ASSESSING THE APPLICABILITY OF EARNED VALUE MANAGEMENT TECHNIQUE IN ENHANCING PERFORMANCE OF CONSTRUCTION PROJECTS IN UGANDA: A CASE OF KAMPALA CITY

BY

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Kyambogo University a dissertation titled **"Assessing the Applicability of Earned Value Management Technique in enhancing Performance of Construction Projects in Uganda: A Case of Kampala City",** in fulfillment of the requirements for the award of a degree of Master of Science in Construction Technology and Management of Kyambogo University

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DECLARATION

I, **Mugabi Ronald,** do here by declare that this dissertation is my original work and has never been submitted to any institution or university for any academic award.

Signed…… Date…….

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DEDICATION

This dissertation is dedicated to my father and mother, Mr. Muhambani Nathan (RIP) and Mrs.Florence Muhambani, my wife, Mrs. Erina Mugabi and my children: Shalom Mugabi, Shena Mugabi, Shine Mugabi and Shaniece Mugabi.

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LIST OF ABBREVIATIONS

AC	Actual Cost
ARB	Architects Registration Board
AV	Actual Value
C/SCSC	Cost/Schedule Control Systems Criteria
DOD	Department of Defense
DV	Dependent Variable
ERB	Engineers Registration Board
EV	Earned Value
EVM	Earned Value Management
LCC	Local Construction Contractors
PERT	Program Evaluation Review Technique
PMI	Project Management Institute
PV	Planned Value
SRB	Surveyors Registration Board

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Abstract

Monitoring is the most important component in project management. It deals with measuring performance of a project at certain time intervals and reports that performance to the organization for process control. Any project with considerable cost overrun and schedule delay typically gets in trouble at its beginning, and unfortunately, project managers do not realize this problem until late in the implementation when their ability to recover the project to achieve its planned objectives diminishes. This study aimed at assessing the applicability of Earned Value Management (EVM) technique on measuring the performance of construction projects in Kampala City, and adopted a mixed method research design that employed both quantitative and qualitative techniques. Data were collected and analyzed using SPSS software. The study established that among the standard practices used in measuring performance Critical Path method was the most commonly used. This means that emphasis should be put to understanding the effect of this method to performance of projects. It was further established that barriers that hinder the effective application of Earned Value Management Technique were as follows in descending significance, with the use of construction equipment having a significance level of 84.3%, followed by level of technology at 78.2%, labour ratesat 20.9%, and material prices at 19.7%; and based on these findings a performance monitoring tool for construction projects was developed as $Y = -5.698 + 0.197LR + 0.181MP + 0.036CE + 0.009LT$. The study thus concluded that EVM techniques are less commonly used and less known than Critical path method and PERT method for measuring performance of construction projects. The study further concluded that the application of EVM on projects is greatly affected by labour rates, and material prices as indicated in the developed performance monitoring tool. It is envisaged that the developed tool will be useful in monitoring the performance of projects right from inception to completion paying most attention to equipment, technology in used, cost of labour and material costs.

Key Words

Earned Value Management, technique, Construction Projects, Performance Measurement, Kampala city.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Projects are executed within the constraints of time, budget and quality and a project manager should exercise strict monitoring and control to ensure project delivery within these constraints. Project monitoring deals with measuring performance of project at certain time interval and reports that performance to the organization for process control. Thus, monitoring and controlling is a persistent process throughout the entire duration of project. Uganda spends between 20 to 35% of her annual budget on infrastructure, for example, Uganda allocated 35% of her 2019/20 annual budget to infrastructure. Most of the infrastructure development projects are developed against a backdrop of urgent need with pressure to deliver.

A common attribute of infrastructure projects is that they often address needs rather than opportunities and as such are executed with beneficiaries and other stakeholders already waiting and demanding delivery. Service delivery protests attest to this, and on-time delivery is therefore a high priority. Project control tools and their effective use are key to delivering projects within the triple constraints of cost, time, and quality (Al-Jibouri, 2013; Vandevoorde and Vanhoucke, 2006).

The performance of a construction project can be judged by using different traditional approaches like day to day monitoring, monthly or weekly management reports, performance reviews, key performance indicators and project audit reports. In these

traditional approaches, usually there are two data sources, the budget (or planned) expenditures and the actual expenditures. The comparison of budget versus actual expenditures merely indicates what was planned to be spent versus what was actually spent at any given time Mohd et al., (2011). Accordingly, this approach does not count for the value of work accomplished thus ignoring a third dimension: the earned value (EV) of work (Fleming and Koppelman, 2013).

Cost performance on the project is determined by comparing EV to actual cost (AC). AC represents what has actually been spent and accrued to do the work so far, and EV represents what was planned to be spent to do the work so far. The difference shows whether the project is over spent or under spent. Schedule performance is determined by comparing the EV to the planned value (PV). PV shows the amount of work that was planned to have been done and EV represents the amount that has been done.

Earned Value Management (EVM) originated late in the 1960s as a financial management tool to control defense acquisition projects. Project control specifications were defined by the US Department of Defense (DoD) to correct projects' deviations through cost and schedule accounting and reporting. During the 1980s the methodology emerged as a project management tool and was available also to other industries across the USA. In 2012, the Project Management Institute (PMI) established its first College of Performance Management, today the premier professional organization for EVM research and project planning and control, and included the methodology in its standards (PMI, 2008). Consequently, the technique got across other countries and many industries.

In the late 1980s and early 1990s, EVM emerged as a project management methodology to be understood and used by managers and executives, not just the EVM specialists. By 1989, EVM leadership was elevated as an essential element of program management and procurement. In 1991, some defense projects and programs were cancelled because of performance problems detected by EVM (Marshall, 2006). This demonstrated how EVM mattered to successful projects, programmes and portfolios.

EVM was originally developed for cost management and has not widely been used for forecasting project duration. However, recent research trends show an increase of interest to use performance indicators for predicting total project duration. It is extremely natural to think project schedule performance in terms of time rather than cost. Earned value measures performance of project in terms of cost. In addition, EVM method truthfully follows for project that finishes on time. Unfortunately, its schedule indicator loses its predicting ability for late finish projects especially at final third of the project. EVM shows schedule variance equal to zero and schedule performance index equal to unity even when project finishes unacceptably late (Fleming and Koppelman, 2010).

Various researchers have found knowledge and understanding to be a barrier to EVM implementation (Kim et al., 2003; Pillary et al., 2013). In fact, the factors established by these researchers point to problems in the project environment, such as project maturity and readiness, rather than the technical applicability of EVM. According to Vanhoucke (2012), there are three key parameters of EVM required in order to measure project performance namely planned value (PV), actual cost (AC) and earned

value (EV). Chen (2008) stated that the key parameters of EVM need to be in the same unit. It can be measured in either US dollar ($) or work hour (time) (Pratt, 2006 & Chen, 2008).

EVM as compared to the traditional project management analysis enhances the cost performance analysis of a project (Raby, 2000). It uses uniform unit to measure the project performance and allows the comparison among different work scopes consistently. Anbari (2013) specified that EVM can be applied to make progress payment to the contractor through the EV of contracted or outsourced work. EVM also provides precise and concurrent analysis on both time and cost performance of a construction project (Assaf and Al-Hejji, 2006). The utilization of EVM in project management was proven to be a reliable forecasting tool on the project duration after it was applied on real-life projects (Kim et al., 2003; Vandevoorde and Vanhoucke, 2006). A research made by Marshall et al., 2008 also confirmed the ability of EVM in forecasting project progress.

Indicators are essential management tools in monitoring and evaluating project activities, as they allow the achievement of goals to be monitored as well as advances and improvements in quality to be identified. To monitor the project is to compare the current with the planned situation, determining if the costs and the schedule are progressing according to plan, in order to take corrective action when needed (De Marco and Timur, 2013). The performance indicator in engineering projects is particularly important because it allows problems that may occur during the course of the project to be foreseen, enabling adjustments and corrections, as well as avoiding

deviations from the plan. EVM is a powerful tool in managing scope, time and costs, allowing scheduled performance indices and costs to be achieved (Anbari, 2013). Alternately, the Earned Value Management Technique (EVM) emerged. Developed by the US Defense Department, this technique is widely used as tool of control and it is indicated by the Project Management Institute (PMI) as a standard tool for project performance measurement. The PMI provides an historic view on the evolution of this technique departing from the initial efforts with Program Evaluation and Review Technique/Cost (PERT/COST) developed between 1962 and 1965; and Cost Schedule Planning and Control Specification (CSCS) in 1967and 1996. Major advances are the integration of planning, control and definition of project scopes into a single tool (Fleming and Koppelman, 2008).

EVM is a powerful quantitative technique for measuring actual work performance and associated cost and time versus an agreed plan (PMI, 2005). The earned value analysis gives early indications of project performance to highlight the need for eventual corrective action. Any project with considerable cost overrun and schedule delay typically gets in trouble at its beginning, and unfortunately, project managers do not realize this problem until late in the project when their ability to recover the project to achieve its planned objectives diminishes (Assaf and Al-Hejji, 2006). According to the PMI (2005), EVM has proven itself to be one of the most effective performance measurement and feedback tools for managing projects and enabling managers to close the loop in the plan-do check-act project management cycle. The primary purpose of managing a construction project is to complete it on time and within the budget while conforming established requirements and specifications (Pewdum et. al., 2009). To

achieve this objective, substantial effort on managing the construction process must be provided and could not be done without an effective performance monitoring system. Performance measurement is a basic requirement for tracking cost, time, and quality of a construction project (Yang et. al., 2010).

EVM focuses on forecasting final costs and project duration, what is deemed crucial to alert managers and enforce their reaction to overcome delays and costs overruns. It addresses value from the perspective of the developer or building company, only indirectly generating views of final value that are of interest for final data clients. The uniqueness of the method is that it provides accurate cost performance and progress measurement for project monitoring and control (Demarco, 2013). However, research in many developing countries, Uganda inclusive indicates that work programs, reports, project budget and inspection of works, among others, are the techniques used to manage project cost.

Despite of the existence of knowledge on EVM that can be gathered from literature elsewhere, there is scanty information that has been documented about EVM practices in the implementation of construction projects in the Uganda construction industry. Therefore, this study assessed the application of earned value management technique in enhancing performance of construction projects in Uganda.

1.2 Statement of the Problem

The inability to complete construction projects on time and within budget continues to be a chronic problem and is worsening worldwide and that it is more severe in developing countries (Uganda National Association of Building and Civil Engineering Contractors (UNABCEC, 2019). The delays and cost overruns in Uganda are attributed to poor project management, inaccurate estimation, inappropriate construction methods and delayed payments (Muhwezi et al., 2014).

There is strong evidence of inconsistent performance of Ugandan construction projects both by international firms and local construction contractors (LCC) and the trend is growing rapidly (UNABCEC, 2019). Projects are reportedly failing across all the key performance measures of cost, time and quality and the dramatic shift in the capacity and volume of the Ugandan construction sector over the last decade warrants a systematic analysis of an appropriate performance measurement technique within the industry. For instance, it took 56 months to complete Mapeera House on Kampala road instead of the original 13 months, representing a total delay period of 43 months (tripling the construction period); the church house project in Bukoto next to traffic light junction was expected to be completed within 18 months from the date of commencement of works (April 2011), but the works took over 36months to be completed.

These time overruns are accompanied with extra costs to clients which trend must be averted. If this problem is not addressed, the project beneficiaries shall continue to be deprived of the benefits that accrue from timely completion of the projects and

sometimes there could be complete abandonment of important projects which restrains the economic growth and failure in realizing the intended benefits of the country. The purpose of this study, therefore, was to assess the applicability of Earned Value Management (EVM) as a technique to enhance the performance of building construction projects in Uganda.

