	**2** 9.5%	**21** 100%	3.00	3
4	Poor designs and delays in design	**4** 19%	**3** 14.3%	**5** 23.8%	**7** 33.3%	**2** 9.5%	**21** 100%	3.00	3
5	Delay preparations and approval of drawings	**4** 19%	**4** 19%	**3** 14.3%	**9** 42.9%	**1** 4.8%	**21** 100%	2.95	4
					Average Means: 3.02				

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation note that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores are grouped to represent respondents who

believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

From Table 4.5, nine respondents, representing 42.9% of the total number of respondents, believed that there was a negligible influence of Frequent design changes on cost deviation while as eight respondents representing 38.1% of the total number of respondents believed that there is a strong influence of Frequent design changes on cost deviation and only four respondents representing 19% of the total number of respondents were not sure whether Frequent design changes had a great influence or not on cost deviations. The mean of 3.05 implied that majority of the respondents believed that Frequent design changes had a strong influence on cost deviation and was ranked 2^{nd}. It was established that some projects, especially Kitgum-Orom road project, had in complete designs at the time of tender which led to a change in the thickness design of the road wearing course and shoulder at some sections during the implementation. As a result the project experienced negative cost deviations in both drainage cost and wearing course / shoulder cost deviations. The finding agrees with previous findings by Aziz (2013); Enhassi et al., (2010); Omoregie and Radford (2006); Otim and Alinaitwe (2013).

Also from Table 4.5, seven respondents, representing 33.3% of the total number of respondents, believed that there was a negligible influence of Incomplete design at the time of tender on cost deviation while as eight respondents representing 38.1% of the total number of respondents believed that there is a strong influence of Incomplete design at the time of tender on cost deviation and only six respondents representing 28.6% of the total number of respondents were not sure whether Incomplete design at the time of tender had a great influence or not on cost deviations. The mean of 3.10 implied that majority of the respondents believed that Incomplete design at the time of tender had a strong influence on cost deviation and was ranked in 1st position. An incomplete design was also noted in Kitgum-Orom project where design for swamp raising at one section came when the project was already on-going hence contributing to the negative cost deviation noted on the project. The finding is in agreement with previous findings by Chilese and Berko (2010) and Enhassi et. al.,(2010).

Generally, the overall Average Means was 3.02 implying that majority of the respondents believed that the factor Design and Documentation is one of the major factors that influence cost deviation within road maintenance projects within Uganda National Roads Authority. Design and documentation factor is mainly contributed by incomplete design at the time of tender and frequent design changes. If designs are not complete, accurate project scopes cannot be visualized and estimated. This leads to cost deviations due to variations realized as a result of frequent design changes.

4.5.3 Financial Management factors

Table 4.6: Descriptive statistics of Financial Management

No	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Contractual claim	**0** 0%	**3** 14.3%	**8** 38.1%	**8** 38.1%	**2** 9.5%	**21** 100%	3.43	1
2	Delay in payment	**1** 4.8%	**4** 19%	**6** 28.6%	**8** 38.1%	**2** 9.5%	**21** 100%	3.29	2
3	Financial difficulties of owners	**0** 0%	**5** 23.8%	**7** 33.3%	**8** 38.1%	**1** 4.8%	**21** 100%	3.24	3
4	Cash flows and financial difficulties faced by contractors	**2** 9.5%	**4** 19%	**5** 23.8%	**9** 42.9%	**1** 4.8%	**21** 100%	3.14	4
5	Delays in progress payments	**1** 4.8%	**4** 19%	**9** 42.9%	**5** 23.8%	**2** 9.5%	**21** 100%	3.14	4
6	Poor financial control on site	**1** 4.8%	**4** 19%	**9** 42.9%	**6** 28.6%	**1** 4.8%	**21** 100%	3.10	5

Average Means: 3.223

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation note that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores a grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

According to Table 4.6, six respondents representing 28.6% of the total number of respondents believed that there was a negligible influence of Cash flows and financial difficulties faced by contractors on cost deviation while as ten respondents representing 47.7% of the total number of respondents believed that there is a strong influence of Cash flows and financial difficulties faced by contractors on cost deviation and only five respondents representing 23.8% of the total number of respondents were not sure whether Cash flows and financial difficulties faced by contractors had a great influence or not on cost deviations. The mean of 3.14 implied that majority of the respondents believed that Cash flows and financial difficulties faced by contractors had a strong influence on cost deviation and ranked 4th. The finding is in agreement with previous finding by Al-Agele and Al-Hassan (2016).

Also from Table 4.6, five respondents, representing 23.8% of the total number of respondents, believed that there was a negligible influence of Poor financial control on site on cost deviation while as seven respondents representing 33.3% of the total number of respondents believed that there is a strong influence of Poor financial control on site on cost deviation and only nine respondents representing 42.9% of the total number of respondents were not sure whether Poor financial control on site had a great influence or not on cost deviations. The mean of 3.10 implied that majority of the respondents believed that Poor financial control on site had a strong influence on cost deviation and was ranked 5th. Poor financial control on site greatly affected Gulu-Rackoko project to the extent of project termination when progress was at 68%. The finding is in agreement with findings by Oguya and Muturi (2016).

In addition to that, five respondents, representing 23.8% of the total number of respondents, believed that there was a negligible influence of Financial difficulties of owners on cost deviation while as nine respondents representing 42.9% of the total number of respondents believed that there is a strong influence of Financial difficulties of owners on cost deviation and only seven respondents representing 33.3% of the total number of respondents were not sure whether Financial difficulties of owners had a great influence or not on cost deviations. The mean of 3.24 implied that majority of the respondents believed that Financial difficulties of owners had a strong influence on cost deviation and ranked 3rd. This is in agreement with the findings of Tarimo (2017).

It was also established from Table 4.6 that, five respondents representing 23.8% of the total number of respondents believed that there was a negligible influence of Delays in progress payments by owners on cost deviation while as seven respondents representing 33.3% of the total number of respondents believed that there is a strong influence of Delays in progress payments by owners on cost deviation and only nine respondents representing 42.9% of the total number of respondents were not sure whether Delays in progress payments by owners had a great influence or not on cost deviations. The mean of 3.14 implied that majority of the respondents believed that Delays in progress payments by owners had a strong influence on cost deviation and ranked 4th. This is in agreement with findings by Alinaitwe et. al., (2013) and Otim et. al., (2011), who established that delays in progress payment is one of the factors causing delays and cost overruns of public sector construction projects and one of the factors affecting performance of pavement road construction projects in Uganda respectively. This was reportedly the cause of frustration of the contractor for Gulu-Corner Kilak project leading to a termination.

The study also established that, five respondents representing 23.8% of the total number of respondents believed that there was a negligible influence of Delay in payment to supplier/ contractor on cost deviation while as ten respondents representing 47.7% of the total number of respondents believed that there is a strong influence of Delay in payment to supplier/ contractor on cost deviation and only six respondents representing 28.6% of the total number of respondents were not sure whether Delay in payment to supplier/

contractor had a great influence or not on cost deviations. The mean of 3.29 implied that majority of the respondents believed that Delay in payment to supplier/ contractor had a strong influence on cost deviation and ranked 2nd. Delay in payments to contractor was noted in studied projects under all the UNRA stations selected. The delays normally attract additional claims by contractors.

