An Extension of Earned Value Management for Forecasting of Project Performance

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ABSTRACT

The inherence of risks in every type of project due to the uncertain Project Management (PM) environment may affect the performance of a project leading to cost, time, and scope overruns. Thus, PM needs a technique that will cater for these problems and hence improve the performance of projects. Earned Value Management (EVM) is one of the best techniques for monitoring and forecasting of project performance. However, given a number of studies that have been done, EVM predicts the future performance of a project from its past performance without considering the possibility of other factors (risks) that may affect the performance of a project during the project life cycle. Therefore, the study sought to extend Earned Value Management in forecasting of project performance by advancing its forecasting formulae to incorporate the risk element into it for better forecasting of project performance. This was achieved by examining the risk factors that influence forecasting of project performance, assessing the ability of EVM in respect to forecasting of project performance, and developing a combined approach of EVM and Enterprise Risk Management for forecasting of project performance.

The study found out a number of factors affecting the performance of projects such as equipment shortages, staff turnover, and climatic conditions among others. Further, the study ascertained that EVM has a weakness in forecasting of project performance because it does not take notice on the likelihood of risk elements that may affect the performance of a project in the cause of a project life cycle. The EVM-ERM model was found out to forecast project performance with reductions in completion time and cost. From the findings of the EVM-ERM model subjection to the infrastructure projects in Kenya funded by the World Bank, the study ascertained that the performance of the individual projects was enhanced with reductions in completion time and cost. Additionally, in comparing the efficiency of EVM and EVM-ERM, the study deduced that the latter model stood out in forecasting of project performance depicting an improvement in forecasting of completion time and cost of a project. Hence, it is imperative for the risk element to be incorporated to the EVM technique to enhance the performance of projects.

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LIST OF ABBREVIATIONS

AC	Actual cost
ANSI	Americans National Standards Institute
BAC	Budget at completion
CPI	Cost performance index
C/SCSC	Cost/ schedule control system criteria
CV	Cost variance
EAC	Estimate at completion
EAC	Time estimate at completion
EIA	Electronics industries alliance
ERM	Enterprise risk management
EV	Earned value
EVM	Earned value management
EVMS	Earned value management system
LRI	Latest revised estimate
PD	Planned duration
PM	Project management
PMBOK	Project management body of knowledge
PMI	Project management institute
PV	Planned value
RBS	Risk breakdown structure
RM	Risk management
SPI	Schedule performance index
SV	Schedule variance
TCPI	To complete performance index
VAC	Variance at completion

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DEDICATION

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CHAPTER ONE: INTRODUCTION

1.1 Introduction to the study

In today's cost and time conscious environment; with increasing and changing project uncertainties, there is need for a robust project management technique for monitoring and forecasting project performance. Earned Value Management is one tool that has confirmed itself as the most proficient and reliable in measuring project performance and managing projects (Project Management Institute [PMI], 2011). The technique aids project managers in approximating the future performance of projects (Tabriz, Farrokh, Nooshabadi, & Nia, 2013). As stated in the Project Management Glossary of Terms; PMGT (2005), EVM incorporates scope, time, and cost in a single methodology to factually measure the performance and progress of projects.

According to Tabriz et al. (2013), the elements; scope, time, and cost, are very essential in driving the project towards success. Additionally, its efficacy has demonstrated it as a resourceful tool to be put to use to any kind of project, from complex projects to minor projects (Czarnigowska, 2008). Therefore, it enables the project team and other project stakeholders to have the big picture of the current position of the project in terms of performance and progress to avoid deviations from the original plan (Czarnigowska, Jaskowski, & Biruk, 2011). Further, it shows where the project is headed likened to its desired state and the direction it is supposed to take that is management with lights on (PMI, 2011).

Similarly, conforming to PMI (2011) the efficiency of EVM requires that it be put to practice where the standards and guidelines of good project management are practical as outlined in Project Management guides such as, the Project Management Body of Knowledge (PMBOK). This calls for a proper choice of EVM method to be made with appropriate set standards on which decisions on its worth can be based, to perfectly suit the needs of project control and monitoring (De Marco & Narbaev, 2013). Moreover, PMI (2005:2011) emphasize that its link with PMBOK guide especially in the knowledge areas should be looked at in order to establish its role in Project Management. Project Management is involved with planning, executing, and controlling work, thus EVM should perfectly fit in (PMI, 2005).

1.2 Background to the study

In the Project Management world, the key to project success in terms of performance is the control of projects which is based on the cost control (PMI, 2011). However, the familiarity with projects that have failed depicts that control of projects should be more than the cost control (Hernandez, Otegui, and Gomez, 2013). This gives way for the integration of key project success drivers namely time, cost, and scope which is paramount in this study. This is made possible by the use of EVM whose role in Project Management is to assess and track the physical progress of projects (monitor) towards their success and further forecast the future performance of a project (PMI, 2011). This has been accelerated by a striking increase in environmental and social concerns, amid projects becoming complex each new day, which calls for its proficiency in measuring project performance.

Relative to its efficiency and effectiveness, EVM has been practiced in a number of departments, ranging from defense, engineering to project management (De Marco & Narbaev, 2013). According to Anbari (2003, citing Flemming & Koppleman, 2000; Kim,2000), the origin of EVM in its most simple usage can be traced back to the late 1800's, then known as Earned Value Analysis. During this time, it was practiced by industrial engineers on the industrial unit/factory floor. In the late 1960's, it was adopted by the Americans in the defense sector as a cost/schedule control system criteria (C/SCSC) in its first practice (Henderson, 2007; Kwak & Anbari, 2012). This was mainly to enhance an understanding on the financial facets of projects and encourage its usage in big and complex projects, so as to bring about a stable method founded on best and reliable practices.

Towards the end of 1996, the Cost/Schedule Control System Criteria name was cast-off by the American federal government (Kwak & Anbari, 2011). This brought up a better and more flexible technique by the name; Earned Value Management System (EVMS) to help plan well and in time so as to ascertain essential tasks that can be measured in a short time (Kwak & Anbari, 2010). Additionally, Kwak and Anbari (2011) emphasize that the flexible approach (EVMS) was to inspire firms and individuals on its practice. Other institutes followed suit in encouraging the use of the tool. For instance, the American National Standards Institute (ANSI)/ Electronics Industries Alliance (EIA) came up with the Earned Value Management System principles to guide on its applicability and usage.

Further, the Project Management Institute (PMI) extended the guidelines by providing the fundamentals of the technique (formulae and terminologies) (Kwak & Anbari, 2012). As from 2002, PMI has increasingly provided developments on the same in its management and knowledge guidebooks (PMI, 2011). As pointed out by Kwak and Anbari (2010), EVM has been used under several names such as Earned Value Project Management, Earned Value Method, Earned Value Analysis and Cost/Schedule Summary Report. All these names refer to the same project management methodology discussed in this study; EVM. Presently, the concern in its adoptability, applicability, and usage has increased in almost all sectors (De Marco & Narbaev, 2013). This has proven it to be a competent technique for monitoring and forecasting of project performance and for enhancing the success of projects.