1.3 Research Objectives

1.3.1 Main objective of the Study

The main objective of the study was to assess the applicability of EVM Technique in enhancing the performance of building construction projects in Uganda.

1.3.2 Specific objectives

The specific objectives of the study were to:

i. Establish the standard practices of EVM Technique in measuring performance of construction projects in Uganda;
ii. Establish the barriers that hinder effective application of EVM in enhancing performance of construction projects in Uganda and;
iii. To develop an effective performance monitoring tool for construction projects.

1.4 Research Questions

Guiding research questions included:

i. What are the standard practices of EVM Technique in measuring performance of a construction projects in Uganda?

ii. What are the barriers to effective application of EVM technique in enhancing performance of construction projects in Uganda?

iii. What can be done to effectively apply earned value management (EVM) technique in enhancing performance of construction projects in Uganda?

1.5 Scope of the study

1.5.1 Content Scope

The study focused on EVM technique as the independent variable and project performance as the dependent variable. The independent variables included: Cost Performance Index, Cost variance, Schedule Variance, Schedule Performance Index and the Critical Ratio; barriers hindering application of EVM technique; while the dependent variable (performance of construction projects) was based on four major indicators which included: timely delivery, cost and quality of work and customer satisfaction. The barriers that hinder effective application of EVM were used to develop a tool to enhance performance of construction projects in Uganda.

The study examined projects executed between 2010 and 2016 because during this period, Kampala City experienced major developments in the building construction sector where some projects were completed while others were unsuccessful up to date, which has caused great loss to the private clients and the government at large.

1.5.2 Geographical Scope

The study was carried out within Kampala Capital City Authority and focused mainly on construction projects. Kampala City was selected as study area because it is one of

the fastest growing cities with a high level of infrastructure development including buildings and roads that connect to different parts of the country.

1.5.3 Time Scope

The study was conducted within one academic year from September 2018 to June 2019.

1.6 Significance of the Study

This information will be useful to academicians and researchers for carrying out further research in the area of building construction project performance. The information will also help the construction parties, policy makers, Government and all other stakeholders who could use the findings to make improvement within the industry and also make appropriate and timely decisions.

1.7 Justification of the study

Cost and schedule overruns are one of the most common problems faced during project execution and if this problem is not addressed, it may lead to project delays, cash flow problems. In order to solve these problems, a substantial effort on managing the construction process must be provided and could not be done without an effective performance monitoring tool.

1.8 Conceptual Framework

This is a scheme of variables which indicates the relationships among the research variables in order to achieve the set objectives. Figure 1.1 illustrates the relationship between these variables.

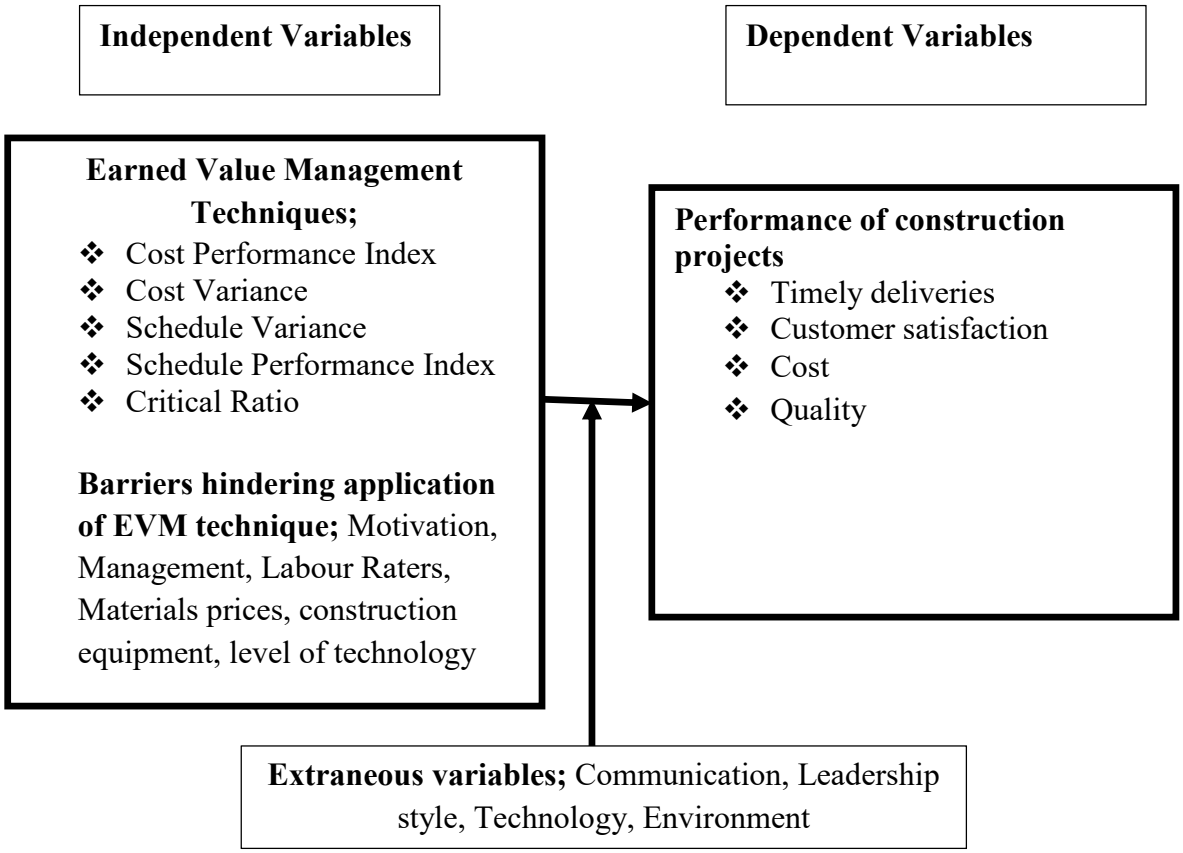

Figure 1. 1: Conceptual framework for the study

The study focused on three dimensions of Earned Value Management (Cost performance index, Schedule performance index and critical ratio) as independent variables and performance of projects (quality, cost, customer satisfaction and time factors) as dependent variable. Variables within each group are interrelated and intra-related. A variable in one group can influence a variable in the others, and vice versa.

1.9 Operational Definitions

EVM: This is a technique to control the time and cost performance of a project and to predict the final project duration and cost.

Construction: this is the process of constructing infrastructure which includes buildings, roads and bridges.

Project: Planned set of interrelated tasks to be executed over a fixed period and within certain cost and other limitations.

Performance: is the measure of the building project in terms of time, cost and quality.

Critical Ratio (CR): This indicator combines both the cost performance index (CPI) and schedule performance index (SPI) to represent the **project** status.

S**chedule Performance Index** (**SPI**): is a measure of how close the project is to being completed compared to the **schedule**. As a ratio it is calculated by dividing the budgeted cost of work performed, or earned value, by the planned value.

C**ost Performance Index** (**CPI**): is a measure of the financial effectiveness and efficiency of a project. It represents the amount of completed work for every unit of **cost** spent. As a ratio it is calculated by dividing the budgeted **cost** of work completed, or earned value, by the actual **cost** of the work performed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents review of relevant literature on the applicability of EVM technique on measuring the performance of construction projects. The Chapter focuses on the manner in which the concept of EVM technique has been applied into project management. This chapter is sequentially arranged from the Theoretical review, Conceptual review, EVM Performance analysis and Forecasting, an outline of knowledge gaps addressed by this study and finally synthesis of the literature review.

2.2 Theoretical Framework

A theory is a system that explains phenomena by stating constructs and the laws that interrelate these constructs to each other (Koke, 2019). The research was conducted basing on the theory of Goal setting which was proposed by Edwin Locke in 1968, with focus on the area of performance measurement. Goal refers to future valued outcomes (Locke & Latham 2006). While measuring performance, according to the theory of Goal Setting, there are five basic principles that allow goal setting to perform better. These include: clarity, challenge, commitment, feedback, and task complexity (Locke & Latham, 2006).

Clarity refers to a clear and measureable goal that can be achieved within specific timeline and within goal setting. In case of the construction industry, the charity is the CPI which is the ratio of the value of the work achieved to date, to the actual cost of

achieving those results. The CPI identifies the work efficiency to date. Challenge refers to the goals being able to achieve decent level of difficulty, motivating the individual and organization to strive for positive goal achievements. In the construction of infrastructures, this is related to Schedule variance which compares the value of the work achieved to date with the planned value of achieving those results (Gower, 2007).

Feedback provides information on the progress towards achieving goals. In building projects, this relates to the Schedule Performance Index (SPI) which is the ratio of the value of the work achieved to date, to the actual cost of achieving those results. SPI identifies the time efficiency to date. Task complexity makes the achieving of goals easier by laying down process and steps. In building projects, the critical ratio is a performance factor that act as an indicator to predict cost at completion. According to this theory, goal setting can be applied in all places where effective results are desired through efficient goal setting (Williams, 2008).

2.3 Project Management

Project Management Book of Knowledge (PMBOK (2018:168)) addresses EVM on Project Cost Management. The section on Cost Control identifies five tools and techniques: Cost Change Control System, Performance Measurement Analysis, Forecasting, Project Performance Reviews, Project Management Software; and Variance Management. Since all of those techniques are directly or indirectly related to earned value methods, PMBOK actually devotes nearly 19 of its 21 Cost Control pages to EVM.

2.3.1 Construction Project Management

According to Gower (2014), the purpose of project management is to "foresee or predict as many of the dangers and problems as possible and to plan, organize and control activities so that projects are completed successfully in spite of all the risks". This need plan early before resources committed there is need of organization to have management technique, and the process must continue until all work is finished. Earned value management technique to an organization may be able to help the organization. Kerzner (2017), state that "the project manager must control company project resources within time, cost, and performance and Most companies have six resources those are Money, Manpower, Equipment, Facilities, Materials and technology". Lester A (2017) argues that the role of the project manager is to help the team get the work completed.

2.3.2 Construction Project Management Process

According to PMBOK (2018); Williams (2018) and Bower, (2015), in order to meet the requirement of the project, project management process is accomplished through the following sequential and intergraded project phases: Initiating, Planning, Executing, Monitoring and controlling and Close out. The project manager's role is to deliver the project while balancing the requirement of the project scope schedule and budget (PMBOK, 2018).

2.3.3 The Trend of Construction Project Management

Projects and project management are not new concepts. The whole time history, the records of projects of different magnitudes have been creatively undertaken on generations. Projects Management earliest time to 1900 were generally managed by

the creative architects and engineers themselves. There was no standard professional for project management, people study by working practices at site, the job done with only commonsense (Gower, 2014). However there are few skilled and generous persons like French Engineer Henry Fayol (1841 – 1925), who observed that every manager can perform on five management functions: planning, organizing, commanding, coordinating and controlling.

The second, flight pilot Henry Gantt was an American engineer, who is famous for developing the Gantt chart and still in use today as tool in a project manager's toolkit (Seymour and Hussein, 2014). Flow line scheduling in the 1930s was used to schedule the construction of the Empire State Building in record time. In 1956, Kelly and Walker developed "Activity-on-Arrow ", a method of critical path scheduling. In 1957-1958, the US air force developed CPM/PERT, both focuses to deliver the project on time and cost, time as the key variable, and in 1969, Dr. Martin Barnes (UK) described the 'iron triangle' of time, cost and scope for performance of project (Rahman et. al., 2012).