Whereas, only three respondents representing 14.3% of the total number of respondents believed that there was a negligible influence of Contractual claim such as extension of time with claim on cost deviation while as ten respondents representing 47.7% of the total number of respondents believed that there is a strong influence of Contractual claim such as extension of time with claim on cost deviation and only eight respondents representing 38.1% of the total number of respondents were not sure whether Contractual claim such as extension of time with claim had a great influence or not on cost deviations. The mean of 3.43 implied that majority of the respondents believed that Contractual claim such as extension of time with claim had a strong influence on cost deviation and was ranked first. Extension of time was noted in projects under Gulu, Moyo and Kitgum. However there was only one claim recorded in one of the projects in Kitgum. Most contractors reportedly fear to make claims for fear of losing out on chances of getting future contracts with UNRA for being stubborn.

Generally, the overall Average Means was 3.223 implying that majority of the respondents believed that the factor Financial Management is one of the major factors

that influence cost deviation within Road Maintenance Projects in Uganda National Roads Authority (UNRA).

4.5.4 Information and Communication Technology (ICT) related factors

Table 4.7: Descriptive statistics of Information and Communication Technology (ICT)

No.	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Lack of communication between parties	**3** 14.3%	**7** 33.3 %	**6** 28.6%	**3** 14.3 %	**2** 9.5%	**21** 100 %	2.71	1
2	Lack of coordination between parties	**3** 14.3%	**8** 38.1 %	**6** 28.6%	**3** 14.3 %	**1** 4.8%	**21** 100 %	2.57	2
3	Slow information flow between parties	**3** 14.3%	**9** 42.9 %	**4** 19%	**4** 19%	**1** 4.8%	**21** 100 %	2.57	2
				Average Means: 2.62					

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation it should be noted that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores a grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

Findings in Table 4.7, indicate that majority of the respondents believed that the factor Information and Communication Technology (ICT) is not among the major factors influencing cost deviation within Road Maintenance Projects in Uganda National Roads Authority. There is fairly good communication, coordination and information flow between contractors and the UNRA officers across all UNRA stations under the study. Although this is not in agreement with the findings of Rahman et. al., (2013).

4.5.5 Labour Management related factors

Table 4.8: Descriptive statistics of Labour Management

No.	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Low Labour productivity	**1** 4.8%	**3** 14.3%	**6** 28.6%	**8** 38.1%	**3** 14.3%	**21** 100%	3.43	1
2	High cost of labour	**0** 0%	**5** 23.8%	**5** 23.8%	**8** 38.1%	**3** 14.3%	**21** 100%	3.43	1
3	Shortage of site workers	**0** 0%	**4** 19%	**7** 33.3%	**8** 38.1%	**2** 9.5%	**21** 100%	3.38	2
	Shortage of skilled labour	**0** 0%	**4** 19%	**6** 28.6%	**10** 47.6%	**1** 4.8%	**21** 100%	3.38	2
4	Labour absenteeism	**2** 9.5%	**5** 23.8%	**5** 23.8%	**8** 38.1%	**1** 4.8%	**21** 100%	3.05	3

Average Means: 3.334

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation it should be noted that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores a grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

From Table 4.8, only four respondents representing 19.1% of the total number of respondents believed that there was a negligible influence of Low Labour productivity on cost deviation while as eleven respondents representing 52.4% of the total number of respondents believed that there is a strong influence of Low Labour productivity on cost deviation and only six respondents representing 28.6% of the total number of respondents were not sure whether Low Labour productivity had a great influence or not on cost deviations. The mean of 3.43 implied that majority of the respondents believed that Low Labour productivity had a strong influence on cost deviation and was ranked 1st. Most of the project sites studied reportedly had low labour productivity. This is partly explained by inadequate site monitoring and control by the contractor's supervision team. An activity is then likely to take more time and cost to complete. The finding is in agreement with that of Rahman et al., (2013) and Chilese and Berko (2010), who established that low labour productivity is one of the significant factors causing cost overruns in large construction projects in Malaysia and Ghana respectively.

It is also established that, only 4 respondents representing 19% of the total number of respondents believed that there was a negligible influence of Shortage of site workers on cost deviation while as 10 respondents representing 47.7% of the total number of respondents believed that there is a strong influence of Shortage of site workers on cost deviation and only seven respondents representing 33.3% of the total number of

respondents were not sure whether Shortage of site workers had a great influence or not on cost deviations. The mean of 3.38 implied that majority of the respondents believed that Shortage of site workers had a strong influence on cost deviation and was ranked 2nd. The finding agrees with that of Rahman et. al., (2013) and Alinaitwe et. al., (2013) that shortage of site workers causes delays and cost overruns in Malaysia and Uganda respectively. Shortage of site workers is reportedly due to poor remunerations by the contractors.

In addition to that, only four respondents representing 19% of the total number of respondents believed that there was a negligible influence of Shortage of skilled labour on cost deviation while as eleven respondents representing 52.4% of the total number of respondents believed that there is a strong influence of Shortage of skilled labour on cost deviation and only six respondents representing 28.6% of the total number of respondents were not sure whether Shortage of skilled labour had a great influence or not on cost deviations. The mean of 3.38 implied that majority of the respondents believed that Shortage of skilled labour had a strong influence on cost deviation and was ranked 2nd. The finding agrees with the findings in other countries by Rahman et. al., (2013). Shortage of skilled is reportedly brought about by poor contractor's remunerations to the skilled labourers.

About the high cost of labour, only five respondents representing 23.8% of the total number of respondents believed that there was a negligible influence of High cost of labour on cost deviation while as eleven respondents representing 52.4% of the total number of respondents believed that there is a strong influence of High cost of labour on cost deviation and only five respondents representing 23.8% of the total number of respondents were not sure whether High cost of labour had a great influence or not on cost deviations. The mean of 3.43 implied that majority of the respondents believed that High cost of labour had a strong influence on cost deviation and was ranked 1st. The finding also agrees with finding of Rahman et. al., (2013) conducted in Malaysia that high cost of labour causes cost overruns in construction projects. Shortage of labourers at site is reportedly the one contributing to the high cost of labour experienced in the entire region under study.

Whereas on labour absenteeism, only seven respondents representing 33.3% of the total number of respondents believed that there was a negligible influence of Labour absenteeism on cost deviation while as nine respondents representing 42.9% of the total number of respondents believed that there is a strong influence of Labour absenteeism on cost deviation and only five respondents representing 23.8% of the total number of respondents were not sure whether Labour absenteeism had a great influence or not on cost deviations. The mean of 3.05 implied that majority of the respondents believed that Labour absenteeism had a strong influence on cost deviation and ranked 3rd. This also agrees with the findings of Rahman et. al., (2013) that absenteeism of labour causes cost

overruns in construction projects in Malaysia. Labour absenteeism noted is reportedly due to bad weather.