As reported byHenderson (2007), EVM provides up to date information on project performance on the present status of a project. The method enables managers to complete projects in time and on budget. Moreover, it helps project managers to predict the future performance of projects using the patterns of today's performance (Czarnigowska, 2008). This enables them not to spend more than the forecasted time and cost, and better still not to go beyond the planned scope (Poppendieck, 2002). As reported by Tabriz et al. (2013, citing Gowan, Mathieu & Hey, 2004), EVM gives apt and targeted response on any problems and deviations to project managers and other project stakeholders to help them take corrective actions in good time. This is enhanced by its metrics; performance indices and forecasting parameters which provide values for discrepancies that can be applied to evaluate the status of a project presently and estimate its future performance based on its past performance (Tabriz et al., 2013).

Good metrics give us eyesight to do the right things and do them well. According to PMI (2011), EVM enables the project stakeholders know where exactly the problem is, if the problem is critical to be dealt with immediately, and what can be done to the activities posing difficulties. This is to get the tasks and the entire project back to the right track. This makes it easier for the project manager and other project stakeholders to have a glimpse of what to be done at what time and to which activity or task of the project to ensure the best is achieved at all times. Further, Anbari (2003) found out that the metrics make it a reliable and value adding tool that enhances project success at its most efficient practice and applicability.

Nevertheless, given that EVM rests on the assumption that the future performance of a project can be determined from its past performance (PMI, 2011; Tabriz et al., 2013), the supposition is under dispute. This is because every project is unique and the uncertainty component that exits continuously to a certain extent in projects (Vanhoucke & Shtub, 2011), explaining the phenomenon of project circumstances fluctuating in totally different ways. In respect to this, a number of factors denote uncertainty; Competitor activities, Market volatility, Material cost, Resources, Client organizational changes, Internal organizational changes and the Macro environment factors among other things (Hillson 2004; Tabriz et al., 2013). Due to this, it cannot be fully said that all projects can be estimated from their past, thus the need to pool EVM with a technique that will cater for uncertainties that affect the performance of a project (Hillson, 2004; Tabriz et al., 2013).

According to Hillson (2009), one of the best methods that deal with uncertainty in an effective way is risk management. It takes care of the possible elements that may affect a project during its project lifecycle, thus helping fill the gap that EVM leaves out; predicting the future performance of a project from its past. Hillson (2004) argues that there is power in synergy and that project management needs to gain from the synergy between EVM and RM.The two (EVM & RM) complement each other by pooling their strengths to overcome each other's weaknesses. Additionally, the combined approach contributes to project performance in a double sense (Hillson, 2004; Tabriz et al., 2013). EVM looks into the past to predict the future performance of a project while RM looks into the possible elements (opportunities and threats) that may affect the future performance of a project. This makes the strength of the combined approach better compared to individual techniques and thus leading to excellent performance measurement.

Outstanding project performance measurement is the hallmark of excellent project performance and enterprises overall performance (PMI, 2011). To measure the performance of a project, the original measures of Earned Value Management are brought out in a vivid way to demonstrate the efficacy of the synergy (Tabriz et al., 2013). The proficiency of the combined effect between Earned Value Management and Risk Management can be demonstrated by looking at individual models and then on their combination in monitoring and forecasting of project performance. This is to test their effectiveness in enhancing project performance.

As reported by Anbari (2003; PMI, 2011; Tabriz et al., 2013), the EVM model rests on its metrics that stems from its fundamental elements; Planned Value (PV), Earned Value (EV) and Actual Cost (AC). Planned Value indicates where the project should be at any given point in time, Earned Value reflects the quantity of work that has been realized after completion of each task, activity and even the entire project and Actual Cost shows the amount of resources that have been put to use to achieve the actual work that has been accomplished to date (PMI, 2011).Metrics are not stand alone; they are accompanied by formulae to make their work easier. Thus, EVM metrics give a basis on which EVM monitors and forecasts project performance.

Conforming to PMI (2011), the EVM metrics are; Budget at completion (BAC) which is the recommended budget for the entire project, Variance at completion (VAC) = BAC-EAC, Cost variance (CV) = EV-AC, Schedule variance = EV-PV, To-cost performance index (TCPI) = (BAC-EV)/ (BAC-AC), Schedule performance index = EV/PV, Estimate at completion (EAC)=BAC/CPI and Time estimate at completion (EAC_t)=(BAC/SPI)/ (BAC/MONTHS). The metrics relate to the management of cost, time and scope of a project. Consequently, the RM model rests on the principle of its four stages of planning on the possibility of risks affecting the project performance, identifying both opportunities and threats, analyzing risk and responding to risk (Tabriz et al., 2013).

Moreover, the RM model gives a list of opportunities and threats that might affect the performance of a project. This is made possible by assessing the extent of uncertainty at the initials stages of a project. Tabriz et al., (2013) uses a risk quantity and a risk ratio in estimating the future performance of a project. The risk quantity is gotten by subtracting values of opportunities from values of threats, and the risk ratio is gotten by dividing the risk quantity by the sum of opportunities and threats. The resulting combined approach uses the risk ratio to adjust EVM indices to come up with conclusive formulae to measure the performance of a project. Hillson (2009; Tabriz et al., 2013) state that the combined approach to EVM and RM is one of the best synergies that leads to excellent project performance. However, the approach misses out in explaining how risks are identified and how they find their way to the entire process, further it does not consider all types of risks (Tabriz et al., 2013). Thus, this study sought to strengthen the forecasting ability of EVM by incorporating the risk element to it by using ERM which supersedes TRM (Razali & Tahir, 2011).

1.3 Statement of the problem

Given an ever changing, complex, unique, and unreliable project environment, there has been an increasing trend in continual project failures (Oracle Primavera, 2011). This is as a result of uncertainty that is ever present to a certain extent in every type of project (Vanhoucke & Shtub, 2011). To manage these uncertainties that results in risk, project planning which is the core of project management needs to incorporate risk. As a result, project performance is enhanced in every aspect. Additionally, the inadequate capacity to estimate the future performance of a project in order to plan for every step of a project effectively affects every project (Oracle Primavera, 2011). For that reason, it is necessary to have dependable forecasts at the planning stage of a project, to cater for the naturally present risk elements (Naeni, 2013).

These risk elements may affect the future performance of a project leading to time and cost overruns, thus calling for a reliable Project Management technique for monitoring and forecasting project performance. EVM has been proven to be the best technique for monitoring and forecasting of project performance (PMI, 2011). However, it is based on the assumption of predicting the future performance of a project from its past (PMI, 2011). Further, PMI emphasizes that in an ideal world, where all factors are kept constant, the assumption holds. But, in the uncertain environment where a number of factors come into play during the project life cycle, the supposition does not hold. In regard to this, the EVM presumption raises questions since it does not take into account risk elements that have a likelihood of affecting the future performance of a project.

Thus, this study sought to extend EVM by strengthening its forecasting ability through advancing its forecasting formulae by incorporating a risk element to it. This was made possible by using ERM which is one of the best forecasting techniques that look into issues of uncertainty and particularly risk in an efficient manner (Razali & Tahir, 2011). This is to better project performance from the roots. The proposed EVM-ERM model is seen to forecast the future performance of a project with reductions in actual cost and actual duration. Additionally, unlike previous studies on combining EVM with TRM (Tabriz et al., 2013) which fails to explain how risks are identified and further ignores an integrated framework of risk elements, the study displays a better model as compared to EVM without the risk element; a practical scenario of infrastructure projects in Kenya funded by the World Bank.