The major professional bodies were established from 1960 to 1979. First project management Association is Institute of Project Management Associations (IPMA), in 1965, and four years later in 1969 Project Management Institute (PMI) were established which is primarily based in the U.S. now is commonly known as the publisher of The Project Management Body of Knowledge (PMBOK). In 1975 Project, Resource, Organization, Management and Planning Technique (PROMPT) was developed by a British company called Simpact Techniques Ltd. and 1979 PROMPTII

was adopted by the UK Central Computer and Telecommunications Agency (CCTA) (Rahman et. al., 2012). The present day Construction Project management is considered as a separate branch form others industrial like IT. There is wider and welcome acceptance that managing company changes as projects can bring faster and better results and more interest on project risk. Well-regarded professional qualifications awarded by universities, follow the appropriate training and can demonstrate competence (Gower, 2013).

2.4 Issues facing the construction Industry

Olden times show the construction projects were performed by slaves, unlike the cost of the current and future construction projects that are faced with several challenges (Muir, 2012). One of the factors make project failure is “the project sponsor dictate the project manager” to finish the project by certain time, budget and get a magnitude of scope while achieving a specified performance level (Lester, 2012). Other issues are: clarity of the project objectives and stake holder agreement, complexity of the project, technological, legal issues, political pressures and government regulation and cultural, ecological (Lester, 2012).

2.5 Construction Performance Measurement using Earned Value Management Technique

Kerzner (2013) recognizes the value of EVM as a risk monitoring tool and acknowledges its importance in determining if risk handling actions are achieving their forecasted results. EVM allows the performance and progress of a project to be assessed at a single point in time, usually repeated on a regular basis such as weekly

or monthly. Projects are composed of many activities with differing durations and start times. Therefore, at any point during the project some activities have been completed, some are underway, and some have not been commenced. The only possible exception arises when a project is divided into separate phases that do not overlap and the point of EV assessment happens to coincide with the period of inactivity between those phases. At that instant, it would be possible for no activities or work to be in progress. Earned value project management is a well-known management system that integrates cost, schedule and technical performance. It allows the calculation of cost and schedule variances and performance indices and forecasts the project cost and schedule duration. The Earned Value concept was conceived by industrial engineers working in American factories over a century ago. This concept improved by the time and in July 1998, the Earned Value Management System became the American National Standards Institute (ANSI/EIA) Standard (Naderpour, 2011).

2.5.1 Key Parameters of Earned Value Management

PMI (2018) classifies EVM terminology into two categories: (i) key parameters of EVM, including Planned Value (PV), Earned Value (EV) and Actual Cost (AC), and (ii) EVM measures (variances, indices and forecasts). Both *Planned Value* and *Actual Cost* dimensions will apply to nearly all construction projects. The only dimension that is sometimes unknown is *Earned Value* in construction, especially on lump-sum or fixed price jobs.

2.5.1.1 Planned Value (PV)

According to the PMBOK Guide, "**Planned Value** (PV) is the authorized budget assigned to work to be accomplished for an activity or WBS component." This is

calculated before actually doing the work; it also serves as a baseline. The total **Planned Value** for the project is known as Budget at Completion (BAC). It is a budget baseline that has been established for a project/work package/activity. It is a function of cost and time as can be seen in Figure 2.1 (S-curve). PV baseline can be used to view the value to be earned at a certain time/phase in the project. PV is frequently referred to as the S curve simply because of the shape of the curve.

2.5.1.2 Planned and Earned Values

In project management, the concepts of planned value and earned value are used to make comparisons between budgeted items and a list of known work items, planned schedule and performance progress. As work progresses according to plan, measuring progress against planned schedule is conducted to determine the performance of the project.

2.5.1.3 Deriving Planned Value

Planned value provides a way to represent the value of a project that is planned to be delivered measured over time. It can be calculated if a project has a budget and a schedule of work activities. The starting point for the calculation is the list of activities that make up the delivery plan, often referred to as the **work breakdown structure (WBS)**. During the project planning stage the effort involved in delivering each of the WBS activities will be estimated and will also be placed into an expected delivery schedule.

Since the level of effort has been estimated for each of the WBS items, a percentage of the overall effort can also be allocated to each of the individual items in the plan.

Then, by stepping through the schedule and accumulating the individual percentages associated with each item planned for completion, we can derive the total planned percent complete that should be delivered at any scheduled date. It is a simple matter to tie this percentage to the overall budget for the project on any schedule date (Fahad M, 2020). The Earned Value parameters are as seen in Table 2.1.

Table 2. 1: Earned Value Key Parameters

Parameter	Description
Planned Value (PV)	It is a budget baseline that has been established for a project/work package/activity. It is a function of cost and time as can be seen in figure 2. (S-curve). PV baseline can be used to view the value to be earned at a certain time/phase in the project. PV is frequently referred to as the S curve simply because of the shape of the curve.
Actual Cost (AC)	This is the cumulative actual cost that has been spent on a project/work package/activity.
Earned value (EV)	This is the cumulative value that has been earned for the work completed at a certain point in time. **Formula:** *Earned value(EV)=total budget for activity x completed proportion*
Budget at completion (BAC)	BAC is the final point and the highest value of the cumulative Planned value curve. BAC represents the total budget for the project/work package/activity.

Source: (Fleming and Koppelman, 2010)

2.5.2 Variance and Indices as Project Performance Indicators

EVM makes use of a combination of key parameters such as variances and indices that measure the performance of a project at any given time as summarized in Table 2.2.

Table 2. 2: Earned Value Management Variances

Earned Value Variances	Description	Formula	Result
Cost Variance (CV)	The difference between the amount budgeted and the amount that was actually spent on the work performed. CV shows whether and by how much amount the project is over or under pre-approved budget.	= Earned Value (EV) - Actual Cost (AC)	> 0 means under budget < 0 means over budget
Schedule Variance (SV)	The difference between the amount budgeted and the amount that was planned for the project. SV is a good indicator to show if and by how much your work is behind or ahead of pre-approved schedule.	= Earned Value (EV) - Planned Value (PV)	> 0 means ahead of schedule < 0 means behind schedule

Source: (Fleming and Koppelman, 2010)

2.5.2.1 Earned Value Management Indices

To make a forecast of the future state of any project, a simplified assumption is made: the *cost performance (CPI)* and the *Schedule Performance (SPI)* are assumed to be a representative indicator for the actual future performance of the project (Fleming and Koppelman, 2008). Schedule Performance Index (SPI=EV/PV) represents the rhythm of production, i.e, the rate of converting planned cost into earned value. It provides the same information as SV, but now in relative terms. It varies around 1: SPI greater than one indicates that time performance is better than expected as indicated in Table 2.3. Sources of inaccuracy for this index are the same as discussed for SV. Cost Performance Index (CPI=EV/AC) represents how efficiently resources are being used. CPI represents the rate of converting AC in EV (PMI, 2005; Fleming and Koppelman,

2008). A CPI smaller than 1 indicates that the project is heading to a cost overrun, since what has been achieved do not correspond to what has been estimated, for the same set of activities. The only explanation is that costs are increasing in comparison with what has been estimated, or as before for CV, activities whose costs are added up to comprise EV were overestimated in the initial budget.

Table 2. 3: Earned Value Management Indices

Earned Value Indices	Description	Formula	Result
Cost Performance Index (CPI)	The ratio of approved budget for work performed (EV) to what was actually spent on the work (AC). CPI reflect the relative value of the work that has been completed to the amount paid for the task. CPI is often referred to as the *Cost efficiency* of a project. **Additional note:** According to Fleming and Koppelman, CPI is one of the two most useful EVM metrics, the reason for that is according to a study of 155 actual contracts showed that at the 20% point of project completion, the final projected results from CPI would only change by +/- 10%. This proves that CPI is an excellent to accurately determine requirements for final performance, in order to meet financial goals (Fleming and Koppelman, 2008).	= EV/AC	> 1 means better progress for the money spent < 1 means less progress for the money spent
Schedule Performance Index (SPI)	The ratio of approved budget for work performed to the actual approved budget for work performed (EV) to what was budgeted for the project (PV). SPI is useful since it reveals if the project is behind	= EV/PV	> 1 means more work performed than had been scheduled < 1 means less work

	or ahead of schedule (Fleming and Koppelman, 2008).		performed than had been scheduled
Project Percent Complete	Percent of project work complete at a given time. *Remember BAC = Budget at Completion*	= (EV/BAC) * 100	
To Complete Performance Index (TCPI)	The cost performance index required to complete the project on the predetermined budget or the required future cost efficiency that is needed to achieve the target Budget at completion (BAC).	=(BAC-EV)/(BAC-AC)	

Source: (Fleming and Koppelman, 2010)

2.5.2.2 Earned Value Management Graph

- The parameters discussed in previous section can be seen in a visual representation in Figure 2.1. It can be useful to have the numbers translated into something visual for a more simple understanding of the status of the ongoing project. Most of the necessary information can be found in the graph and visually it can be seen in the figure that: the **Actual Cost(AC)** of the project is above the predetermined **Planned Value (PV)** that had been established;
- The **Earned Value(EV)** of work completed is lower than the Planned Value;
- By comparing the gaps between the **Actual Cost** and **Earned value** the **Cost Variance** of the project can be found. According to this figure the project is above the pre-approved budget;
- By comparing the gaps between the **Planned Value** and **Earned value** the **Schedule Variance** of the project can be found. According to this figure the project is behind schedule.

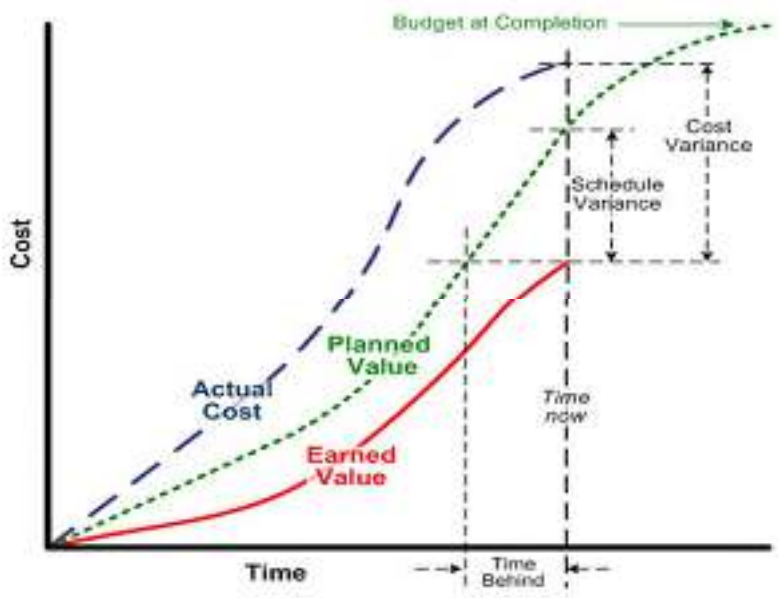

Figure 2. 1: S-Curve graph (PMI, 2015)

2.5.2.3 EVM Performance analysis and Forecasting

EVM relies on three key variables which represent fundamentals of its analysis: budgeted cost of work scheduled (BCWS), budgeted cost of work performed (BCWP), which is also referred to as EV, and actual cost of work performed (ACWP). The fourth data point is the budget at completion (BAC): it represents the total BCWS for the project. The four data points are used for deriving variances of actual versus budgeted performance and associated indices, and for forecasting a project's cost and time at completion. The PMB is the standard against which the project actual cost (ACWP) and progress (BCWP) is compared from start to finish.