Generally, the overall Average Means was 3.334 implying that majority of the respondents believed that the factor Labour Management is one of the major factors that influence the cost deviation within road maintenance projects within Uganda National Roads Authority.

4.5.6 Material and machinery related factors

Table 4.9: Descriptive statistics of Material and Machinery

No.	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Fluctuation of prices of materials	**0** 0%	**1** 4.8%	**3** 14.3%	**12** 57.1%	**5** 23.8%	**21** 100%	4.00	1
2	Equipment availability and failure	**0** 0%	**2** 9.5%	**2** 9.5%	**14** 66.7%	**3** 14.3%	**21** 100%	3.86	2
3	Shortages of materials	**0** 0%	**1** 4.8%	**4** 19%	**14** 66.7%	**2** 9.5%	**21** 100%	3.81	3
	Late delivery of materials and equipment	**0** 0%	**2** 9.5%	**5** 23.8%	**12** 57.1%	**2** 9.5%	**21** 100%	3.67	4
				Average Means: 3.835					
		Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent							

Source: *Primary Data, (2019)*

For purposes of interpretation it should be noted that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores a grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

According to Table 4.9, only one respondent representing 4.8% of the total number of respondents believed that there was a negligible influence of Fluctuation of prices of materials on cost deviation while as seventeen respondents representing 80.9% of the total number of respondents believed that there is a strong influence of Fluctuation of prices of materials on cost deviation and only three respondents representing 14.3% of the total number of respondents were not sure whether Fluctuation of prices of materials had a great influence or not on cost deviations. The mean of 4.00 implied that majority of the respondents believed that Fluctuation of prices of materials had a strong influence on cost deviation with a ranking of 1. This agrees with the findings from other countries by Rahman et al., (2013); Ahmed et al., (2014) and Omoregie and Radford (2016) that fluctuation of material prices significantly cause cost overrun construction projects. Fluctuation of material prices, e.g. cement, steel, fuel, lubricants and gravels were

reportedly very common within the region and was the main cause of negative cost deviations leading to poor cost performance.

Whereas on shortage of materials, only one respondent representing 4.8% of the total number of respondents believed that there was a negligible influence of Shortages of materials on cost deviation while as much as sixteen respondents, representing 76.2% of the total number of respondents, believed that there is a strong influence of Shortages of materials on cost deviation and only four respondents representing 19% of the total number of respondents were not sure whether Shortages of materials had a great influence or not on cost deviations. The mean of 3.81 implied that majority of the respondents believed that Shortages of materials had a strong influence on cost deviation and was ranked 3rd in agreement with findings by Ahmed et. al., (2014); Omoregie and Radford (2016) and Otim et. al., (2013). This was also noted across the region under study.

About late delivery of materials, only two respondents representing 9.5% of the total number of respondents believed that there was a negligible influence of Late delivery of materials and equipment on cost deviation while as fourteen respondents representing 66.7% of the total number of respondents believed that there is a strong influence of Late delivery of materials and equipment on cost deviation and only five respondents representing 23.8% of the total number of respondents were not sure whether Late

delivery of materials and equipment had a great influence or not on cost deviations. The mean of 3.67 implied that majority of the respondents believed that late delivery of materials and equipment had a strong influence on cost deviation and was ranked 4th in agreement with other findings by Omoregie and Radford (2016) that it is one of the causes of cost escalations in Nigeria.

.Similarly from Table 4.9, only two respondents representing 9.5% of the total number of respondents believed that there was a negligible influence of Equipment availability and failure on cost deviation while as seventeen respondents representing 80.9% of the total number of respondents believed that there is a strong influence of Equipment availability and failure on cost deviation and only two respondents representing 9.5% of the total number of respondents were not sure whether Equipment availability and failure had a great influence or not on cost deviations.

The mean of 3.86 implied that majority of the respondents believed that Equipment availability and failure had a strong influence on cost deviation with a rankin of 2nd position. This also agrees with the findings by Alinaitwe et. al., (2013); Enhassi et. al., (2010); Otim et. al., (2013) and Tarimo 2017 who established equipment availability as one of the factors responsible for variation order, cost overruns and poor performance of construction projects in Gaza strip and Uganda. Equipment availability is one of the biggest challenges reportedly being experienced by the contractors for road

maintenance, especially vibro- rollers and bull dodgers. The few are being shared among the contractors and local governments. The equipment have to be moved from one area to another hence increasing cost of hire. On top of being few, most equipment have frequent break down and spares are mainly procured from Kampala, increasing the cost of repairs.

Generally, the overall Average Means was 3.835 implying that majority of the respondents believed that the factor material and machinery is one of the major factors that influence cost deviation within road maintenance projects within Uganda National Roads Authority. The influence of materials and machinery factors was believed to be seen on the negative cost deviations in wearing course and shoulder costs for nine of the fourteen projects.

4.5.7 Project management and contract Administration related factors

Table 4.10: Descriptive statistics of Project management and contract Administration

No.	Details	NA(5)	SE(4)	ME(3)	LE(2)	VLE(1)	Total	Mean	Ranking
1	Poor project management	**2** 9.5%	**7** 33.3%	**0** 0%	**10** 47.6%	**2** 9.5%	**21** 100%	3.14	4
2	Change in the scope of the project	**1** 4.8%	**3** 14.3%	**2** 9.5%	**11** 52.4%	**4** 19%	**21** 100%	3.67	1
3	Delays in decision making	**1** 4.8%	**6** 28.6%	**3** 14.3%	**7** 33.3%	**4** 19%	**21** 100%	3.33	3
4	Inaccurate quantity take off	**2** 9.5%	**3** 14.3%	**4** 19%	**8** 38.1%	**4** 19%	**21** 100%	3.43	2
				Average Means: 3.393					

Key: NA = Not at All, SE = Small Extent, ME = Moderate Extent LE = Large Extent and VLE = Very Large Extent

Source: *Primary Data, (2019)*

For purposes of interpretation it should be noted that scores for NA and SE are grouped to represent negligible influence while LE and VLE scores a grouped to represent respondents who believe that the factor strongly influences cost deviations. In addition, ME represents respondents whose opinion was unclear whether the factor influences cost deviations or not. The Average Means < 3.00 (less than 3.00) reveals scores of

factors with negligible influence on cost deviation and that above >3.00 (greater than 3.00) reveals scores of factors with strong influence on cost deviation.

Findings in Table 4.10, indicate that nine respondents representing 42.9% of the total number of respondents believed that there was a negligible influence of Poor project management on cost deviation while as twelve respondents representing 57.1% of the total number of respondents believed that there is a strong influence of Poor project management on cost deviation and none of respondents was sure whether poor project management had a great influence or not on cost deviations. The mean of 3.14 implied that majority of the respondents believed that Poor project management had a strong influence on cost deviation and was ranked in 4^{th} position. The finding agrees with that of Al- Agele and Al-Hassan (2016) and Omoregie and Radford (2006) who established poor project management as one of the reasons for cost deviations in Iraqi and Nigerian projects.