1.4 Research objectives

1.4.1 General objective

The study sought to extend Earned Value Management approach for forecasting of project performance.

1.4.2 Specific objectives

More specifically, the study sought;

1. To examine risk factors that influence forecasting of project performance
2. To assess the ability of EVM in forecasting of project performance of 37 World Bank infrastructure projects carried out in Kenya
3. To develop a combined approach of EVM and ERM in forecasting of project performance

1.5 Research questions

The study sought to provide answers to the following questions;

1. What are the risk factors that influence forecasting of project performance?
2. What is the ability of EVM in forecasting of project performance of 37 World Bank infrastructure projects carried out in Kenya?
3. What is the ability of a combined approach of EVM and ERM in forecasting project performance?

1.6 Scope of the study

The study was limited to an extent of strengthening the forecasting ability of EVM through advancing its forecasting formulae to incorporate the risk element by using ERM. The ERM concept was explored in line with the type of risks commonly used according to the classification of Razali and Tahir, 2011. Further, in looking at project performance only the cost and time metrics of EVM were quantified. This is because scope is dependent on both time and cost. The study looked at the infrastructure projects in Kenya funded by the World Bank that had run from the initiation stage all through the closure stage of a project life cycle. With regard to risk, the study dealt with the negative (threats) side of risk by displaying it in the EVM-ERM model. This is because threats are the major causes of cost and time overruns as they impact the project negatively.

1.7 Justification of the study

This study purposed to strengthen the forecasting ability of Earned Value Management leading to an improvement in the increase of project scope, time and cost overruns. The study will give insights to companies all over the globe as to the significance of a combined approach of Earned Value Management and Enterprise Risk Management for monitoring and forecasting project performance. Further, the study will provide insights to project managers and other project stakeholders to consider a combined approach to Earned Value Management to be able to measure projects performance in both environments(real and uncertain). Additionally, this study will provide insights to students and instructors to extend their knowledge on Earned Value Management beyond the certain environment and consider the uncertain environment by combining it with Enterprise Risk Management for forecasting of project performance.

The study will also be of help to researchers and academicians as it will provide a spur to carry out more research into the same issue and related subjects so as to add to the existing quantity of knowledge, particularly on the current studies on a combined approach of Earned Value Management and other techniques for monitoring and forecasting project performance. As well, the study will contribute to the Project Management Body of Knowledge by giving insights that Earned Value Management is not supposed to be a stand-alone forecasting tool per se, but rather a strictly monitoring and forecasting tool for performance measurement in project management. Thus, this study will be a revelation especially to the advocates of the major assumption of EVM; predicting the future performance of a project from its past.

Moreover, the study will be imperative to the PM instructors and authorities that RM is an integral part in PM and thus there is need for an advanced training of project managers on the issue of RM and how to integrate the RM techniques with PM techniques in order to enhance project performance. Finally, the study will be of importance to the World Bank organization, to subject the proposed model to its projects in order to capture risk in projects earlier enough and in turn reduce the cost and time overruns. This is because the proposed model was subjected to infrastructure projects from different sectors in Kenya funded by this institution in the forecasting of project performance. Further, majority of the projects being government initiated, the government of Kenya has a chance to benefit from this study.

1.8 Definition of terms

In the context of this study, the following terms were defined in consistency with the discussion of the area under study.

Cost/schedule control system; The original EVM that left out the element of scope and concentrated only in time and cost overruns for the performance of a project.

Enterprise risk management; dealing with all types of project risks in an integrated manner as per the company's (project) strategic plan and objectives (Hillson, 2009).

Extension; advancing of the model/ technique to incorporate a missing element or necessary element.

Performance metrics; Formulae that when calculated gives values with a threshold to denote the position of a project in terms of performance

Project; a temporal, unique, complex activity that has a beginning and an end

Project cost/budget; the monetary worth of a project activity (PMGT, 2005).

Project life cycle; Phases that project management follows from the initiation stage through project closure of an activity.

Project management; the administration of time, cost, and scope of a project to avoid deviations as the project progresses to its closure and even at closure

Project schedule/time; planned dates for undertaking a project activity (PMGT, 2005).

Project scope; what needs to be accomplished in terms of deliverables, objectives among other things (PMGT, 2005).

Risk management; the administration of risks and uncertainties that emerge in the course of a project life cycle that may affect the performance of a project

Standards; principles that guide projects to performance

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

With a marked surge in project cost, time, and scope overruns; and the changing project complexities, it is clear that a valid and reliable project management technique has attracted a significant attention in the contemporary project management world. Earned Value Management is one of the best monitoring and forecasting techniques under project management (PMI, 2011). However, its forecasting ability is in question since it predicts the future performance of a project from its past (Tabriz et al., 2013). For this reason, the study purposed to review literature on the same to give an understanding of EVM for monitoring and forecasting of project performance with a focus of strengthening its forecasting ability by advancing its forecasting formulae through incorporating it with a risk element with respect to project performance. This was achieved by combining it with a more comprehensive forecasting technique; Enterprise Risk Management.

Further, the study aimed at reviewing literature on the factors that influence monitoring and forecasting of project performance. The factors were looked at from the uncertainty point of view with a concentration on uncertainty that matters and in relevance to forecasting. According to Hillson (2004; 2009), uncertainty that matters is referred to as risk and risk has both negative and positive effects. Thus, the study looked at risk in form of opportunities and threats with a concentration on threats to denote the positive and negative effects of risk respectively. Additionally, the study looked into the theories that underpin the concept of Earned Value Management in monitoring and forecasting of project performance. Finally, the study looked into the variables that explain the study, a conceptual framework to denote the relationship among the variables, and concluded with the operationalization of such variables.

2.2 Theoretical framework

Forecasting of project performance refers to the estimation or approximation of the future performance of a project in terms of completion time and cost (PMI, 2011). It has been discussed by various researchers using theories such as risk and uncertainty (Hillson 2004; 2009) and the past determines the future (PMI, 2011). In the context of this study, the uncertainty theory which renders the theory of the past determining the future futile dominates the other theory. It is this theory that brings on board the

reason why EVM's major assumption of predicting the future performance of a project from its past is under dispute. Therefore, the study looked at both theories to give a basis on which the extension of Earned Value Management was founded.

2.2.1 "The past determines the future" theory

This theory stems from pre-existing conditions whereby the evidence of available data helps in estimating the future performance of something. In the context of this study, many researchers (Hillson, 2004; 2009; Henderson, 2007; Vanhoucke & Shtub, 2011; Tabriz et al., 2013) have argued about this theory claiming that it stands the test of reliability and efficiency in the real environment where all factors are kept constant. It is the basis on which Earned Value Management is able to predict the future performance of a project from its past (PMI, 2011). But, with uncertainty, complexities and uniqueness of projects, the presumption is under debate and raises questions (Hillson 2004; 2209; Tabriz et al., 2013). Hence, in order to strengthen the forecasting ability of Earned Value Management, this theory has to be looked at with the uncertainty theory.