The key practice of EVM includes two steps: first, establishing a performance measurement baseline (PMB) and, second, measuring and analyzing a project's performance against the PMB. Steps to effectively build a PMB includes

decomposition of work scope to a manageable level, assigning responsibilities, developing a time-phased budget for each work task, and maintaining PMB integrity throughout the project. Performance measurement and analysis comprises recording resource usage during the project execution, objectively measuring the actual physical work progress, analyzing and forecasting cost/schedule performance, reporting performance problems, and taking corrective actions (PMI, 2011).

Performance management works best when the physical progress of work is objectively planned and measured. The techniques used in EVM to achieve this goal are Earned Value measurement techniques (sometimes called earning and crediting methods) (PMI, 2005). The difference between a PMB and the actual status is measured by using two variances revised continuously throughout the project life. The variances give precise monetary values of positive or negative status and represent the difference between the current status of the project and its baseline, in monetary terms (Pieter & Tim, 2010).

Despite a vast methodological literature, few studies have been conducted to investigate the EVM practices in implementation of construction projects in Uganda. An overview of all EVM key parameters, performance measures and forecasting indicators can be summarized in Figure 2.2.

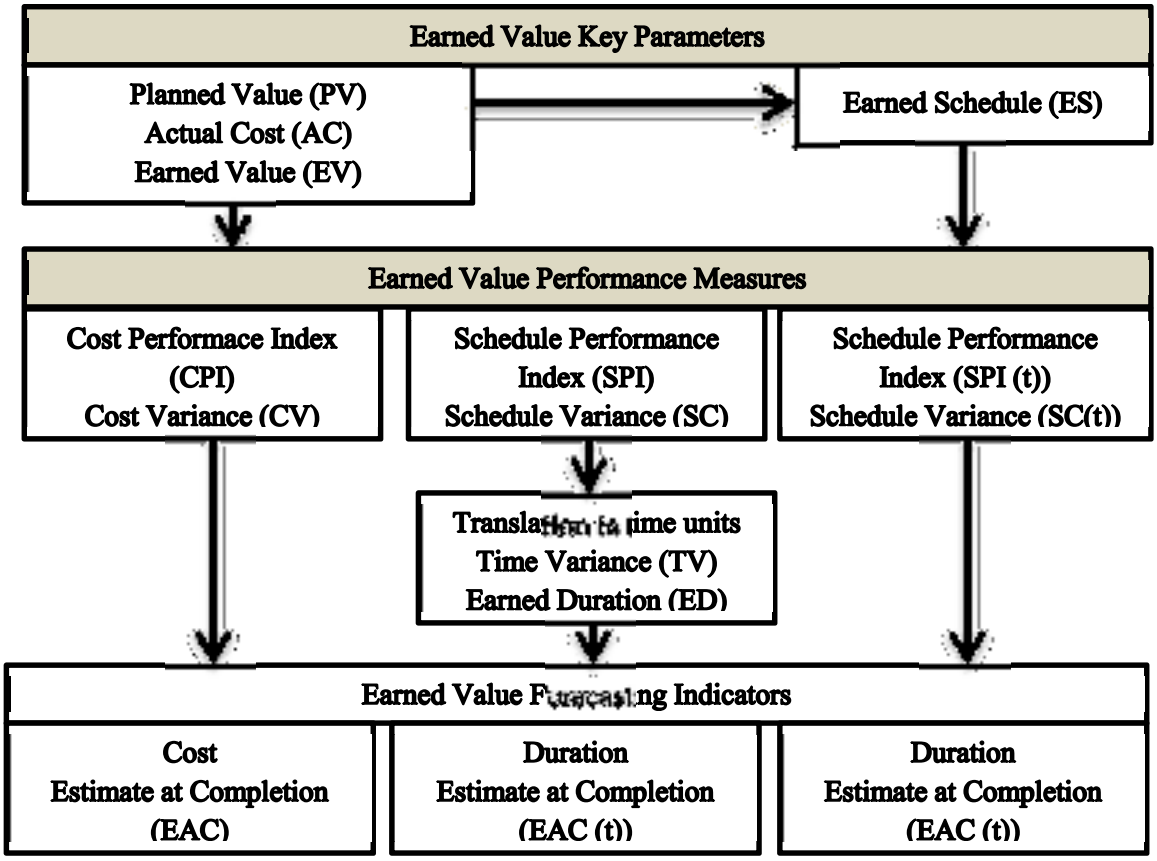

Figure 2. 2: Overview EVM metrics
Source: Vanhoucke, (2010)

2.5.3 Cost forecasting

Here the focus lies on predicting the final cost of the project. This final cost will be referred to as the Estimate at Completion (EAC). The EAC consists of the Actual Cost (AC), the cost that has been spent so far and an estimate of the cost of the remaining work (Estimate to Completion, ETC). In some literature, ETC is also referred to as Planned Cost of Work Remaining (PCWR) (Pieter and Tim, 2010). It can be calculated as follows:

$$ETC = \frac{(\mathrm{BAC}-\mathrm{EVE})}{Performance\ Factor} \quad \text{..... (Equation 2.1)}$$

Several different formulae exist to calculate the EAC, depending on the performance factor that is used to calculate the ETC. In general, eight commonly used forecasting formulae are accepted by project managers as indicated in Table 2.4.

Table 2. 4: EAC Formulae

$EAC_1 = AC + (BAC - EV)$	$EAC_5 = AC + \frac{BAC - EV}{CR}$
$EAC_2 = AC + \frac{BAC - EV}{CPI}$	$EAC_6 = AC + \frac{BAC - EV}{CR(t)}$
$EAC_3 = AC + \frac{BAC - EV}{SPI}$	$EAC_7 = AC + \frac{BAC - EV}{wt1 * SPI + wt2 * CPI}$
$EAC_3 = AC + \frac{BAC - EV}{SPI(t)}$	$EAC_7 = AC + \frac{BAC - EV}{wt1 * SPI(t) + wt2 * CPI}$

EAC_1 assumes a discount factor that is equal to one. This means that to estimate the remaining cost of the project, no project performance measure is taken into account. The remaining cost is assumed to equal the planned cost for the remaining work. The most commonly used formula for cost forecasting is EAC_2. In this formula the CPI is used as a discount factor for estimating the Remaining cost. EAC_3 and EAC_4 on the other hand are used in cases where the duration has a huge impact on the final cost of the project (Pieter and Tim, 2010).

2.5.4 Duration forecasting

EVM has also been used for more than forty years to predict the final duration of projects. This is done analogue to forecasting the EAC. The oldest method calculated the Independent Estimate At Completion (IEAC (t)). This estimate exists of the time that has already elapsed (Actual Time, AT) and the duration of what the remaining

work is estimated to take (Estimate To Complete, ETC (t)). The time that is expected to complete the project is calculated by adjusting the work remaining (Estimate To Complete, ETC) for the work rate that is expected on the remaining of the project. ETC (t) is also referred to as Planned Duration of Work Remaining (PDWR) and can be calculated as follows:

$$ETC_{(t)} = \frac{(\mathrm{BAC}-\mathrm{EVE})}{Work\ Rate} \quad \text{(Equation 2.2)}$$

2.6 EVM Application

2.6.1 Applicability of EVM Technique in measuring performance of construction projects

Many studies about the applicability of the Earned Value Analysis have been made. Thamhain, (2012) evaluated the popularity of different practices of project management. Surveys were made with 400 professionals who work with projects (managers, directors, people in charge) in 180 projects in Fortune-1000 companies. They were asked about the popularity and value of different techniques of performance evaluation. As a result, he could see that the Earned Value Analysis is used by 41% of people who work with projects. It is more used than critical path method, QFD (quality function deployment) and Crashing, among others. The Earned Value Analysis is almost as popular as the net PERT/CPM.

Christensen (2012) states, in his studies about the applicability of Added Value in governing organizations in the United States, that the implementation of Earned Value requires a cultural change, which demands time and effort. This means to make sure that policies and knowledge are taught by the organization and by the project in order

to quicken the work of the ones involved. The Earned Value Analysis enables a supplementary value to the project because it offers a premature visibility of its results, in other words, it is possible to determine a tendency of costs and deadlines of the project in a certain phase of it, when there is still a possibility of implementation of corrective actions (Thamhain, 2012).

From opposite points of view, we may imply that the Earned Value management is a set of powerful intrinsic approaches, wide and varied, like payment method and forecasting. However, it is bound to find great difficulty in either data collection or in the low speed of information generation. Terrel et. al., (2008) state that, in order to make the Earned Value Management effectively implemented, it is necessary to have the information about the resources clearly defined. A failure in obtaining these data, motivate the creation of inaccurate performance measurement baseline (PMB), distant from the real scenario.

Maunsell AECOM the Project Manager (PM) for Hong Kong Science Park Phase 2 Development, proposed the use of EVM Technique as a tool for project performance monitoring and control. Following a series of presentations and briefings by the PM to the client, the Hong Kong Science and Technology Parks Corporation, it was agreed that EVM Technique will be used as a project management tool. It was proposed that in order to set-up the EVM Technique, an Integrated Programme (IP) comprising all aspects of the project was required. The PM was entrusted with the responsibility of setting up and maintaining the IP.

The IP is a collection of individual project level programmes under a Project Group. It became apparent that a formal guideline was essential for the preparation of the project level programmes as various parties were responsible for the preparation of the programmes for their respective scope of works. Therefore, a guideline known as the Protocol for Integration of Programmes was developed by the PM which all parties were required to follow in preparing their own programmes. It was decided that Primavera Project Planner (P3) would be used in preparing all programmes as it has the capability of integrating project programmes to form an IP and also able to handle time and cost data. The necessary clauses were written into the agreements of the Lead Consultant, the Quantity Surveyor and the contract documents of all the works contracts to comply with the Protocol for Integration of Programmes in preparing their programmes.

The Protocol for Integration of Programmes mainly covered the Work Breakdown Structure (WBS), guidelines for the preparation of individual project programmes, the incorporation of project cost information within the project programmes, the procedure for the integration of project programmes and the updating of project progress and cost data. The development of the WBS is considered as the cornerstone of effective project planning, execution, controlling and reporting (US DOE, 2003).

Since EVM Technique is used to report the progress and cost status of the project to the client, it is important that ACWP reflects the cost to the client rather than the cost incurred by the consultants or the contractors. Therefore, ACWP was defined as the total cost of payments that have been certified at any given time. In the case of the

works contracts, it is the total amount of works that the Quantity Surveyor has certified. In the case of the consultancies, it is the total amount certified by the PM. For other payments that are directly handled by the client, the ACWP was defined as the total amount issued for payment by the client (Dissanayake, 2007).

On the contrary, West and Mcelroy (2010) agree that the Earned Value Analysis is an adequate tool for the generation of reports of work done, and not a managerial tool, since the control in real time of the project, using all parameters of analysis becomes unviable: “the Earned Value Analysis shows to the project team the performance obtained until then, and not the future forecast of the project.” Wideman (2012) supports that the technique is conceptually attractive, however it requires great efforts in its maintenance, therefore it needs a qualified team to understand and provide reliable information. He also states that many project managers don’t consider the analysis an appropriate cost-benefit ratio.

To facilitate the measurement of BCWP, it was necessary to develop a systematic method of breaking down the cost and to assign the cost to the specific activities within each project programme. In the case of consultancies, the schedule of fees was the basis for distributing the consultant's fees among the activities. In the case of works contracts, the contractors were required to propose the breakdown of the cost of works based on the bill of quantities and to assign cost figures to a reasonable number of activities within their works programmes (Dissanayake, 2007).