Also findings from Table 4.10, indicate that four respondents representing 19.1% of the total number of respondents believed that there was a negligible influence of Change in the scope of the project on cost deviation while as fifteen respondents representing 71.4% of the total number of respondents believed that there is a strong influence of Change in the scope of the project on cost deviation and only two respondents representing 9.5% of the total number of respondents were not sure whether Change in

the scope of the project had a great influence or not on cost deviations. The mean of 3.67 implied that majority of the respondents believed that Change in the scope of the project had a strong influence on cost deviation and was ranked in 1st position. The finding agrees with findings from other countries by Ahmed et. al., (2014); Alinaitwe et. al., (2013); Aziz (2013); Chilese and Berko (2010) and Niazi and Painting (2017) who established that changes in project scopes is one of the causes of cost overruns in projects in Egypt, Ghana and Afghanistan, among others. This was observed in projects studied under all UNRA stations selected. Sometimes changes in project scope reportedly came as a result of inaccurate quantity take-off by the client when preparing BOQs or delays of taking decisions during quantity take off. Changing project scope is believed to have resulted into changes in additional quantities of materials and labour inputs hence increase in cost of the inputs.

Besides, seven respondents representing 33.3% of the total number of respondents believed that there was a negligible influence of Delays in decision making on cost deviation while as eleven respondents representing 52.4% of the total number of respondents believed that there is a strong influence of Delays in decision making on cost deviation and only three respondents representing 14.3% of the total number of respondents were not sure whether Delays in decision making had a great influence or not on cost deviations. The mean of 3.33 implied that majority of the respondents believed that Delays in decision making had a strong influence on cost deviation and

was ranked in the 3rd position. The finding also agrees with other findings by Omoregie and Radford (2006) and Otim et. al., (2013) that it is one of the causes of cost overruns in projects in Nigeria.

Finally, only five respondents representing 23.8% of the total number of respondents believed that there was a negligible influence of Inaccurate quantity take off on cost deviation while as twelve respondents representing 57.1% of the total number of respondents believed that there is a strong influence of Inaccurate quantity take off on cost deviation and only four respondents representing 19% of the total number of respondents were not sure whether Inaccurate quantity take off had a great influence or not on cost deviations. The mean of 3.43 implied that majority of the respondents believed that Inaccurate quantity take off had a strong influence on cost deviation and was ranked in 2nd position. The finding agrees with other findings by Aziz (2013) and Omoregie and Radford (2006) who established that inaccurate quantity take-off is one of the factors causing cost overruns in Egypt and Nigeria.

Generally, the overall Average Mean was 3.393 implying that majority of the respondents believed that the factor Project Management and Contract Administration is one of the major factors that influence cost deviation within Road Maintenance Projects within Uganda National Roads Authority.

4.6 Predictive model for cost performance improvement of road maintenance in UNRA

To develop a predictive model for cost performance improvement, the data obtained from the reviewed projects were subjected to different statistical analysis to establish their correlations with each other. Their correlation will help in understanding a relationship between them when developing the model. The results are as presented in the subsequent section.

4.6.1 Pearson Correlation between Cost Deviations and Preliminary Cost Deviations

Table 4.11: Correlations between Cost Deviations and Preliminary Cost Deviations

		Cost Deviations	Preliminary cost deviations
Cost Deviations	Pearson Correlation	1	. 712
	Sig. (2-tailed)		.008
	N	14	14
Preliminary cost deviations	Pearson Correlation	.712	1
	Sig. (2-tailed)	.008	
	N	14	14

Source: *Primary Data, (2019)*

The results in Table 4.11 depict Pearson's correlation between Preliminary Cost Deviations and Project Cost Deviations. The correlation value of 0.712 implies that there is a strong positive relationship between Preliminary Cost Deviations and Project Cost

Deviations. This means a reduction in Preliminary Cost Deviations will lead to a reduction in the Project Cost Deviations and an increase in the Preliminary Cost Deviations will lead to a resultant increase in Project Cost Deviations.

4.6.2 Regression Analysis between Project Cost Deviations & Preliminary Cost Deviations

Table 4.12: Model Summary of Project Cost Deviation and Preliminary Cost Deviations

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.712[a]	.505	.501	453771.273

a. Predictors: (Constant), Preliminary cost deviations

Source: Primary Data, (2019)

The model summary in Table 4.12 above reflects the results of a bivariate regression between Preliminary Cost Deviations and Project Cost Deviations. The resultant R2 is 0.505. This implies that Preliminary Cost Deviations accounts for 50.5% (0.505*100) of the variations in Project Cost Deviations. The remaining 49.5% is explained by other factors other than Preliminary Cost Deviations. The Adjusted R Squared of 0.501 (50.1%) implies that the independent variable (Preliminary Cost Deviations) accounts for 50.1% of the variance in the dependent variable (Project Cost Deviations).

4.6.3 Pearson Correlation between Project Cost Deviations and Drainage Cost Deviations

Table 4.13: Correlation between Drainage Cost Deviations and Project Cost Deviations

		Cost Deviations	Drainage cost deviations
Cost	Pearson Correlation	1	.823
Deviations	Sig. (2-tailed)		.000
	N	14	14
Drainage cost	Pearson Correlation	.823	1
deviations	Sig. (2-tailed)	.000	
	N	14	14

Source: *Primary Data, (2019)*

The results in Table 4.13 above depict the Pearson's correlation between Drainage Cost Deviations and Project Cost Deviations, the correlation value of 0.823 implies that there is a very strong positive relationship between Drainage Cost Deviations and Project Cost Deviations, implying that a reduction in Drainage Cost Deviations will lead to a reduction in the Project Cost Deviations and an increase in the Drainage Cost Deviations will lead to a resultant increase in Project Cost Deviations.

4.6.4 Regression Analysis of Project Cost Deviations and Drainage Cost Deviations

Table 4.14: Model Summary of Drainage Cost Deviations and Project Cost Deviations

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.823[a]	.677	.671	458064.878

a. Predictors: (Constant), Drainage cost deviations

Source: *Primary Data, (2019)*

The model summary in Table 4.14 above reflects the results of a bivariate regression between Drainage Cost Deviations and Project Cost Deviations. The resultant R^2 which is 0.677 implies that Drainage Cost Deviations accounts for 67.7% (0.677*100) of the variations in Project Cost Deviations and the remaining 32.3% is explained by other factors other than Drainage Cost Deviations. The Adjusted R Square of 0.671 (67.1%) implies that the independent variable (Drainage Cost Deviations) accounts for 67.1% of the variance in the dependent variable (Project Cost Deviations).