2.2.2 Uncertainty theory

The uncertainty theory in project management can be attributed to the works of Cleden (2009; Hillson, 2004; 2009). A number of definitions have been brought out to refer to uncertainty. For instance, Hillson (2004; 2009) defines uncertainty as the unknown future of the state of affairs and goes forth to classify uncertainty into risk and irrelevancies. He defines risk as uncertainty that matters, and if it occurs can affect the project objectives and irrelevancies as uncertainty that if it occurs has no impact on the project objectives. Thus, in relation to this study, the uncertainty theory was a vital component considered as it gave a basis of this study and concentrated on uncertainty that matters which is risk. In extending of Earned Value Management, the risk that stems from uncertainty was factored into the model and thus a resultant model; Earned Value Management-Enterprise Risk Management model. This was to strengthen the forecasting ability of Earned Value Management by incorporating the risk element that stems from uncertainty to its forecasting formulae. The risk element was gotten from the classification of Enterprise Risk Management (Razali & Tahir, 2011).

2.3 Project Performance

Project performance refers to the success or failure of a project (PMI, 2011). Project performance is vital to organizations and more specifically to firms concerned with project management (Shaban, 2008). Shaban further states that, project performance relates to a number of determinants such as cost, schedule, and quality among others. However, consistent with previous studies (PMI, 2011: Tabriz et al, 2013), the study looked at the three very important determinants; cost, scope and time. In the context of this study, project performance will be measured in terms of the completion time and the completion cost. This is because scope is dependent on time and cost of a project. Each of these measures of performance has been detailed below;

2.3.1 Time Performance

According to the Project Management Institute (2011), time performance refers to as the success or failure of a project with regard to completion time where success refers to completing the project within stipulated period and failure refers to as having time overruns that impacts the projects objectives negatively. Memon, Rahman, and Azis (2012), define time overrun as completion of project activities at a later date compared to the planned duration. They explain further that this is often as a result of many factors such as; contract delay in form of lost cash or incurrence of extra expenses.

2.3.2 Cost Performance

Cost performance is defined on the basis of the concept of project performance whereby it refers to the success or failure of a project with regard to completion cost as compared to the budgeted cost. In case of success the project activities are completed using the same cost as budgeted or less while failure refers to exceeding of the budgeted cost termed as cost overrun.

2.3.3 Scope Performance

Scope performance is the extent to which the project goals and objectives are achieved in a manner that was planned at the project initiation stage (PMI, 2011). Project performance is never stand alone, it is dependent on the time and cost performance.

Therefore, to attain performance based on these factors, a number of indicators have to be looked at. For instance, to attain good performance in terms of costs, top management support and project managers know-how have to be looked into plus many other factors. The same applies to time and scope performance. In dealing with project performance a number of challenges have to be dealt with. Augusto et al (2006, as cited in Shaban, 2008) claim that effective project performance is attained through a number of challenges.

For example, employees quitting before project closure, forcing the management to look for other employees and training them to be at par with the project affects the performance of a project. To deal with such challenges and attain outstanding Project performance, there is need to measure project performance in order to manage projects effectively. These can be done through monitoring, evaluating, reporting and forecasting among others but the study will only look at monitoring and forecasting, with a concentration to forecasting of project performance.

2.3.1 Monitoring and Forecasting of Project Performance

According to Civicus (2001) monitoring is a methodical way of gathering and exploring information during the project life cycle and most importantly it does this as the project advances. Through this, monitoring is purposed to cultivate the project in terms of its efficiency and effectiveness. Civicus further emphasizes that monitoring is an essential PM tool that can track and help management know when things are in good shape and when they have lost shape. Additionally, if done well, it helps the project managers and other project stakeholders determine if the resources at hand are being put to use effectively and if they are adequate.

As stated in PMI (2011) monitoring is an essential element in project management and particularly in driving projects towards success in terms of performance. PMI (2011) denotes monitoring as the tracking of the physical progress of activities, tasks and the entire project during the project life cycle. On the contrary, project forecasting is a prediction on the future performance of a project based on evidence from available data on the same (Anbari, 2003). In addition, forecasting involves the careful analysis of other factors that may stem in the cause of a project life cycle affecting the project (Tabriz et al., 2013). Anbari further states that, forecasting helps

project managers and other project stakeholders to be able to know when to begin new projects and when to continue with already existing projects.

It need be integrated at the very initial stages of a project (Naeni, 2013). This is due to the uncertainty and specifically the risk element which is naturally present in projects (Vanhoucke & Shtub, 2011). This calls for cost, time, and scope to be analyzed gradually following the standards of management by exception; allowing managers and others to make adjustments when and where necessary (PMI, 2011). Hence, it is paramount to look at the factors that influence project performance especially in forecasting. This is to enhance the performance of projects in its core areas; scope, time, and cost. A number of factors as discussed in section 2.4 affects the performance of projects and need be analyzed carefully and their loss mitigated.

2.4 Factors that influence forecasting of project performance

In a perfect world, where the future is well- known with certainty and given the ever changing and non-repetitive nature of projects, there are a number of factors that influence monitoring and forecasting of project performance (Vanhoucke & Shtub, 2011).According to Hillson (2009), a number of factors influence monitoring and forecasting of project performance such as internal project changes and the external environment. In respect to this, the study explored factors that affect the performance of the project in respect to EVM and ERM. From the EVM perspective, factors that denote the past to forecast the future are of importance, but this study concentrated on the factors from the ERM perspective; factors that denote risk and uncertainty in forecasting of project performance. This is to denote the importance of incorporating the risk factors/elements into EVM so as to strengthen EVM's forecasting ability that is question (PMI, 2011).

In looking at risk and uncertainty, Hillson (2009) found out that risk is uncertainty that matters and thus the study discussed the factors in one big umbrella; uncertainty with a concentration on uncertainty that matters. This is because the uncertainty that does not matter (irrelevancies) has no impact on the project objectives. Risk stems from uncertainties and is not always bad and can be classified as opportunities and threats and therefore it is imperative to consider both sides of risks (Tabriz et al., 2013). For instance Opportunities help in achieving the objectives and goals of the project while threats pose difficulties to projects. Hence, the study took the direction

of the threats that pose difficulties to projects in order to enhance the performance of projects.

As cited in Enshassi, Mohamed, and Abushaban (2009), Faridi and El-Sayegh (2006) found out that factors such as; skilled staff, equipment issues including equipment shortages, unsuitable leadership, poor site management, and poor supervision lead to delays in projects thus impacting on the cost of projects. Further, conflicts, incompetence of contractors, and poor workmanship are also major factors that influence the performance of projects in various aspects (Enshassi et al., 2009 as cited in Hanson et al., 2003). This shows that project performance is indeed a critical area that need be looked at carefully for the success of projects. These factors need be looked at with sophisticated tools that are able to reduce the impact and magnitude of such factors leading to outstanding project performance.

Consequently, in a study carried out by Mbachu and Nkando (2007 as cited in Enshassi, 2009), it was ascertained that quality and attitude (performance of project managers) to service were the critical factors that influenced the performance of projects. The quality offered to service especially from the project managers and other key project stakeholders can have real weight on the outcome of the project results. In addition, the core elements depicting the success or failure of projects being the completion time and the completion cost are the major attributes of projects that get affected by many factors influencing the performance of projects. In respect to this, Dissanayaka and Kumaraswamy (1999 as cited in Enshassi, 2009) noted that the completion project cost and time get affected by the project attributes of procurement systems, project team performance, and some of the contractor features.