2.6.2 Possible barriers, benefits and standard practices of EVM Technique in measuring Performance of a construction projects

2.6.2.1 Barriers to application of EVM techniques

Fleming & Koppelman (2009) found that difficulty in applying EVM is about an adequate work Breakdown structure (WBS). If the work is subdivided in small packages of work, it will represent a high cost of control and a lot of paperwork. On the other hand, a badly stratified subdivision may represent an inaccuracy of data, concerning real costs and deadlines. This confirmation may be proved in the low application of the Earned Value Analysis in technology and marketing areas, where the creative work is the variant in a scope previously defined, making its application limited and directly related to the stability of a defined scope, according to Collin and Martens (2015). They state that, the more short-term projects grow, with reduced team and a generically defined scope, the more the Earned Value Analysis, according to Instruction 5000 2R (DOD, 1997) and by ANSI/EIA 748, is not viable, due to inaccurate projections, consequence of a badly defined scope and to high costs noticed by the entrepreneurs.

Kerzner (2012) considers EVA a relevant maturity differential in project management. Managing costs using EVA is referred to as “managing with open eyes” because the manager can clearly see what was planned, what was performed and the actual costs. This is a powerful tool in the decision making process. In the day-to-day activities of the project manager, EVA provides “alarm” signals and facilitates decisions that keep the project on time and on budget. Vagas (2014) found that EVM inspires the participants on the project inspires the participants to pay more attention to costs and

progress, motivates the participants to discuss the cost elements with more intensity and optimize the costs resulting in a project that was finished on time and on budget.

2.6.2.2 Benefits of the application of EVM technques

EVM provides more information than normal project tracking. It is a step further by answering the question; Have we got to where we want to be in the project? and When are we going to finish this project? It helps define more accurately as to where we are in the project as well as calculate its successful completion.

The value added approach helps achieve greater visibility and control of the project activities which helps in responding to issues early on, thus making it possible to meet the project timelines. It provides a clear communication of the activities involved and improves project visibility and accountability.

The basic principle of earned value management (EVM) is that the value of the piece of work is equal to the amount of funds budgeted to complete it (Vagas, 2014).

2.6.2.3 Standard practices in the application of EVM techniques

When it comes to using an EVMS, most organizations follow a learning curve. The purpose of this paper is to help organizations flatten the curve, arming them with EVMS best practices. These best practices are broken down into five guideline areas: • EVMS description • EVMS use • Work Breakdown Structure (WBS) and Control Account • Cost and schedule integration • Earned Value calculation.

2.6.3 Construction project performance techniques

The objective of construction planning and controls is a basic project management function, to ensure a well-coordinated and successful project. A basic element of

planning is the set-up of objectives. The objectives will guide the many decisions made during the project's life. These decisions involve trade-offs between schedule, cost, quality, and other performance attributes. Effective monitoring of the progress of construction projects requires the integration and quantification of the various aspects of performance. The traditional performance indicators in the construction industry are completion time, cost, and quality (Mat Saman, 2014). Most current project control systems measure quantitatively cost and schedule status and forget other major aspects of project performance like cash flow, profitability, quality, safety, project team satisfaction, and client satisfaction which are in some cases as important as cost and schedule. Very few project management systems quantify the latter project attributes and they do so independently without proper integration to the overall project performance. The perception of failure and success of projects is usually based on personal indices and the experience of the project manager and it is not uncommon that two project managers would assess the performance of the same project using the same data differently (Rad, 2013). The disparity of judgment is mainly due to the lack of a clear and consistent evaluation procedures and methodology. There are many occasions where the project is under budget and progressing as scheduled. Yet it is considered a failure by upper management because of the low quality and safety performance records. Conversely, a project can be behind schedule and over budget and still be considered a successful one because it was completed with high quality, excellent safety record, and to the satisfaction of the client.

A great deal of effort is normally spent on accurately measuring some performance indices like cost and schedule whereas the evaluation of the overall performance is

carried out in a less structured or subjective manner. The objective of the dissertation was to develop a monitoring tool which construction practitioners can use to assess project performance during the construction phase.

2.6.4 Objectives or Goals

Objectives are essential to the concept of project management (Pinnell, 2016). Objectives or goals provide the project management team a sense of direction by focusing attention on priorities. A structured goal hierarchy for a project:

- Provides an analytical platform for decisions and corrective action plans.
- Provides a clear and direct method of communicating objectives.
- Serves as a basis for project performance evaluation.
- Provides a rationale for the quantification of the overall project performance.

Without objectives it is difficult to measure results and performance against prior expectations and the project leader may not have any idea of whether the project is on the right track or not.

Because project objectives must be consistent with the policies and procedures of the organization, the objective setting process for construction projects is an extensive exercise that involves many functional departments within the contractor's organization. Some of the areas that are usually part of the objective setting process are: operations, quality, safety, cost/schedule control, human resources, and finance. Once the project objectives are set, sub-objectives are defined in order to track the variance in each main objective. This will enable management to monitor progress for any specific project objective during the project's construction.

In addition, executive management needs to support the project objectives and needs to motivate those who will achieve them. This is best accomplished by developing the project objectives at upper management level with input from the various functional areas of the company. This will ensure that the project objectives are in line with the overall company goals. During the execution phase, the project management team should review the performance indicators periodically, analyze any overruns, propose, and implement corrective actions. It is the ultimate responsibility of the project manager to make sure the project objectives are communicated and accomplished.

2.6.5 Communication of Objectives

Setting up a hierarchy of objectives and priorities for a construction project is necessary but not sufficient. The project objectives need to be communicated to all participants through a set of mechanisms. Rowings et. al., (2012) identified two categories of mechanisms: primary and reinforcing. Primary mechanisms are used to directly communicate objectives to project participants and can include items such as:

- Scope of work
- Contract clauses
- Policies and procedures
- Written objectives and priorities.

Primary mechanisms are vital to project success, but alone, would not guarantee the success of a project. Reinforcing mechanisms will maintain focus and will support the communication of objectives and priorities in an indirect manner. These mechanisms give project leaders the opportunity to clarify the objectives. The following are some of the reinforcing mechanisms identified by Rowings et. al., (2012):

- Weekly progress meetings
- Progress reports
- Safety reports
- Project instructions
- Cost and schedule reports
- Toolbox safety talks
- Upper management reviews.

The objectives of the project must be made known to all project personnel and team leaders at every level of the organization (Kerzner, 2012). If the project goals are not timely and accurately communicated, then it is entirely possible that functional managers and project leaders may all have a different understanding of the ultimate project objective, a situation that generates conflict among competing objectives.

2.6.6 Identification of Construction Performance Objectives

Most construction organizations look only at the time and cost parameters. If a schedule slippage or cost overrun occurs, then project managers will identify the cause of the variance. Looking only at time and cost performance might identify immediate contributions to profit, but will not tell whether or not the project itself was managed properly. Construction project success is often measured by the evaluation of three parties: the project team, the construction organization, and the client's organization. The assumption here is that a construction project cannot be considered successful unless it is recognized so by the three groups. This study presents a hierarchy of construction performance objectives that takes into account all success factors as viewed by the major players. The proposed goal hierarchy is systematic, and flexible

enough to handle specific project requirements. The reader should realize that although project procedures can vary from project to project, project policies are usually similar in nature and do not differ between projects. Figure 2.3 depicts a project performance hierarchy that forms the structural foundation for a formal construction performance evaluation system.

Figure 2.3. Hierarchy Design for the Project Performance Model
(Source: Kerzner, 2012)

2.6.7 Normalization for capital project benchmarking

Cost-related absolute metrics measure actual or planned costs to other measures (e.g., physical dimension, capacity, or duration), while relative cost metrics measure the relative difference between planned and actual costs (Dai et al., 2012). In order to reasonably evaluate cost performance through absolute metrics, cost data needs to be normalized from the project location and time to the reference location and time (Hwang et al., 2008). The normalization process enables the costs to be maintained in current dollars at a common location, thereby allowing reasonable comparisons from location to location, and from a particular time to the current year via absolute metrics (Dai et. al., 2012; Hwang et. al., 2010). The existing cost normalization method, which was adapted by the CII pharmaceutical / biotech project benchmarking program, was

designed with three main steps; 1) currency conversion, 2) localization, and 3) time adjustment. This sequence of the three steps was tested and identified to be an optimal way to minimize cost variations resulting from different sequential combinations (Dai et. al., 2012).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was adopted during the study. It describes and discusses the research design and approach, study population, sample size and selection, the data collection methods used and their corresponding data collection instruments. The chapter further presents 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 and Approach

According to Sekaran, (2013), a research design shows the details of the study in relation to purpose of the study, types of investigation, and the extent of research interference, measurement and measures, unit of analysis, sampling design, data collection methods and data analysis, are integral to research design. The study adopted a mixed method approach with both quantitative and qualitative research methods to be able to explain the extent to which EVM is being applied in measuring performance of construction projects. Even though, the domination of one method cannot be avoided, the other was used to perform as a supportive function. The design was basically descriptive, correlative, and analytical in nature. For qualitative data, the study adopted the field research method where the researcher relied on extensive field notes which were subsequently coded and analyzed.

3.3 Study Population

The targeted population of this study was 175 respondents. This population was selected based on their role and contribution to the construction industry. This was arrived at with the assumption that they had the relevant information in relation to the study variables contained within this scope. The population comprised of different professionals as indicated in Table 3.1.

Table 3. 1: Target population

Categories of respondents	**Target Population**
Project Managers from construction firms in Kampala City who had worked with construction projects in Kampala between 2010-2016	40
Architects from (ARB) who had supervised construction projects in Kampala between 2010-2016	40
Engineers from (ERB) who had worked on construction projects in Kampala between 2010-2016	55
Quantity surveyors from (SRB) who had worked on construction projects in Kampala between 2010-2016	40
Total	**175**

3.4 Sample Size Determination

Sampling is the process of selecting a sufficient number of elements from the population, so that a study of the sample and an understanding of its properties or characteristics would make it possible to generalize such properties or characteristics to the population elements (Sekaran, 2013). The study sample comprised of 120 respondents and this was obtained using Krejcie and Morgan (1970) table for sample size determination with a known population as seen in Table 3.2.

Table 3. 2: Sample Size Determination

Category	Targeted number	Sample size
Project managers	40	28
Engineers	55	40
Architects	40	28
Quantity surveyors	40	24
Total	**175**	

3.5 Sampling Techniques and Procedure

Random sampling was used to come up with different construction firms working with buildings and project managers from those construction firms since they are expected to have knowledge on EVM technique and performance of infrastructure projects in Wakiso and Kampala Central. The same sampling technique was used to obtain desired information from other selected respondents who included the Engineers, Architects and Quantity Surveyors in their respective professional bodies, chosen based on the past experience of working on construction projects within Kampala from 2010 to 2016. These key respondents were sampled because they are believed to have technical and specialized knowledge about the topic under investigation by virtue of the offices that they held.

3.6 Data collection Methods

3.6.1 Questionnaire Survey Method

The study used the questionnaire method to collect data. The questionnaire was used to gather responses quantitatively from the Project Managers, Engineers, Architects and Quantity Surveyors. The questionnaire was structured to contain questions that

addressed the variables in the conceptual framework. Such data were deemed to best be tapped using a closed ended questionnaire which allows easy generation of frequencies and percentages as suggested by Amin (2005). Factors that affect implementation of EVM in construction projects were obtained from literature review and later validated with responses to the related questions in the questionnaire.

3.6.2 Interview Method

The study also employed interview method. Interviews in this study helped the researcher to obtain additional information from the project managers, Architects, Engineers and Quantity Surveyors on the topic under investigation. This method offered the researcher an opportunity to draft questions, make clarity by using the appropriate language, clear doubts and establish rapport and probe for more information. The kind of questions involved establishing the background, designation, qualification, and age of the respondents; ascertaining the methods used to measure performance; expertize, opinion, frequency, effectiveness and efficiency of using EVM.