4.6.5 Pearson Correlation between Cost Deviations and Wearing Cost Deviations

Table 4.15: Correlation between Wearing Cost Deviations and Project Cost Deviations

		Cost Deviations	Wearing course & shoulders' cost deviations
Cost Deviations	Pearson Correlation	1	.524
	Sig. (2-tailed)		.002
	N	14	14
Wearing course & shoulders' cost deviations	Pearson Correlation	.524	1
	Sig. (2-tailed)	.002	
	N	14	14

Source: *Primary Data, (2019)*

The results in Table 4.15 above depict Pearson's correlation between Wearing course & shoulders' Cost Deviations and Project Cost Deviations, the correlation value of 0.524 implies that there is a moderate positive relationship between Wearing course & shoulders' Cost Deviations and Project Cost Deviations, implying that a reduction in Wearing course & shoulders' Cost Deviations will lead to a reduction in the Project Cost Deviations and an increase in the Wearing course & shoulders' Cost Deviations will lead to a resultant increase in Project Cost Deviations.

4.6.6 Regression Analysis between Cost Deviations and Wearing Cost Deviations

Table 4.16: Model Summary of Wearing Cost Deviations and Project Cost Deviations

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.524[a]	.275	.271	419180.964

a. Predictors: (Constant), Wearing course & shoulders' cost deviations

Source: *Primary Data, (2019)*

The model summary in Table 4.16 above reflects the results of a bivariate regression between Wearing Cost Deviations and Project Cost Deviations. The resultant R^2 which is 0.275 implies that Drainage Cost Deviations accounts for 27.5% (0.275*100) of the variations in Project Cost Deviations and the remaining 72.5% is explained by other factors other than Wearing Cost Deviations. The Adjusted R Square of 0.271 (27.1%) implies that the independent variable (Wearing Cost Deviations) accounts for 27.1% of the variance in the dependent variable (Project Cost Deviations).

4.6.7 Multivariate Model

Table 4.17: Preliminary, Drainage, Wearing cost deviation and Project Cost Deviation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.934[a]	.872	.864	425751.730

a. Predictors: (Constant), Wearing course & shoulders' cost deviations, Drainage cost deviations, Preliminary cost deviations

Source: *Primary Data, (2019)*

The model summary in Table 4.17 above reflects the results of a multivariate regression between Preliminary Cost Deviation, Drainage Cost Deviations, Wearing Cost Deviations and Project Cost Deviations. The resultant R^2 which is 0.872 implies that the three variables Preliminary Cost Deviation, Drainage Cost Deviations and Wearing Cost Deviations account for 87.2% (0.872*100) of the variations in Project Cost Deviations and the remaining 12.8% is explained by other factors other than these three variables that include Preliminary Cost Deviation, Drainage Cost Deviations and Wearing Cost Deviations. The Adjusted R Square of 0.864 (86.4%) implies that the independent variables (Preliminary Cost Deviation, Drainage Cost Deviations and Wearing Cost Deviations) accounts for 86.4% of the variance in the dependent variable (Project Cost Deviations).

4.6.8 Model Coefficients

Table 4.18: Preliminary, Drainage, Wearing cost deviation and Project Cost Deviation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	90460.816	259094.665		.349	.000
	Preliminary cost deviations	.973	.766	.400	1.271	.002
	Drainage cost deviations	.739	2.173	.299	.340	.001
	Wearing course & shoulders' cost deviations	.763	.405	.553	1.884	.009

a. Dependent Variable: Cost Deviations

Source: *Primary Data, (2019)*

The standardized beta coefficients are 0.400, 0.299 and 0.533 which are positive, this reflects a direct relationship between the independent variables Preliminary Cost Deviations, Drainage Cost Deviations and Wearing Cost Deviations, and the dependent variable which is Project Cost Deviation, which implies that an increase in Preliminary Cost Deviations, Drainage Cost Deviations and Wearing Cost Deviations leads to a higher likelihood of Project Cost Deviation and where there is low level of Preliminary Cost Deviations, Drainage Cost Deviations and Wearing Cost Deviations there is usually a low likelihood of Project Cost Deviations. This relationship is depicted in general

equation (3.1) between Project Cost Deviation and Preliminary Cost Deviations, Drainage Cost Deviations and Wearing Cost Deviations

$揂rCD = a_0 + a_1PCD + a_2DCD + a_3WCD + \varepsilon$……Equation (3.1)

From the results in Table 4.18,

$PrCD = 90{,}460 + 0.4PCD + 0.299DCD + 0.553WCD$ …..…..…… (Equation 3.2)

This is PrCD for 889km of unpaved roads studied. Therefore, PrCD per every km of unpaved road maintained, obtained by dividing equation (3.2) by 889km, is;

$PrCD = 102 + 0.00045PCD + 0.00034DCD + 0.00062WCD$…..… Equation (3.3)

Where;

a_0 is the constant;

a_1, a_2 and a_3 are the slopes of PCD, DCD and WCD respectively;

ε is the Error Term;

PCD is Preliminary Cost Deviations;

DCD is Drainage Cost Deviations;

WCD is Wearing course Cost Deviations and

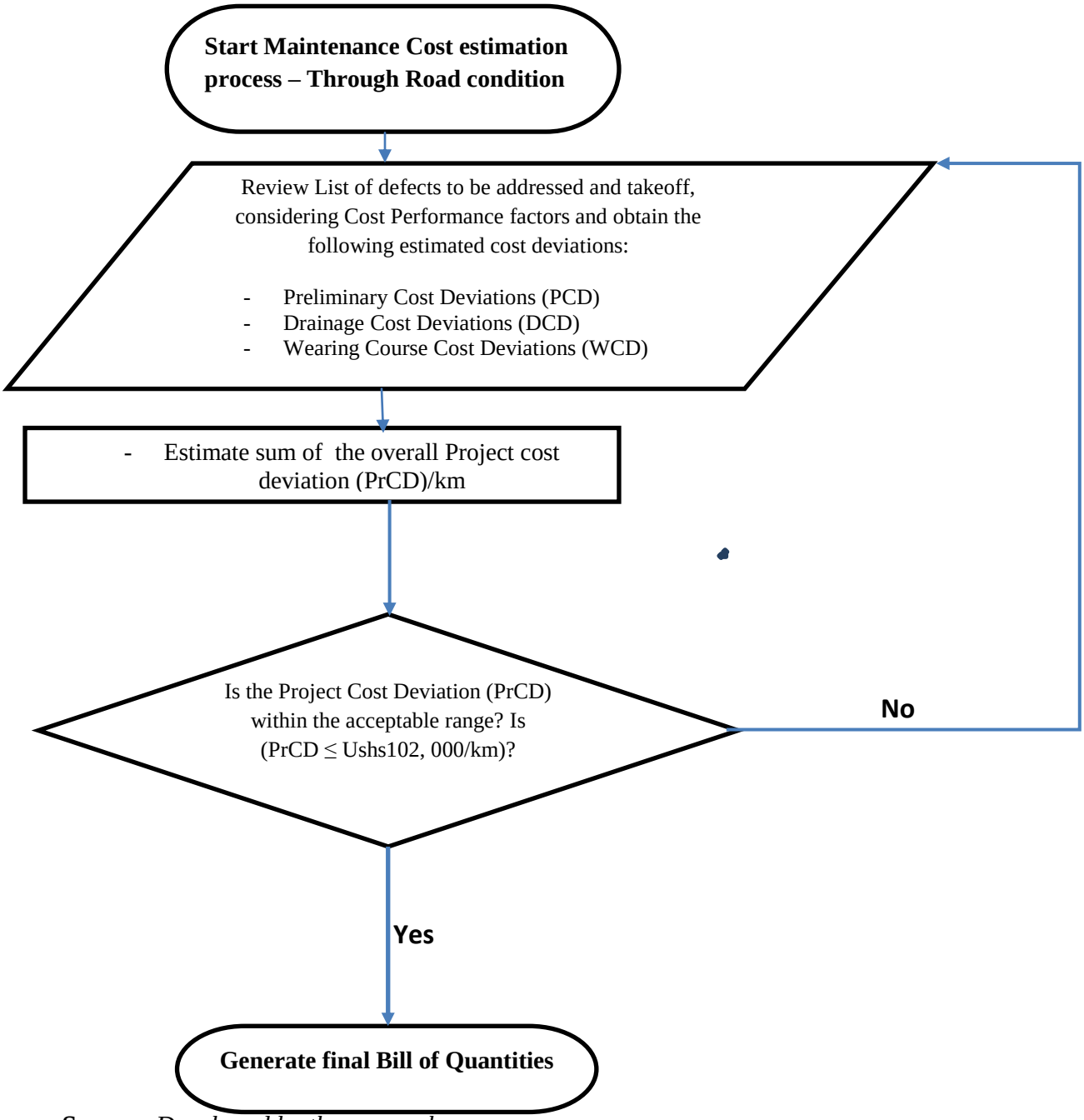
$PrCD$ is Project Cost Deviations.