Further, in agreement with other studies on the factors that influence project performance such as Dissanayaka and Kumaraswamy, 1999), Iyer and Jha (2005 as cited in Enshassi, 2009), noted that the project manager's competence, top management support in an organization, economic factors, and various climatic conditions are major factors that determine the success or failure of projects in various industries and sectors. On the contrary, Belassi and Tukel (1996) grouped the factors that affect project performance into four categories; factors related to the project itself, factors that are related to the project managers and other team members, factors that are related to the organization in which the project is being undertaken, and the

factors related to the external environment. They ascertained that the combination of this stated factors can affect the performance of projects and lead to project failures.

Additionally, Gichoya (2005) found out that finance, poor systems, and skilled personnel to be paramount factors that lead to project failures. Hence, there is need for a reliable project management technique that will incorporate the risk elements/factors for better forecasting of project performance and to reduce the cost and time overruns. This study looked at the techniques used in monitoring and forecasting of project performance and the integration of the discussed factors to enhance the performance of projects.

2.5 Techniques used in monitoring and forecasting of project performance

Project Management and specifically attaining project performance is a challenging undertaking with many activities of multifaceted tasks. This calls for sophisticated tools and techniques to realize and accomplish the tasks. To do this, a number of tools and techniques are in place that can be used to attain excellent project performance. Some tools and techniques can be put into use manually but some require the help of software. Thus, a proper choice of a tool and technique should be made to suit the very purpose of a project undertaking (PMI, 2011). In the context of this study, tools and techniques will be discussed in respect to monitoring and forecasting of project performance with a focus to forecasting of project performance. There are a number of them (Stochastic S curves, Risk Management, Earned Value Management Enterprise Risk Management among others). In respect to this, this study gave attention on the ones that relate to the core project performance measurement concept (forecasting) which is under question in relevance to Earned Value Management; Risk Management and ERM and their combination with EVM.

2.5.1 Earned Value Management

Among all the tools and techniques discussed in this study and even those not covered in the study, none matches the ability of EVM to monitor and forecast project performance and for enhancing the success and progress of projects (PMI, 2011). Henderson (2007), points out that it provides up to date information on project performance on the present status of a project. According to Pedro et al. (2011), the technique gives true and comprehensive verdict of time and cost of a project at any stage of its life allowing easy track of the project and easier administration of its

activities on every step of the way. Additionally, Vanhoucke and Shtub (2011), stresses that EVM has the capacity to detect when the project is not going on the right direction at any point from the activity to task and finally to the project level. This is through the use of performance measures and metrics through the entire project Work Break down Structure (WBS) and Organizational Breakdown Structure (OBS).

Table 2.1 shows a summary of the Earned Value Management performance measures and Project Management questions they answer based on the data category (budget at completion which shows the total planned value for the project, actual cost, planned value and earned value). Table 2.2 gives an interpretation of EVM on its metrics.

Table 2.1: EVM performance measures and PM questions; PMI, 2011

Category	**EVM performance measures**	**PM questions**	**Formulae**
Variances	Variance at completion(VAC)	Will we be under or over budget?	$\text{BAC} - \text{EAC}$ VAC% =VAC/BAC
	Cost variance(CV)	Are we under or over our budget?	$\text{EV} - \text{AC}$
	Schedule variance(SV)	Are we a head or behind schedule?	$\text{EV} - \text{PV}$ $\text{CV\%} = \text{CV}/\text{EV}$
Indices	To-complete performance index(TCPI)	How efficiently must we use our remaining resources?	$(\text{BAC} - \text{EV})/(\text{BAC} - \text{AC})$
	Cost performance index(CPI)	How efficiently are we using our resources?	EV/AC
	Schedule performance index(SPI)	How efficiently are we using time?	EV/PV
Forecasts	Time estimate at completion(EAC_t)	When are we likely to finish work	$(\frac{\text{BAC}}{\text{SPI}})/(\frac{\text{BAC}}{\text{MONTHS}})$
	Estimate at completion(EAC)	What is the project likely to cost?	BAC/CPI
	Variance at completion		

Table 2.2: EVM interpretation- PMI, 2011

Metric	**Interpretation**
CV & SV	Always denoted by a positive or negative. A positive indicates a head of time or below budget
CPI & SPI	Always denoted by greater than or less than one. Greater than one indicates that the project is a head of time or below budget. Less than one indicates that the project is behind time or above budget

EAC & EACt	If the EAC ≥ budgeted cost, then the completion cost ≥ budgeted cost. If EAC ≤ budgeted cost, then the completion cost ≤ budgeted cost. If EAC = budgeted cost, then the completion cost = budgeted cost. If the EACt ≥ planned duration, then the completion time ≥ the planned duration. If the EACt ≤ planned duration, then the completion time ≤ planned duration. If the EACt = planned duration, then the completion time = planned duration

2.5.2 Risk Management

Given the uncertainty nature of projects, risks are inherent in every type of project and thus a robust forecasting technique is of importance (Vanhoucke & Shtub, 2011). Pullan and Webster (2012) contend that uncertainty is an inescapable component of change in projects. Hillson (2004) looks at risk as uncertainty that matters. On the other hand Tabriz et al. (2013) considers risks to be the same as uncertainty. The study will look at risks from Hillson's point of view, because clearly risks and uncertainties are not one and the same. This is because risk stems from uncertainty. In the presence of uncertainty and thus risk, Tabriz et al (2013) discusses the process of dealing with Risk Management. Tabriz et al argue that RM involves four stages of planning for the risks, identifying risks that will affect the project, analyzing the risks and responding to them to mitigate them. The risk analysis stage is of importance and is done either qualitatively and quantitatively (Hillson, 2004).

In identifying the risks, a list need be generated which can be gotten by the use of a Risk Breakdown Structure (RBS). This assists in separating the opportunities from the threats. From these discussions, RM can be seen as an effective technique in managing risks. However, it looks at risks in an individual sense. This means RM does not integrate risks in a unified way to deal with them as a single component (Razali & Tahir, 2011). In respect to this, Razali and Tahir argue that over time, RM has taken a different transition. They date the history of RM back to the 1950's when it was developed for insurance purposes and thus insurable risks. In 1963 RM took a different direction of covering pure and speculative risks. In the 1970's a financial

aspect of risk came into play due to the issue of exchange rates and increase of prices in the petroleum sector. In the 1980's due to the rise of politics among multinationals, political risks attracted a significant attention. In the 1990's, given the changing environments and more so in technology, RM had to take a different path involving not only hazard risks but also strategic risks, operational risks and financial risks. Razali and Tahir (2011) argue that RM could not be managed separately and thus the need of integrating the various types of risks into a single component; ERM.

For this reason, the study sought to extend EVM by advancing its forecasting formulae for forecasting of project performance. This was to strengthen the forecasting ability of EVM using ERM that looked at risks in a unified way with the classification of; operational, strategic, financial, and hazard risk factors.