3.6.3 Document Review

The documents as indicated in Chapter Two were to help establish whether EVM was actually being practiced by construction firms and if so, to what extent were these firms knowledgeable about it. The documents were also reviewed, in order to guide in identifying the gaps from where this research picked, to proceed.

3.7 Data Collection Instruments

3.7.1 Self-Administered Questionnaire

The study employed a questionnaire with close ended questions as a tool of data collection. Closed ended questions were developed to help respondents make quick decisions; in addition, closed ended questions were intended to help the researcher to code the information easily for subsequent analysis and narrow down the error gap while analyzing data as recommended by Sekaran (2013). The questionnaires looked at background and designation of the respondents before delving into the technical concerns of the available methods for measuring the performance of construction projects and thereafter considered knowledge, frequency, reasons, effectiveness and efficiency.

3.7.2 Interview Guide

An unstructured interview guide was used as a tool for collecting in-depth information from the key informants. The selection of the interviewees was based on their roles in execution of the projects. The guide had a list of questions which were explored in the course of conducting the interviews. The guide was drawn with the questions soliciting for the perception of the key informants regarding the application of EVM to the measurement of performance within the construction firms in Kampala.

3.8 Validity and Reliability of the Research Instruments

3.8.1 Validity

To ensure validity, the questionnaire was developed and given to three expert professionals to score the relevance of each question in providing answers to the study.

Thereafter, a content validity index C.V.I was computed using equation 3.1; number of items declared valid/number of items in the questionnaire. A CVI of 0.833was obtained which is acceptable according to Amin, (2005).

$$CVI = \frac{Number\ of\ valid\ items}{Number\ of\ total\ items\ in\ the\ questionnaire} \ldots\ldots\ldots\ldots\ldots (Equation\ 3.1)$$

$$CVI = \frac{15}{18} = 0.833$$

3.8.2 Reliability

A pre-test was done on 10 of the respondents who were not part of the final study. Data were coded and entered into the computer. Cronbach's Alpha Reliability Coefficients were obtained using the statistical package for social scientists (SPSS) computer program to estimate the reliability of the questionnaire. Generally, alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e., rating scale: 1 = poor, to 5 = excellent). The Cronbach's alpha reliability coefficient was obtained as 0.88 as indicated in Table 3.3 which was deemed acceptable (acceptable coefficient should be greater than 0.70) according to (Sekaran, 2013). Therefore the data used were reliable and could lead to reliable and dependable findings.

Table 3. 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. Items
0.88	0.89	18

3.9 Research procedure

A letter of introduction from Kyambogo University was obtained and presented to the authorities at the construction firms and professional bodies. A self-administered questionnaire was used to collect information from the above mentioned respondents. Purposively selected officials from ERB, ARB, SRB and construction projects were interviewed. After data collection, it was analyzed; a report is now here written and submitted to Kyambogo University for acceptance.

3.10 Data Analysis

3.10.1 Analysis of quantitative data

The statistical package which was used for analysis of data in this study is the SPSS version 21.0. Descriptive statistics namely frequency counts, percentages were the main parameters used to analyze the respondents' demographic characteristics and the mean and standard deviation were used to analyze the respondents' opinion on the application of EVM to the measurement of construction projects performance.

3.10.2 Analysis of qualitative data

Qualitative data were analyzed using content analysis where, responses from key informants, was grouped into recurrent issues. The recurrent issues which emerged in relation to each guiding question, were presented in the results, and with selected direct quotations from participants offered as illustrations.

3.11 Measurement of variables

Data on the respondent's views and opinions about EVM was obtained using scaled variables from a self-developed questionnaire. The variables were measured by

operationally defining concepts. For instance the questionnaire was designed to ask respondents, using guidelines proposed by Barker and Zabinsky (2010) and Genchev et. al., (2011). These were channeled into observable and measureable elements to enable the development of an index of the concept.

Measure - measurement scale of the variable. The default chosen by SPSS depends on the data type. For example, for variables of type "numeric," the default measurement scale is a continuous or interval scale (referred to by SPSS as "scale"). For variables of type "string," the default is a nominal scale. The third option, "ordinal," is for categorical variables with ordered categories but is not used by default. It is good practice to assign each variable the highest appropriate measurement scale ("scale" > "ordinal" > "nominal") since this has implications for the statistical methods that are applicable. The default setting can be changed by highlighting the respective cell in the tenth column and choosing an appropriate option from the drop-down list. The next chapter presents the analysis and discussions of the results obtained.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF RESULTS

4.1 Introduction

This chapter presents, analyzes and then interprets the study findings based on the questionnaire, interviews, primary data and observations. The first section presents the response rate, background information about the respondents on EVM technique. The second section discusses the empirical findings of the study.

4.2 Background information about the respondents

To establish the background characteristics of the respondents, the study focused on professions, job title, education level and experience worked with a given organization and the findings are presented in the subsequent sections of the observations.

4.2.1 Response rate

A total of 120 questionnaires were issued but only 103 questionnaires were returned and considered in the study giving a response rate of 91.0% as seen in Table 4.1, which according to Amin, (2005) is a very good response rate for the study and also suggests that the results contain substantial data collected and the survey results were representative of the surveyed population.

Table 4. 1: Response Rate

Category	Sample size	Responses	Percentage response rate
Project Managers	28	28	100%
Architects	40	18	45.0%
Engineers	28	31	111%
Quantity Surveyors	24	26	108%
Total	**120**	**103**	**91.0%**

Source: Primary data, 2019

4.2.2 Professions of the Respondents

Respondents were requested to indicate their professions. This subsection presents the findings in this regard as indicated in Table 4.2.

Table 4. 2: Profession of the respondents

Profession	Frequency	Percent	Valid Percent	Cumulative Percent
Project Managers	28	27.2	27.2	27.2
Architects	18	17.5	17.5	44.7
Engineers	31	30.1	30.1	74.8
Quantity Surveyors	26	25.2	25.2	100.0
Total	**103**	**100.0**	**100.0**	

Source: Primary data, (2019)

Table 4.2 shows that a majority, 31 (30.1%) of the respondents were Engineers, 28 (27.2%) were Project Managers, 26(25.2%) were Quantity Surveyors and 18(17.5%) were Architects. This finding suggests that data were collected from a range of professionals believed to possess good knowledge of earned value management and thus expected to generate reliable and dependable results and conclusions.

4.2.3 Gender of the Respondents

This subsection presents the gender of the respondents and the findings regarding the gender of the respondents are presented in Table 4.3.

Table 4. 3: Gender of the respondents used in the study

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	62	60.2	60.2	60.2
Female	41	39.8	39.8	100.0
Total	**103**	**100.0**	**100.0**	

Source: Primary data, 2019

The findings in Table 4.3 indicate that majority, 62 (60.2%) of the respondents were male, while 41 (39.8%) were female. This finding suggested that the study accessed more male respondents in all fields than female. This finding also revealed that the study was not gender biased since there was a fair representation of both male and female respondents.

4.2.4 Education Level of the Respondents

This subsection presents the level of education of the respondents and the findings regarding the highest level of education of the respondent are presented in Table 4.4.

Table 4. 4: Education level of the respondents used in the study

Education Level	Frequency	Percent	Valid Percent	Cumulative Percent
High school	1	1.0	1.0	1.0
Diploma	10	9.7	9.7	10.7
1st Degree	58	56.3	56.3	67.0
Masters	25	24.3	24.3	91.3
PhD	9	8.7	8.7	100.0
Total	**103**	**100.0**	**100.0**	

Source: Primary data, (2019)

Table 4.4 shows that majority, 58 (56.3%) of the respondents had attained a first degree as their highest level of education, 25 (24.3%) had attained a master's degree, 10 (9.7%) had attained a diploma, 9 (8.7%) had attained a PhD while 1 (1.0%) had attained an advanced certificate level of education. These study findings suggested that

the respondents had a reasonable level of education believed to understand and appreciate issues of EVM technique and its proper use in measuring performance of construction projects and therefore information gathered would be highly reliable to give credible results.

4.2.5 Experience of the respondents

This subsection presents the experience in years the respondents had worked within the given position, at the time of the interview and the findings are presented in Figure 4.1.

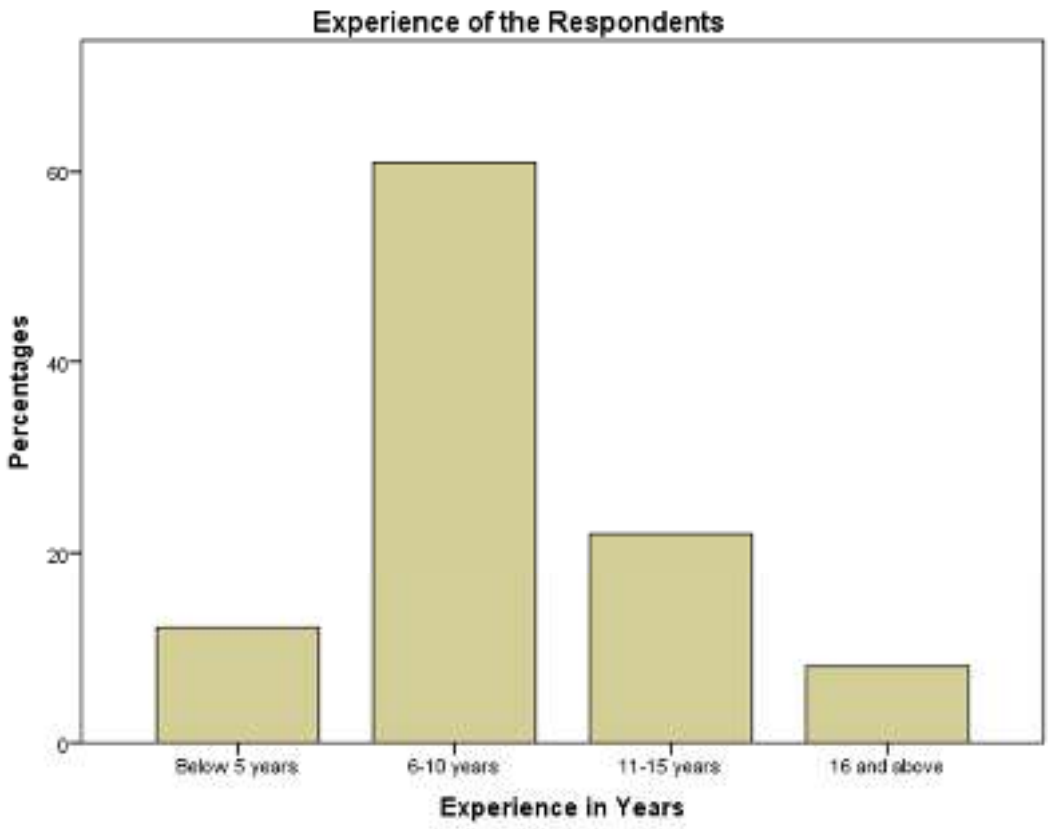

Figure 4. 1: Experience of the respondents

Source: Primary data, 2019

It shows that majority, 61 (59.2%) of the respondents had worked for 6-10 years, 22 (21.4%) had worked for 11-15 years, 12 (11.7%) had worked for less than 5 years while 8 (7.8%) had worked for 16 years and above. This finding suggests that the respondents had reliable experiences in EVM since combined total of 88.3% had worked for more than 5 years and therefore respondents of such experience were believed to provide reliable data to produce reliable and dependable results that can be applied with certainty to improve performance of construction projects.

4.2.6 Age of the respondents

This subsection presents the age of the respondents, at the time of the interview and the findings are presented in Table 4.5.