Furthermore, the coefficients of 0.00045, 0.00034 and 0.00062 imply that a unit increase in Preliminary Cost Deviations, Drainage Cost Deviations and Wearing Cost Deviations respectively will lead to a 0.00045, 0.00034 and 0.00062 increase in Project Cost Deviations respectively and a unit decrease in Preliminary Cost Deviations, Drainage

Cost Deviations and Wearing Cost Deviations will lead to a 0.00045, 0.00034 and 0.00062 decrease in Project Cost Deviations respectively. Whereas if there is no increase or decrease in Preliminary Cost Deviations, Drainage Cost Deviations and Wearing course and shoulder Cost Deviations, Project Cost Deviations will always remain constant at Ushs 102,000 per every kilometer of unpaved road budget. This figure of the constant is subject to inflation.

Equation (3.3) can be used by policy makers in UNRA to predict future values of project cost deviations per every km of road to be maintained through a cost deviation reduction framework, as illustrated in Figure 4.3:

Cost Deviation Reduction Framework Model



Source: *Developed by the researcher*

Figure 4.3: Cost deviation Reduction Framework model

The reduction model framework in Fig 4.3 is meant to improve cost performance of road maintenance projects by early prediction and minimization of cost deviations leading to accurate estimations of project cost.

Project cost estimation is expected to start with road condition survey field work. During the field work, all road defects to be treated should be listed and measured accurately. Critical factors which are likely to affect maintenance project costing at this stage should be accurately assessed. These include, among others, availability of local materials and local labour force with their unit costs.

Using the field data and information, preliminary cost, drainage cost and wearing course / shoulder cost are developed, taking into consideration identified factors affecting cost performances at this stage. The factors include material price fluctuations, equipment availability and failure, inaccuracies in taking off, existing high cost of labor, mistakes and errors in designs, among others. The estimated cost should constitute an allowance of additional cost estimates for each of the budget elements of preliminary, drainage and wearing course costs. The additional cost is estimated to cover cost deviations in each of the budget element against the earlier identified factors.

With the known cost deviations provided in each of the budget element, an overall project cost deviation can be estimated using equation (3.3). If PrCD estimated is more than Ushs 102,000, which value is subject to adjustments due to inflation, per km length of unpaved roads to be maintained, the project cost is likely to exceed the project budget at the end of the project, resulting into negative cost deviations. The estimator should review the field data and cost deviations earlier estimated. If the PrCD is less or equal to Ushs 102,000 per every km of the road to be maintained, the project cost is likely to be managed within the project budget or the project cost may experience a positive deviation from the budget.

4.6.9 Chapter summary

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

- There was too much cost attached to traffic management, quality control and material testing, overheads and profits and signboards budget yet very little was spent from the budget item. This was inflated and later on re allocated to cover variations in other budget elements in order to avoid project cost overruns.
- There was inadequate budget provided for road shaping and gravelling and a s result the budget item experienced negative cost deviations
- 10 of the 14 projects studied experienced negative deviations in some or all of the budget elements implemented.
- 24 major factors were established to influence cost performances. This includes: inadequate monitoring and control of the project, inadequate time and cost

estimates, inadequate planning and scheduling of work, incomplete designs at the time of tendering, frequent design changes, contractual claim, delays in payments to contractors, financial difficulties of the clients, delays in making progress payments, poor financial control on site, cash flows and financial difficulties faced by contractors, low labour productivity, shortages of site workers, shortages of skilled labour, high cost of labour, labour absenteeism, fluctuation of prices of materials, equipment availability and failure, shortages of materials, late delivery of materials and equipment, change in the scope of the projects, inaccurate quantity take-off, delays in decision making and poor project management.

- Preliminary cost deviations, drainage cost deviations and wearing course and shoulder cost deviations account for 87.2% of Project cost deviations.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study aimed at developing a model for Cost Performance Improvement of road maintenance projects in Northern Uganda focusing on Uganda National Roads Authority projects. It was conducted in four stations which included Moyo Station, Gulu Station, Kitgum Station and Arua Station. This chapter presents the conclusions made by the researcher as well as the policy recommendations organized with reference to the specific objectives of the study and finally the chapter areas for further research. The first section presents the conclusions followed by recommendations of the study in relation to the specific objectives of the researcher's study.

5.2 Conclusions of the study

5.2.1 Cost performances of road maintenance projects in UNRA

The study concluded that;

- There was inaccurate budgeting of project costs with over inflation of preliminary unit costs and under estimation of wearing course and shoulder costs resulting into widespread negative cost deviations in some or all the elements budgeted, hence a bad cost performances experienced

5.2.2 Factors that influence cost performances of road maintenance projects

This study concluded that, there are several factors that affect or influence the costs of road maintenance projects in Uganda. However, based on the findings of the study, out of the examined seven (7) factors believed to affect cost of road maintenance projects which included; Contractors site management factors, Design and documentation related factors, Financial Management factors, Information and Communication Technology (ICT) related factors, Labour management related factors, Material and machinery related factors and Project management & contract Administration related factors only the following six factors were found to affect cost deviations:

Table5.1: Overall ranking of factors affecting cost performances

Factor	Mean	Ranking
Material and machinery related	3.835	1
Project management and contract administration related	3.393	2
Labour management related	3.334	3
Financial management related	3.223	4
Contractor site management related	3.025	5
Design and documentation related	3.02	6

Source: Primary Data, (2019)

From table 5.1, it is apparent that the most important factor affecting cost performances of unpaved road maintenance work is material and machinery related factor and the least is design and documentation related factor. It can then be concluded that critical

attention be paid to the problems under each of these factors when planning and implementing road maintenance budgets. This will contribute to the improvement of cost performances of the road maintenance projects.