2.5.3 Enterprise Risk Management

Enterprise Risk Management which stems from Traditional Risk Management can be defined as the integration of all types of risks in a single framework (Razali & Tahir, 2011). In line with this definition, a number of researchers have come up with different meanings of the term (Razali & Tahir, 2011 citing Lam, 2008; Makomaski 2008: Hillson, 2009). For instance, Hillson (2009) refers to ERM as a companywide way of managing risks. In the context of this study, ERM will denote department wide way of managing risks; the project unit will be viewed as an organization and thus risks stemming from all sides will be looked at which will be classified into one; project risk factor. According to Razali and Tahir (2011; Hillson, 2009), table 2.1 provides a classification of all types of risks that may affect a project with their examples.

Table 2.3: Types of risks as per ERM

Type	Definition	Example	Abbreviation
Hazard risk	Risk that poses threat or injury to a project	Climatic conditions.	Hr
Financial risk	Risk affecting the project financial resources	Rise in interest rates Fall in interest rates	Fr
Strategic risk	Risk affecting the project objectives; mission, vision, goals etc.	Delays of disbursement processes	Sr
Operational risk	Risk affecting the efficient use of resources	Careless project manager	Or
ERM =Hr + Fr + Sr + Or			

2.6 Combined approaches of EVM for forecasting of project performance

Due to the limited number of project management techniques for monitoring and forecasting project performance, there is need for the combination of the same techniques to enhance project performance. Existing techniques have shortcomings that lead to overruns in scope, cost and schedule leading to project failures and poor performance. As a result, a combined approach to one of the most effective tools in PM; EVM is of importance to help curb the shortcomings of the techniques that are already in place. A number of combined approaches are in place-Earned Value Management and Critical Chain, Earned Value Management and Tree Maps (Cable et al., 2004;Baker, 2013 but for the purposes of this study only a combined approach of EVM and RM was considered and extensions on the same.

2.6.1 Earned Value Management and Risk Management

The combined approach is attributed to the works of Hillson (2004; Tabriz et al., 2013). Hillson affirms that despite Earned Value Management's strength in monitoring and forecasting project performance, EVM's forecasting ability is wanting since it predicts the future performance of a project from its past. Given the uncertain environment and many other factors affecting project performance, the assumption does not hold. Thus need for Risk Management to help with the forecasting element. In agreement with Hillson (2009), Tabriz et al. (2013) emphasizes on the forecasting weakness of EVM. Thus a combined approach on the same to monitor and forecast project performance is gotten by adjusting the EVM indices using Risk Management. Tabriz et al. (2013), uses a risk ratio to do the adjustments. The resulting estimates from the adjustments of the EVM indices with RM to make the approach combined denotes; if the risk adjusted estimate at completion ($R(A^2EAC)) \geq BAC$, then final cost>budgeted cost.If ($R\ (A^2EAC)) \leq BAC$, then final cost< budgeted cost. If ($R\ (A^2EAC_t) = BAC$, then final cost=budgeted cost.

For the case of the planned duration (PD), if ($R\ (A^2EACt) \leq PD$, then completion time< budgeted time, if $R\ (A^2EAC_t) \geq PD$, then completion time>budgeted time and if $R\ (A^2EACt) = PD$, then completion time= budgeted time. These calculations are based on a strong belief that the project cost and time can be forecasted with certainty (Tabriz et al., 2013). Hillson (2004; Czarnigowska et al., 2011), uses a different approach of integrating the time-cost risk model which results in S-curves commonly referred to as onion ring diagram. They present the cumulative impact of dealing with key risks enabling the most crucial risks to be dealt with first. The model also, if applied to PV, reveals risks that affect the earned value and project performance giving managers a wakeup call to stay focused. However, this approach does not explain how risks are identified and does not consider all types of risks that may affect a project. Therefore, the study sought to extend the combined approach of EVM and RM by using Enterprise Risk Management which deals with all risks affecting a unit in an integrated way.

2.6.2 Earned Value Management and Enterprise Risk Management

Given a number of valuable studies on a combined approach to EVM and Risk Management (Hillson 2004; 2009; Tabriz et al., 2013) in monitoring and forecasting project performance, there is limited literature on the extensions of the combined approaches on the same. Thus, this study aimed at looking into the strength and effectiveness of Earned Value Management in monitoring and forecasting project performance. Given that only its forecasting ability has been questioned (Vanhoucke & Shtub, 2011; PMI, 2011) implying that its monitoring ability is at par in line with excellent performance. Therefore, the study used the ERM project risk factor to adjust the forecasting metrics of EVM to help strengthen its forecasting ability. This was done by incorporating the ERM project risk factor into the EVM forecasting formulae presenting a combined model; EVM-ERM model.

Existing EVM model (PMI, 2011) and Existing ERM model (Hillson 2004; 2009; Razali & Tahir, 2011):

Forecasting EVM formulae; Given that EVM is based on cost, time, and scope measures in respect to project performance, only cost and time have been quantified. This is because scope is dependent on the time and the cost. Also, whatever is not in the work break down structure is not defined as scope (PMI, 2011).

Cost forecasting formula; $\mathrm{EAC} = \mathrm{AC} + \left[\mathrm{BAC} - \frac{\mathrm{EV}}{\mathrm{CPI}}\right] = \mathrm{BAC}/\mathrm{CPI}$……..... [2.1]

Where EAC is the estimate at completion in terms of cost, AC is the actual cost, BAC is the cost budgeted for the entire project undertaking; EV is the earned value which is the budget that is approved for the scheduled work to be completed at a particular date. CPI is the cost performance index which shows how well the project is doing in terms of cost. Concerning this, a number of assumptions and formulae are in place to denote the EAC, but the study used the formulae that relate to the direction the study was taking (strengthening forecasting ability of Earned Value Management). Thus, the assumption: the future cost performance will take the trends of the past cost performance.

Time forecasting formula; $\mathrm{EAC}_t = \left(\frac{\mathrm{BAC}}{\mathrm{SPI}}\right)/\left(\frac{\mathrm{BAC}}{\mathrm{MONTHS}}\right)$…… [2.2]

Project Risk formulae; Enterprise Risk Management formulae

Given the types of risks under ERM; let Hr represent hazard risk, Fr represent financial risk, Sr represent strategic risk, and Or represent operational risks. Thus taking all the risks to be represented by the term project risk to be denoted by Pr and since EVM is an additive/subtractive model; ERM model will follow the same trend but take the additive direction since risk need be incorporated in EVM. Therefore, the ERM formulae; $Pr = (Hr + Fr + Sr + Or)$ ……. [2.3]

In getting the project risk, the model was based on the assumption that the four risk factors are inherent in every project but their individual magnitude is irrelevant since the probability expectation is computed on a summation basis. Therefore, the probability of an event (A) happening equals the number of happenings of A divided by the total number of happenings giving basis for the indicator variable put into use as shown below;

(Project Risk Factor) = $\begin{cases} 1 \ldots\ldots \text{If any of the risk factors exist.} \\ 0 \ldots\ldots \text{Otherwise} \end{cases}$

Thus, Probability of Risk; P (r) = Risk Factor (r)/ Total number of project risk factors (r_p), where rp = 4 (Operational risk factors, Strategic risk factors, Financial risk factors, and Hazard risk factors).Thus, expected probability of risk;

$E [P(r)] = \sum r\ p(R = r)$.