Table 4. 5: Age of the respondents

Age bracket	Frequency	Percent	Valid Percent	Cumulative Percent
18-25 years	12	11.7	11.7	11.7
26– 30 years	24	23.3	23.3	35.0
31 – 40 years	38	36.9	36.9	71.8
Over 40 years	29	28.2	28.2	100.0
Total	**103**	**100.0**	**100.0**	

Source: Primary data, 2019

Table 4.5 shows that majority of 38 (36.9%) of the respondents were of age between 31-40 years, 29 (28.3%) were of age above 40years, 24 (23.3%) were of age between 26-30 years while 12 (11.7%) were of age between 18-25years. This finding suggested that 88.3% of the respondents were above 25years of age and therefore could use experiences and maturity to make reliable decisions concerning the applicability of EVM in measuring performance of construction projects.

4.3 Empirical Findings

The study sought to investigate the applicability of earned value management techniques in enhancing construction project performance in Uganda. In order to establish this, quantitative data were obtained from questionnaires, and the qualitative data were generated from interviews to present empirical evidence. Three objectives were set to guide the study. The analysis was carried out on an objective by objective basis chronologically with descriptive results, significances and correlations presented that informed the results. Findings from the interviews and documentary reviews were discussed to aid triangulation of the information.

4.3.1 Standard practices of EVM technique used in measuring performance of construction projects in Uganda

The specific objectives of the study were to establish the standard practices of EVM Technique in measuring performance of construction projects in Uganda, establish the barriers that hinder effective application of EVM in enhancing performance of construction projects in Uganda and to develop an effective performance monitoring tool for construction projects. Project performance in this study was premised on cost and time. This subsection first details the findings on the methods used to track project costs and progress as indicated in Table 4.6.

Table 4. 6: Methods used for tracking Project Costs and Progress

	Frequency	Percent	Valid Percent	Cumulative Percent
Critical Path Method	40	38.8	38.8	38.8
PERT Method	37	35.9	35.9	74.8
EVM: Earned Value Management Tool	19	18.4	18.4	93.2
Others	7	6.8	6.8	100.0
Total	**103**	**100.0**	**100.0**	

Table 4.6, unveil the methods that are practiced in tracking of construction project costs and progress in Uganda. The findings show that the common method used was Critical Path Method with 40 respondents (38.8%) followed by PERT method with 37 respondents (35.9%) then EVM tool with 19 respondents (18.4%) and lastly 7 respondents (6.8%) were reported to be using other methods than the ones specified. This finding indicates that EVM is not well known and thus less used in tracking project performance in terms of cost and time.

4.3.1.1 Knowledge levels on EVM

Respondents were requested to indicate how knowledgeable they were about EVM and this subsection ranks the findings on their knowledge level in the use of EVM as indicated in Table 4.7.

Table 4. 7: Knowledge levels on use of EVM

Knowledge levels on EVM	Frequency	Percent	Valid Percent	Cumulative Percent
Expert knowledge	7	6.8	6.8	6.8
Very knowledgeable	13	12.6	12.6	19.4
Knowledgeable	19	18.4	18.4	37.9
Slightly knowledgeable	34	33.0	33.0	70.9
Not knowledgeable	30	29.1	29.1	100.0
Total	103	100.0	100.0	

Table 4.7 provide responses from Construction Managers, registered Architects, registered Engineers and registered Surveyors who at the time of sampling had projects and were linked to projects from within Kampala. The information provided in table 4.7 shows that the knowledge level in using Earned Value Management indicated that the professionals who were slightly knowledgeable on the use of EVM were ranked highest with 34 (33.0%), those rated as being slightly knowledgeable about EVM, at

30 (29.1%), with no knowledge, followed by 19 (18.4%) knowledgeable, and then those very knowledgeable were 13 (12.6%) while only 7 (6.8%) had expert knowledge on the use of EVM techniques.

4.3.1.2 Frequency in use of EVM Techniques

In this study, professionals were requested to indicate how often they employed EVM techniques in their projects. This subsection presents the statistics on the frequency of using EVM techniques as indicated in Table 4.8.

Table 4. 8: Frequency in using EVM techniques

Use of EVM	Frequency	Percent	Valid Percent
Always	5	4.9	4.9
Frequently	14	13.6	13.6
Occasionally	9	8.7	8.7
Rarely	48	46.6	46.6
Never	27	26.2	26.2
Total	103	100.0	100.0

Table 4.8 details the frequency by professionals in using Earned Value Management Techniques. The highest ranking of 48 (46.6%) indicated that EVM was rarely used, 27 (26.2%) indicated that they had never used EVM, 14 (13.6%) showed that there was frequently used and only 5(4.9%) always used EVM.

4.3.1.3 Opinion on the value of EVM

This subsection sought to understand the opinions of respondents on whether they considered EVM of value in successful execution of construction projects. It presents the statistics on the opinion of professionals on the value of EVM as indicated in Table 4.9.

Table 4. 9: Opinion on the value of EVM

Opinions of respondents	Frequency	Percent	Valid Percent	Cumulative Percent
Extremely valuable	8	7.8	7.8	7.8
Useful for most projects	22	21.4	21.4	29.1
Suitable for some projects	39	37.9	37.9	67.0
Not worth the effort	34	33.0	33.0	100.0
Total	103	100.0	100.0	

Table 4.9 gives a breakdown on opinions that the professionals shared concerning the value on Earned Value Management. The findings show that those who think that EVM was only suitable for some projects were 39 (37.9%); 34 (33.0%) think it is not worth the effort; 22 (21.4%) think that it is useful for most projects; while 8 (7.8%) were of the opinion that EVM is extremely valuable.

4.3.1.4 Reasons for use of EVM in organizations

This subsection details the statistics on the reasons for use of EVM technique by organizations as indicated in Table 4.10.

Table 4. 10: Reasons for use of EVM in organizations

Reasons	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Required by client	1	1.0	1.0	1.0
Required by project sponsors	7	6.8	6.8	7.8
Used voluntarily by project managers	31	30.1	30.1	37.9
Used on a trial basis, or occasionally	42	40.8	40.8	78.6
Not certain of reason why it is used	22	21.4	21.4	100.0
Total	103	100.0	100.0	

Table 4.10 expounds on the different reasons why organizations employ Earned Value Management techniques. The results show that majority organisations just used it on trial basis 42 (40.8%), followed by 31 (30.1%) voluntary use by project managers, then 22 (21.4%) were not sure of any reason, 7 (6.8%) could use EVM because it was required by the project sponsors while only 1(1.0%) used EVM because it was required by the Client. This finding shows that one of the reasons why EVM is not widely used could be related to the fact that it is not a requirement by most clients (1.0 %) and to a small extend preferred at 6.8% by the sponsors as indicated in Table 4.10. Given that the terms and conditions of the contract are propagated or usually set by clients and or sponsors, it becomes clear, as to why EVM technique is not commonly used.

4.3.2 Barriers that hinder effective application of EVM in enhancing performance of construction projects in Uganda

The second specific objective was to establish the barriers that hinder effective application of EVM to enhance performance of construction projects in Uganda. This subsection presents the findings on the major barriers that influence the effectiveness and efficiency in cost management as presented in Table 4.11.

Table 4. 11: Major barriers that hinder effective application of EVM

Barriers	N	Mean	Std. Dev.	Ranking
Usage of construction equipment (CE)	103	2.45	0.78	1st
Material prices(MP)	103	2.41	0.79	2nd
Labour rates(LR)	103	2.38	0.75	3rd
Level of technology(LT)	103	2.21	0.80	4th
Change of construction policy or code(CP&C)	103	2.00	0.86	5th
Usage of new materials(NM)	103	1.87	0.77	6th
Current situation of construction process(CP)	103	1.75	0.77	7th

Primary Data 2020

One of the factors that was highly ranked as a barrier that hinders effective application of EVM was Usage of construction equipment in the first position (Mean= 2.45 and st.dev. =0.78). The process of construction traditionally has involved the reworking of naturally occurring materials to form a new material and or to build structures. This form of situation leads to adjustment in construction methods and subsequently reducing on the satisfactory performance (Mohamed et. al., (2014) and Manning, 2010). More innovative designs, whole life costing, design/build/operate procurement and the influence of European integration promote the use of new materials, which materials play more important role in construction process. The second highly ranked factor was material prices (Mean =2.41 and st.dev =0.79). The findings in Table 4.11 are in agreement with (Micheal, 2013) who indicated that material prices often times lead to reduction in performance. The relationship between construction policy, code and performance is dependent on the stability of the government structural systems and it is observed that there is a direct relation in that poor policies lead to low performance (Bi qiu et. al., 2018). The level of technology, Labour rates, Construction equipment and Material prices, were discussed by Zhipeng et. al., (2013), Brochner et. al., (2013), and Saad et. al., (2019) as key and technical factors that relate to training, safety handling of equipment on site, results orientation and are directly proportional to the construction performance. Therefore, from Table 4.13, findings revealed that the usage of construction equipment highly affects application of EVM in projects with a mean value of 2.45. Material prices was ranked 2nd with a mean of 2.41; followed by labour rates (mean= 2.38); Level of technology (mean=2.21). In this study, factors with mean values above 2.00 were considered to be major factors that affect implementation/application of EVM in construction projects. Change of construction

policy or code (mean = 2.00), usage of new materials (mean = 1.87), current situation of construction process (mean = 1.75) were not considered significant barriers in the application of EVM in construction projects.

4.3.3 Development of Performance Monitoring Tool for Construction Projects

A different angle to the barriers that hinder the application of EVM to measuring performance of construction project was to conduct regression analysis on the factors in order to establish their significance by selecting only those with mean values above 2.00. Four factors: Use of Construction Equipment denoted as (CE), Material Price (MP), Labour Rates (LR) and Level of Technology (LT) were selected and subjected to regression analysis. As a result, a regression model was obtained as seen in equation 4.1 and regression model coefficients are presented in Table 4.12.

$Y = -5.698 + 0.197LR + 0.181MP + 0.036CE + 0.009LT$ ……. (Equation 4.1).

This developed model will be used as a performance monitoring tool for projects by monitoring the variables in the equation.

Table 4. 12: Model Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig. P
		B	Std. Error	Beta		
1	(Constant)	-5.698	.070		-.806	-.236
	Level of technology (LT)	0.009	.155	.005	.055	-.956
	Labour rates (LR)	0.197	.165	.106	1.194	.025
	Usage of construction equipment (CE)	0.036	.161	.020	1.222	.000
	Material prices (MP)	0.181	.157	.102	1.153	.000
a. Dependent Variable: Which elements do you think are the major barriers of company to practice efficient and						

Considering model coefficients in Table 4.12, the findings indicate that the use of construction equipment, Labour rates, and Material prices were the significant barriers to the application of EVM in enhancing performance of construction projects. The values of p are below 0.05 and therefore significant which means they are the ones that significantly affect implementation of EVM in enhancing performance of construction projects. This finding, therefore, indicates that to have effective application of EVM, then much attention should be paid to Labour rates, use of construction equipment and Material prices in the market. The results of statistical analysis of variance (ANOVA) and fitness of the model as well as the effect of significant individual terms on performance of construction projects are presented in Tables 4.14, 4.15 and 4.16.

Table 4. 13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.892[a]	.845	.840	.140519
a. Predictors: (Constant), Material prices, Labour rates, Level of technology, Usage of construction equipment				
b. Dependent Variable: Which elements do you think are the major barriers of company to practice efficient and				

To test the fitness of the model, the regression equation and the coefficients of determination (R^2) were evaluated. It was established that the value of R^2 was 0.845 which means that a variation of 84.5% in the application of EVM to enhance performance is due to the barriers indicated in the model of construction projects and only 15.5% is attributed to other factors not explained by the model. The value of the adjusted coefficient of determination (Adjusted R^2= 0.840) is also reasonably high which further supports the significance of the model (Khuri and Cornell, 1987; Saqib et. al., 2012).