The research findings are in line with the findings of Rahman et. al., (2013), Niazi and Painting (2016), Oguya and Muturi (2016), Meeampol and Ogunlan (2006), Enshassi et. al., (2010), among others, about the different factors established to be among the factors causing cost overruns and escalations in construction projects in their respective countries, as earlier explained.

However, the researcher also concluded that Information and Communication Technology (ICT) did not have any impact on cost deviations within road projects in UNRA.

5.3.3 A predictive model for cost performance improvement of road maintenance in UNRA

This study concluded that there is a strong positive relationship between Preliminary Cost Deviations and Project Cost Deviations with a correlation coefficient of 0.712. The study also concluded that an increase in Preliminary Cost Deviations significantly leads to an increase in Project Cost Deviations.

This study further concluded that there is a very strong positive relationship between Drainage Cost Deviations and Project Cost Deviations with a correlation coefficient of 0.823. The study also concluded that an increase in Drainage Cost Deviations significantly leads to an increase in Project Cost Deviations and the reverse is true.

This study also concluded that there is a moderate positive relationship between wearing course & shoulders' Cost Deviations and Project Cost Deviations with a correlation coefficient of 0.524. The study also concluded that an increase in Wearing course & shoulders' Cost Deviations significantly leads to an increase in Project Cost Deviations and the reverse is true.

In summary, the researcher concluded that there is inaccurate budgeting of project cost and a number of factors are indeed influencing cost performances which need to be critically considered during budgeting and implementation of project budgets.

5.3 Recommendations of the study

5.3.1 Cost performances of road maintenance projects in UNRA

There is need for UNRA to give an adequate time for planning and budgeting for Term / Periodic maintenance of unpaved roads so that accurate and realistic budgets are

prepared to address the effects of cost performance factors which lead to negative cost deviations in the studied projects.

5.3.2 The factors that influence cost performances of road maintenance projects

The researcher proposes the following;

To government

- Adequate and timely release of maintenance funds to UNRA to minimize problem of financial difficulties faced by UNRA leading to extension of time of contract. This results into contractual claims.

To UNRA

- Give adequate time for planning and budgeting of maintenance works
- Conduct a detail assessment of the sites prior to preparation of project costs
- Establish a framework for lending equipment to contractors where there is need
- Minimize bureaucracies in processing payments to contractors

To Contractors

- Improve on monitoring and supervision of work at project sites
- Improve on planning and scheduling of work so that materials and equipment are supplied to sites in time

- Explore the possibility of improving their cash flows through borrowing from financial institutions
- Endeavor to visit project sites prior to bidding

5.3.3 A predictive model for cost performance improvement of road maintenance in UNRA

This study recommends that Preliminary Cost Deviations, Drainage Cost Deviations and Wearing course & shoulders' Cost Deviations should as much as possible is minimized as a measure to control Project Cost Deviations within UNRA and other related organizations through;

- Accurate budgeting and costing
- Strong management approach over entire implementation of the project period

5.4 Contribution of the study

This study developed a mathematical model that is based on Preliminary Cost Deviations, Drainage Cost Deviations and Wearing course & shoulders' Cost Deviations that can be used to predict Project Cost Variations, per every kilometer of unpaved roads:

$$PrCD = 102 + 0.00045PCD + 0.00034DCD + 0.00062WCD \ldots\ldots \text{Equation (5.1)}$$

Where;

PCD is Preliminary Cost Deviations;

DCD is Drainage Cost Deviations;

WCD is Wearing course Cost Deviations and

$PrCD$ is Project Cost Deviations.

A cost deviation reduction framework describing how to minimize cost deviations was also proposed that shall contribute to the body of knowledge as presented on page 74 (reduction framework model 4.3).

Through the use of the mathematical model and a framework developed and proposed by the researcher, UNRA will be in position to predict and minimize Project Cost Deviations hence improving cost performance in maintenance work.

5.5 Future research

The researcher recommends that subsequent researchers should examine the effect of project management style on Project Cost Deviations. This is because some factors identified only contribute to cost deviations after the project costing stage, at the implementation stage when management styles now play a greater role in implementations. Management styles may vary according to different management approaches each contract manager may apply.

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ANNEX A: DATA COLLECTION QUESTIONARE

KYAMBOGO UNIVERSITY

DEVELOPING A MODEL FOR COST PERFORMANCE IMP

ROVEMENT OF ROAD MAINTENANCE PROJECTS IN NORTHERN UGANDA – CASE STUDY OFUGANDA NATIONAL ROADS AUTHORITY

QUESTIONARE FORM 1

Dear Sir/Madam;

I am Abonga Alfred Alexis, a graduate student of Kyambogo University, undertaking a Master of Science Degree in Construction Technology and Management. I am conducting a study on how to improve on cost performance in road maintenance projects, which will come up with a predictive tool that can be used to check cost deviations during planning stages. You have been identified to participate in this study by filling in this form, as a key stakeholder in road maintenance projects. I therefore kindly request you to share your opinion, which opinion shall be confidential and strictly for this study only.

1. Title of Respondent.....Organization.....

2. For how long have you been working on road maintenance projects?

…… (days/months/years)

3. Road maintenance projects, like any construction projects, are subject to cost deviations from the original budgeted sum. Kindly tick, in your opinion, the likely causes of the cost deviations from the information below?

Factors of cost deviations	**Not at all**	**Small extent**	**Moderate extent**	**Large extent**	**Very large extent**
Contractors site management factors					
Poor site management and supervision					
Inadequate planning and scheduling					
Lack of experience					
Inadequate time and cost estimate					
Mistake during construction					
Inadequate monitoring and control					
Design and documentation related factors					
Frequent design changes					
Mistakes and errors in designs					
Incomplete design at the time of tender					
Poor designs and delays in design					
Delay preparations and approval of drawings					
Financial Management factors					
Cash flows and financial difficulties faced by contractors					
Poor financial control on site					
Financial difficulties of owners					
Delays in progress payments by owners					
Delay in payment to supplier/ contractor					
Contractual claim such as extension of time with claim					

Information and Communication Technology (ICT) related factors Lack of coordination between parties Slow information flow between parties Lack of communication between parties					
Labour management related factors Low Labour productivity Shortage of site workers Shortage of skilled labour High cost of labour Labour absenteeism					
Material and machinery related factors Fluctuation of prices of materials Shortages of materials Late delivery of materials and equipment Equipment availability and failure					
Project management and contract Administration related factors Poor project management Change in the scope of the project Delays in decision making Inaccurate quantity take off					
List other actors …… ……					

ANNEX B: RESEARCH WORK PLAN

Period / months	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Description of works										
Problem identification										
Literature review										
Research title Submission										
Proposal Development, experiment and observation										
Proposal Submission										
Developing Questionnaires										
Data collection										
Data Analysis and interpretation										
Draft report writing										
Final Report submission										
Presentation										