The EVM-ERM model put into use the probability expectation of risk as the project risk factor as represented below;

Project risk factor = $\sum [OrP + SrP + FrP + HrP)$……. [2.4]

Where; P is the probability of each individual risk factor.

2.6.2.1 Proposed EVM-ERM Model

The Forecasting Cost Formulae:

Let BEAC represent the estimate at completion in terms of cost; EAC in original EVM, where BEAC stands for the budgeted estimate at completion.

Thus, BEAC= BAC/CPI

But CPI = EV/AC

Where EV $= \%C *$ BAC, and %C is the work completed as per the planned date of project completion in terms of a percentage.

Therefore, BEAC = BAC/ (EV/AC')

Simplifying further; BEAC = BAC * AC'/EV

Hence, BEAC = BAC* AC'/ (%C *BAC)…….. [2.5]

AC' represents the cost that would have been expended as per the original planned closure date.

Thus, EV does not play a role in estimating the future cost of a project and therefore a risk component need be integrated into BAC. This is because, at the planning stage nothing has been earned and therefore risk need be incorporated at the planning stage. The value denoting the risk element was subtracted from the budget at completion to denote the burden the project had to undergo in the occurrence of such risk factors. Further, this is because the study concentrated on the threats that impacted on the projects under study negatively causing overruns in completion cost. The 'A' before the formula denotes adjusted which denotes the incorporation of the risk element.

Therefore, ABEAC = (BAC- Pr) * AC'/ (%C * BAC)…… [2.6]

The Forecasting Time Formulae:

Let SEAC represent the time estimate at completion; EACt in original EVM. Where SEAC is the schedule estimate at completion.

Original EVM; EACt =$[(\frac{\text{BAC}}{\text{SPI}})/(\frac{\text{BAC}}{\text{MONTHS}})]$…… [2.7]

Simplifying further; BAC/SPI * MONTHS/BAC which gives MONTHS/SPI. Thus, SEAC$=$ MONTHS$/$SPI

But, SPI$=\frac{\text{EV}}{\text{PV}}$, hence SEAC $=$ MONTHS(PV)$/$EV

PV= (planned % at completion) * BAC

Then, the risk component is introduced to the planned value since it involves the approximated value of the amount of work planned to be accomplished. The negative impact of risk factors leading to completion time overruns was reflected by the threat direction. Additionally, given that EVM is an additive/subtractive model, the project

risk took the subtractive direction as in the case of the EVM/ERM cost forecasting formulae to denote the direction the study took in exploring the risk elements.

Thus, ASEAC =MONTHS (PV- Pr)/ %C *BAC …… [2.8]

MONTHS represents the entire planned duration till closure in form of months.

Therefore, EV does not play a role in time estimate at completion, this is because at the time of approximating the completion time (during the planning stage of a project), nothing has been earned and thus use of PV. Considering the major assumption of EVM; predicting the future performance of a project from its past, risk elements should be catered for at the planning stage of a project lifecycle and hence should be factored into PV. This calls for ERM formulae to provide the risk factor to adjust the EVM indices.

Combined adjusted EVM-ERM formulae:

ABEAC = (BAC- Pr) * AC'/ (%C * BAC)
ASEAC =MONTHS (PV- Pr)/ %C *BAC …… [2.9]

2.7 Conceptual Framework

Following a discussion on previous studies on EVM's assumption that the future performance of a project is predicted from its past performance (PMI, 2011) and the need to extend the EVM forecasting formulae to incorporate the risk element in order to strengthen the forecasting ability of EVM, the conceptual framework for this study was developed from a review of existing literature and the variables under study. The dependent variable for the study was project performance while the independent variable was the proposed EVM-ERM model.

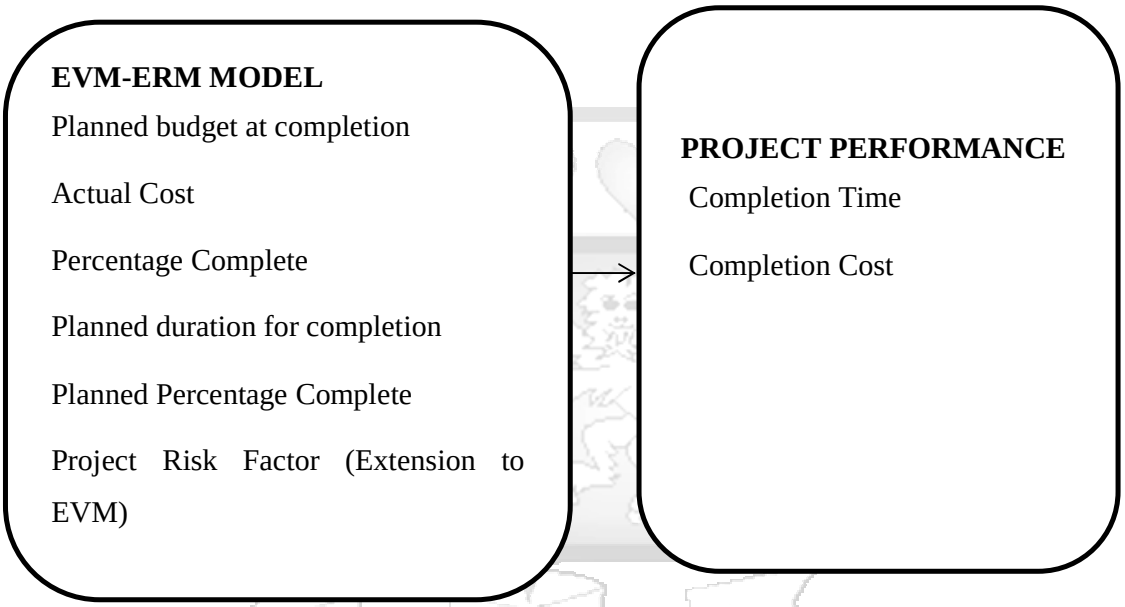


Figure 2.1: Conceptual framework for an extension foam for forecasting of project performance.

2.8 Variable Operationalization

The independent variable is a combination of subcomponents from each individual technique. The first five components in the conceptual framework for the independent variable represent Earned Value Management while the sixth component (Project Risk Factor- used to extend Earned Value Management) represents Enterprise Risk Management.

The planned budget at completion is the BAC (refer to the EVM-ERM model in section 2.6.2.1 in equation 2.9). This denotes the budget put aside for the project activities till the planned closure date. The BAC is a cost and thus was measured in US$ in millions. The actual cost is the cost that was expended in the project activities as per the original closure date and thus referred to AC' in the EVM-ERM model (refer to section 2.6.2. in equation 2.9). The AC' is a cost and was measured in US$ in millions. The percentage complete depicts the amount of work completed as per the planned closure date and was measured in a percentage form where zero was taken as the minimum and a hundred as the maximum percentage.