Table 4. 14: Analysis of barriers to application of EVM techniques

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.117	4	1.529	403.774	.000[b]
	Residual	254.719	129	1.975		
	Total	260.836	133			
a. Dependent Variable: Which elements do you think are the major barriers of company to practice efficient and						
b. Predictors: (Constant), Material prices, Labour rates, Level of technology, Usage of construction equipment						

The Fisher F-test (F_{model}=403.774) with a low probability value of ($p<0.0001$) shows high significance for the regression model at 95% level of confidence. The p-value (probability of error) less than 0.05 indicates that a particular model term is significant. The smaller the p-value, the more significant is the corresponding model variable (Chen et. al., 2008). From the ANOVA results, three of the four variables studied : use of construction equipment, material prices, and labour rates were found to be statistically significant terms and therefore are significant barriers to the application of EVM on performance of construction projects. From the mathematical model developed (equation 4.1) it can be deduced that the effectiveness in monitoring performance of projects will (largely depend on Labour rates followed by Material prices and lastly use of construction equipment.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of findings, conclusions and recommendations of the study in relation to the research objectives of the study and review of the related literature on EVM technique. The first section presents a summary of findings on summary of the study findings. This is followed by conclusions, recommendations, limitations of the study, contributions of the study and recommendations for further studies.

5.2 Conclusions of the study

This sub section presents the conclusions of the study on the assessment of the applicability of EVM Technique on measuring the performance of construction project in Kampala. The study concluded that EVM Techniques are not commonly used for measuring performance of construction projects but rather the optional techniques like Critical path method and PERT method are commonly used compared to EVM.

The study further concluded that any changes in labour rates and material prices significantly affect the performance of construction projects. EVM is seen to affect project performance at a low rate compared to Critical path method and PERT method. This suggests that any method that is used to measure performance directly affects cost management.

5.3 Recommendations of the study

This sub section presents the recommendations of the study on the assessment of the applicability of EVM technique in measuring performance of construction projects. More research needs to be done on the efficiency and effectiveness of using EVM technique in measuring performance. This will help in advising and concretizing the use of EVM in the construction industry. Training sessions on the viability and use of EVM in measuring performance of construction projects, should be encouraged by construction industry professionals. Construction management course unit in universities should include EVM content so that graduates get out into the industry when they are fully equipped with the knowledge on EVM.

5.4 Limitations of the study

The study relied on the primary data collected from observations, interviews and questionnaire on a sample of Construction managers, Engineers, Architects and quantity surveyors with experts' views and use of secondary data from documentary review which limits the study findings objectivity. Similarly the study used registered professionals in the above mentioned fields, which has a limitation of generalization of the study results. A comparative analysis of selected target categories would enable amore generalizations of the study results to other construction fields. Never the less, the study findings and recommendations based on the views of the selected fields and are in line with the set objectives.

5.5 Contributions of the study

The study has helped to reveal the need for emphasis on the use of Earned Value Management technique. The developed tool will be of use to project/cost managers in consciously handling construction resources (labour, materials etc.) to improve performance of construction projects. Similarly, the study has also helped cover literature gaps by providing empirical evidence on the importance of EVM.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

Research Title: "Assessing the applicability of earned value management (EVM) technique in measuring the performance of construction projects in Kampala".

Dear Respondent,

I am a student of Kyambogo University, Kampala pursuing a Master's of Science degree in construction technology & management. This questionnaire is intended to help the researcher get information on the relationship between EVM Technique and performance of construction projects in Kampala. The purpose of this study is purely academic and the information given will be treated with the highest degree of confidentiality. You have been selected as a key respondent for this study. Kindly, complete the questionnaire to enable the researcher complete the study. Please tick the answer which represents your best opinion on the subject.

I appreciate your participation in this effort.

Thank you,

Mugabi Ronald

SECTION A: Background Information

1. Sex:

   1) Male ( ) 2) Female ( )

2. Age bracket

1) 20 – 25 years ( )

2) 26– 30 years ( )

3) 31 – 40 years ( )

4) Over 40 years ( )

3. Designation

1) Project Manager ( )

2) Architect ( )

3) Engineer ( )

4) Quantity Surveyor ( )

4. Education

1) High school ( )

2) Diploma ( )

3) Degree ( )

4) Masters ( )

5) PHD ( )

6) Others ( )

If others please specify …….....

5. How many years have you been in this service?

1) Below 5 years ( )

2) 6-10 years ( )

3) 11-15 year ( )

4) 16 and above ( )

From questions 6 - 15, tick or circle the number that best indicates your opinion on the question using the following scales

6. How do you track Project Costs/Progress? (Multiple choice)

1. Critical path method
2. PERT method
3. EVM: Earned Value Management Tool
4. Others

And if others, please specify below ……..

7. How knowledgeable are you about EVM?

1. Expert
2. Knowledgeable
3. Familiar
4. Slightly familiar

5. Not familiar

8. How often do you use EVM techniques?

1. Always
2. Frequently
3. Occasionally
4. Rarely
5. Never

9. What is your opinion of the value of EVM?

1. Extremely valuable
2. Useful for most projects
3. Suitable for some projects
4. Not worth the effort

10. If EVM is used in your organization, identify one of more of the following reasons:

1. Required by client
2. Required by project sponsors
3. Used voluntarily by project managers
4. Used on a trial basis, or occasionally
5. Not certain of reason why it is used

11. How much do you agree that EV, as a new estimate value on top of Plan Value and Actual Cost, is necessary in cost estimate systems?

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

12. How much do you agree that your organization is able to provide up-to-date information of project cost and schedule in time?

1. Strongly agree
2. Agree

3. Neutral
4. Disagree
5. Strongly disagree

13. If EVM is not used in your organization, identify one or more of these reasons:

1. **Not requested:** Senior management or clients do not require EVM reports
2. **Not successful:** Earned value techniques were tried in the past, and rejected
3. **No training:** Project managers are untrained in the application of EVM
4. **Too complex:** Earned value procedures seem too complicated
5. **No budget:** Project budgets are not required by management or clients
6. **No schedule:** Project schedules are not required by management or clients
7. **Partial costs:** Project budgets do not cover the cost of all project resources or costs
8. **Not sure:** Uncertain, or other reasons

14. Which elements do you think are the major barriers of company to practice efficient and effective cost management and Earned Value Management?

1. Change of construction policy or code
2. Current situation of construction process
3. Labour rates
4. Usage of construction equipment
5. Usage of new materials
6. Various material prices
7. High level of technology

15 Which Technique do you recommend to measure performance on a construction project and why?

…….....

.....

.....

THANK YOU FOR YOUR PARTICIPATION!

APPENDIX 2: FOCUS GROUP GUIDE

"Assessing the applicability of earned value management (EVM) technique in the measurement of performance of construction projects in Kampala".

INTRODUCTION:

The purpose of the interview is to gather key information from the project managers, Architects, Engineers and Quantity Surveyors about the application of Earned Value Management (EVM) Technique to Measuring the Performance of a Construction Project in Kampala-Uganda.

1. What are the existing performance measuring techniques used on the construction projects?
2. How effective and efficient are they in measuring performance of a construction project
3. What are the possible barriers of EVM Technique in measuring performance of a construction project in Kampala?
4. What are the likely recommendations with regard to the above challenges?
5. What are the possible benefits of EVM Technique in measuring performance of a construction project in Kampala?
6. What are the standard practices of EVM Technique in measuring performance of a construction project in Kampala?
7. What is the relationship between earned value management (EVM) technique and the performance of a construction project in Kampala?
8. What perception do professionals have on the EVM Technique in measuring performance of a construction project in Kampala?
9. Any general comment with regard to the application of EVM Technique on measuring the performance of construction projects in Kampala city?

APPENDIX I: QUESTIONNAIRE

Research Title: "Assessing the applicability of earned value management (EVM) technique in measuring the performance of construction projects in Kampala".

Dear Respondent,

I am a student of Kyambogo University, Kampala pursuing a Masters in Master of Science in construction technology & management. This questionnaire is intended to help the researcher get information on the relationship between EVM Technique and performance of construction projects in Kampala. The purpose of this study is purely academic and the information given will be treated with the highest degree of confidence. You have been selected as a key respondent for this study. Kindly, complete the questionnaire to enable the researcher complete the study. Please tick the answer which represents your opinion on the subject.

I appreciate your participation in this effort.

Thank you,

Mugabi Ronald

SECTION A: Background Information

1. Sex: Male ( ) Female ( )

2. Age bracket

20 – 25 years	( )
26– 30 years	( )
31 – 40 years	( )
Over 40 years	( )

3. Designation

Project Manager	( )
Architect	( )
Engineer	( )
Quantity Surveyor	( )

4. Level of education

High school	( )
Diploma	( )
Degree	(√)
Masters	( )
PHD	( )

Others (please specify) .....

5. How many years have you been in this service?

Below 5 years	( )
6-10 years	( )
11-15 year	(√)
16 and above	( )

From questions 1 – 10, tick or circle the number that best indicates your opinion on the question using the following scales

1. How do you track Project Costs/Progress? (Multiple choice)

√a. Critical path method

b. PERT method

c. EVM: Earned Value Management Tool

d. Others

And if others, please specify below

2. How knowledgeable are you about EVM?

a. Expert

b. Knowledgeable

c. Familiar

√d. Slightly familiar

e. Not familiar

3. How often do you use EVM techniques?

a. Always

b. Frequently

c. Occasionally

d. Rarely

√e. Never

4. What is your opinion of the value of EVM?

a. Extremely valuable

b. Useful for most projects

√c. Suitable for some projects

d. Not worth the effort

5. If EVM is used in your organization, identify one of more of the following reasons:

a. Required by client

b. Required by project sponsors

c. Used voluntarily by project managers

d. Used on a trial basis, or occasionally

e. Not certain of reason why it is used

6. How much do you agree that EV, as a new estimate value on top of Plan Value and Actual Cost, is necessary in cost estimate systems?

a. Strongly agree

√ b. Agree

c. Neutral

d. Disagree

e. Strongly disagree

7. How much do you agree that your organization is able to provide up-to-date information of project cost and schedule in time?

√ a. Strongly agree

b. Agree

c. Neutral

d. Disagree

e. Strongly disagree

8. If EVM is not used in your organization, identify one or more of these reasons:

a. **Not requested:** Senior management or clients do not require EVM reports

b. **Not successful:** Earned value techniques were tried in the past, and rejected

c. **No training:** Project managers are untrained in the application of EVM

d. **Too complex:** Earned value procedures seem too complicated

e. **No budget:** Project budgets are not required by management or clients

f. **No schedule:** Project schedules are not required by management or clients

g. **Partial costs:** Project budgets do not cover the cost of all project resources or costs

h. **Not sure:** Uncertain, or other reasons

9. Which elements do you think are the major barriers of company to practice efficient and effective cost management and Earned Value Management?

a. Change of construction policy or code

b. Current situation of construction process

c. Labour rates

d. Usage of construction equipment

e. Usage of new materials

f. Various material prices

g. High level of technology

10 Which Technique do you recommend to measure performance on a construction project and why?

Cost variance tec
Cost Variance technique. It helps to track cost discrepancies

THANK YOU FOR YOUR PARTICIPATION!

TABLE 1

Table for Determining Sample Size from a Given Population

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

Note.—*N* is population size.
S is sample size.