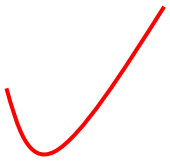
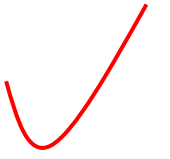
ANNEX C: RESEARCH BUDGET

Item	**Description**	**Qty**	**Rate (Ushs)**	**Amount (Ushs)**
1	Internet data bundle	10GB	135,000	135,000
2	Purchase of online publications	5	125,000	625,000
3	Printing papers	5 reams	20,000	100,000
4	Transport expenses	20 times	80,000	1,600,000
5	Accommodation expenses	80 nights	50,000	4,000,000
6	Assorted stationaries		LS	200,000
	Total			**6,660,000**

ANNEX D: REVIEWED COMPLETED PROJECTS

S/N	PROJECT DETAILS	STATUS
	GULU STATION	
1	Periodic maintenance of 44 Selected National Roads (26 Lots) Lot 25: Aber-Anyeke- Ngai- Aromo-Awere Roads (100kms). Ref No: UNRA/WORKS/2013-14/00028/01/25 Contractor: M/S Universal Plan Build Joint Venture Starting Date: 16/4/2015. Completion Date: 15/18/2016 Contract Sum: Ushs 4,063,410,240	
2	Term maintenance contract for 21 Selected National Roads Lot 9: Gulu – Rackoko (90km) Contractors: Concerted Contractors Contract Sum: Ushs 4,695,240,000 Ref: UNRA/WORKS/2012-13/00002/04/09 Starting Date: 15/1/2014 Complete date: 14/1/2017	
	MOYO STATION	
3	Term maintenance of 48 Selected National Roads- Phase V (21 lots), Lot 21: Adjumani –Mungula – Amuru (88km) Contractor: Olet Elyak Ltd Procurement No: UNRA/WORKS/2013-14/00019/21 Contract Sum: Ushs 5,984,274,120 Commencement date: 24/12/2014 Completion date: 23/12/2017	
4	Period maintenance of Selected National Roads Lot 12: Moyo-Obongi Road (28km) Ref: UNRA/WORKS/2014-15/00015/12 Contract Sum: Ushs 1,309,786,000 Contractor: M/S Consolidated Contractors Ltd Starting Date: 26/5/2016 Completion Date: 19/9/2017	

5	Term maintenance of Selected 23 National Roads- Lot 10: Moyo – Yumbe (69km) Ref No: UNRA/WORKS 2012-2013/00002/01/10 Contractor: M/S Nippon Parts- U –Ltd Starting Date: 12/7/2013 Completion date: 11/11/2016 Sum: 6,089,480	
	ARUA	
6	Term maintenance of 48 Selected National Roads- Phase V (21 lots), Lot 13: Wandi – Rhino Camp (51km) Rf No: UNRA/WORKS/2013-14/00019/02/13 Contractor: Kaark Technical Services Ltd Contract Sum: Ushs 3,573,438,550 Starting Date: 24/2/2015 Completion date: 25/2/2018	
7	Term maintenance of 48 Selected National Roads- Phase V (21 lots), Lot 13: Koboko –Lodonga-Yumbe (36km) Ref No: UNRA/WORKS/2013-14/00019/02/13 Contractor: Kaark Technical Services Ltd Contract Sum: Ushs 2,825,806,500 Starting Date: 25/2/2015 Completion date: 25/2/2018 Ref: UNRA/WORKS/2013-14/00019/02/13	
8	Term maintenance of 23 Selected National Roads- Lot M9: (21Wandi – Yumbe Road (70km) Contractor: Rukooge Enterprises (U) Ltd Starting Date: 11/7/2013 Completion date: 10/7/2016 Sum: Ushs 3,306,660,000 Ref: UNRA/WORKS/2012-13/00002/01/09	
	KITGUM	

9	Term maintenance of 48 Selected National Roads- Phase V (21 lots)- Lot 16: Pajule-Pader-Kwonkic (27km) Contractor: Olet Elyak Ltd Procurement Ref: UNRA/WORKS/2013-14/00019/02/16 Contractor: Continuum Engineering Ltd P.O Box 812 Mukono Starting Date: 6/2/2015 Completion Date: 6/6/2018 Contract sum: Ushs 1,976,047,700	
10	Term maintenance of 48 Selected National Roads- Phase V (21 lots)-Lot 16: Naamokora –Lokapel –Adilang (74km) Procurement Ref: UNRA/WORKS/2013-14/00019/02/16 Contractor: Continuum Engineering Ltd Starting Date: 6/2/2015 Completion Date: 6/2/2018 Contract sum: Ushs 5,204,848,000	
11	Kitgum - Orom (90 Km) Contractor: Upland Enterprises Starting date: 19/12/2015 Completion date: 18/5/2018 Sum: Ushs 5,949,777,000	
12	Term maintenance of Palabek –Atiak road (65km) Starting Date: 19/12/2015 Completion Date: 18/5/2018 Contract sum: Ushs 4,693,092,000 Contractor: Upland Enterprises Construction Co Ltd	
13	Term maintenance of Ngomoromo – Bibia roads (34km) Contractor: KUUKA Investment Starting date: 10 Jan 2016 Completion date: 20/Mar./2017 Contract Sum: Ushs 1,882,550,000	
14	Term maintenance of Kilak – Adilang road (65km) Contractor: PNR Services Starting date: 18/May/2014 Completion date: 19/May/2017 Contract sum: Ushs 4,051,726,000	

ANNEX E: INTRODUCTORY LETTER TO THE FIELD

KYAMBOGO UNIVERSITY

Department of Civil and Building Engineering

P. O. BOX 1, KYAMBOGO – KAMPALA, UGANDA

TEL: +256-41-4287340, FAX: +256-41-4289056/4222643

UGANDA NATIONAL ROADS AUTHORITY RECEIVED NAME: Jean W. 24 APR 2018 TIME: 10:25 MAIN RECEPTION

18th April 2018

TO WHOM IT MAY CONCERN

RE: INTRODUCTION LETTER FOR MR. ABONGA ALFRED ALEXIS REG.NO. 16/U/13477/GMET/PE

This is to introduce the above-named final year student who is undertaking a Master of Science in Construction Technology and Management at the Faculty of Engineering, Department of Civil and Building Engineering, Kyambogo University. Mr. Abonga is undertaking a research study on the topic titled **"Cost performance improvement of road maintenance projects in Uganda- Case study of Uganda National Roads Authority".** It is one of the requirements for graduation at Kyambogo University to conduct research and submit a dissertation/thesis by graduate students before awarding them a degree.

The purpose of this communication is to humbly request your office and the relevant staff to assist him access the necessary information and guidance to help him successfully conduct his research at your organisation. The information will only be used for academic purposes and shall be kept confidential. We thank you in advance for your cooperation and we hope the findings of this research will also benefit the organisation.

Yours faithfully,

THE HEAD OF DEPARTMENT CIVIL AND BUILDING ENGINEERING KYAMBOGO UNIVERSITY

Dr. Jacob Nyende
Head of Department