Planned duration for completion reflects the time planned to complete the project and was measured in months of thirty days each. Planned percentage complete shows the amount of work planned to be completed as per the planned closure date in form of a percentage. Finally, the project risk factor indicates the quantification of the risk factors that affected the infrastructure projects in Kenya funded by the World Bank between the closure projects dates of 1975 to 2013. The risk factor was factored using the probability theory and measured as one if it existed and zero otherwise. These factors were measured in relation to project performance in terms of completion time and cost. Completion time refers to the amount of time the project runs from its initiation stage of a project life cycle all through closure and was measured in months .completion cost refers to the amount of resources in terms of finances that have been expended for the project from its initiation stage all through closure. Completion cost was measured in US$ in Millions.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The sole aim of this study was to strengthen the forecasting ability of Earned Value Management by advancing its forecasting formulae to incorporate the risk element. This was achieved through developing a combined approach of EVM and ERM for monitoring and forecasting of project performance. The chapter emphasized on the target population that was studied, the research design that the study employed, and the target population that was put into use. Further, the chapter looked at the data collection methods together with the data collection instruments, the EVM-ERM model developed (derived from the last section of chapter two;), how the model was tested, data analysis, model assumptions and interpretation, research quality, and the ethical considerations.

3.2 Research design

The study employed a quasi-experimental research design. A quasi- experimental research design considers two groups without the element of random assignment (Kothari, 2003). In the two groups, a factor is introduced to one of the groups and then the groups are compared to depict their behavior before the introduction of the element and after the introduction of the element. This study sought to advance the forecasting formulae of EVM by incorporating the risk element into it for forecasting of project performance. Therefore, the quasi-experimental aspect of this study was exhibited from the model side. The first group (control) was the original EVM forecasting model subjected to infrastructure projects in Kenya funded by the World Bank. The other group (experimental) was the EVM-ERM model in which risk had been incorporated subjected to the infrastructure projects in Kenya funded by the World Bank. This was to denote the importance of incorporating the risk element into the existing EVM model.

3.3 Target population

The study targeted all the infrastructure projects in Kenya funded by the World Bank from the closure year 1975 to 2013(75 projects). The study looked at 37 of them that had run from the initiation stage of the project life cycle all through closure stage of a project. Projects that were carried out in Kenya but have a link to other countries were excluded as the study concentrated on projects in the Kenyan context.

Further, projects that had US$ 0.00M indicated as their commitment amount were excluded as no project will be undertaken even to its first step with such an amount. The target population was selected on the basis that infrastructure projects in Kenya are faced by risks, which may affect the performance of such projects. For instance, the demand for housing due to the rise in population, growing investor interest et cetera (Tharani, Anjarwalla, & Khanna, 2012). Moreover, in a study carried out by Kagiri and Wainaina, (2008), it was found out that factors that affect infrastructure projects in Kenya relate to risk factors. Hence, due to a small population, there were no sampling procedures carried out.

3.4 Data collection methods

A secondary data collection methodology was employed whereby data was collected by reviewing World Bank projects and operations reports from the years 1969 to 2013 and extracting data from the documents. The data collected was; risk factors, the budgeted amount for the entire project undertaking, actual cost of the project at completion, planned duration for the project, the effectiveness date (when the project became effective), approval date(when the board of directors approved the commencement of the project), original closure date, revised closure date, and the actual closure date. All these data was collected in favour of the calculations of the various components of the proposed EVM-ERM model.

3.5 Data Analysis and Model Development

3.5.1 Data Analysis

Data collected was first sorted and cleaned for any errors. Besides, Content and computational analysis was carried out. Content analysis involved reviewing various World Bank documents to explore on the risk factors that influence project performance and EVM metric data. Further, computational analysis involved fitting the results from the content analysis into the model through advancement of its forecasting formulae. This yielded the final EVM-ERM forecasting model on which data for various components of EVM extracted from the same reports was fitted into to give final results of the proposed EVM-ERM forecasting model. The data and the results from the same data were presented through tabulations and graphical representations.

3.5.2 Model Development

From section 2.6.2, the EVM cost and time formulae are adjusted by the ERM formulae to bring about the final EVM-ERM model to be used to forecast project performance.

Therefore, ABEAC = (BAC - Pr) / (%C *BAC) /AC …….. [3.1]

Thus, let BAC be represented by X, %C by Y, and AC by Z.

Hence, the adjusted budget at completion (ABEAC) = (X + Pr) / (Y * X) /Z

Thus, the final cost formulae in the EVM-ERM model;

ABEAC = (X -Pr) / (Y * X) /Z…… [3.2]

ASEAC =MONTHS [(Planned % at completion * BAC) - Pr / (%C* BAC)]

Thus, let MONTHS be represented by T, Planned percentage at completion by W.

Hence, the adjusted time at completion (ASEAC) = T [(W * X) - Pr /(Y * X)]

Thus, the final time formulae in the EVM-ERM model;

ASEAC = T [(W * X) -Pr /(Y * X)…… [3.3]

N/B: the A before the formulae denotes adjusted.

3.5.3 Model assumptions and Interpretation

This study sought to propose an extended Earned Value Management based model that will forecast the future performance of projects with reductions in completion time and cost as depicted from the practical scenario of infrastructure projects in Kenya funded by the World Bank from the closure year 1975 to 2013. The Earned Value Management-Enterprise Risk Management model took into consideration a number of assumptions for its suitability in the uncertain and the larger Project Management world. The assumptions are as follows;

Risk is uncertainty that matters and in the case of this study, the threat side of risk was the one explored to bring out the proposed Earned Value Management-Enterprise Risk Management model. Besides, the calculation of risk has been based on the probability theory whereby the four risk factors are inherent in every project but their individual magnitude is irrelevant since the probability expectation is computed on a summation basis. The probability expectation of risk is used for computation in the

Earned Value Management-Enterprise Risk Management model as the project risk factor. Further, the study computed the risk factor based on the classification of risk as per Enterprise Risk Management; hazard, financial, strategic and operational. Finally, the Adjusted Budget Estimate at Completion and Adjusted Schedule Estimate at Completion are based on the assumption that the past performance determines the future; this is from the original Earned Value Management forecasting measures.

Model Interpretation

The interpretation of the final model borrowed a lot from the original EVM forecasting model and the trend is as shown below;

If ABEAC ≥ budgeted cost, then completion cost > budgeted cost.

If ABEAC ≤ budgeted cost, then completion cost < budgeted cost.

If ABEAC = budgeted cost, then completion cost = budgeted cost.

Consequently;

If ASEAC ≥ planned time, then completion time ≥ planned time.

If ASEAC ≤ planned time, then completion time ≤ planned time.

If ASEAC = planned time, then completion time = planned time.

3.5.4 Model testing

The extended EVM forecasting model was tested for reliability, consistency, and efficiency. For reliability, the model was tested for taking all the factors that it presumed to measure. This was found out to be true since the model was a makeup of risk factor, cost elements, and time elements with the scope of the project not quantified since it is dependent on time and cost. In addition, these elements; scope, time, cost, and risk are among the knowledge nine areas of project management and thus the model is a basis of pure grounded Project Management drivers of performance. For consistency, the model was subjected to 37 infrastructure projects in Kenya funded by the World Bank from the various sectors of the state. It was noted that the model took a uniform trend from one project to another depicting its ability to forecast project performance in every type of project in any type of environment. Finally, for efficiency the model was tested by comparing the estimated actual completion cost and time with the real completion actual cost and time.

3.6 Research quality

The study ensured quality was achieved in form of validity and reliability. This is in line with the data collected and the instruments that were used to collect the data. Different documents were reviewed to confirm homogeneity and consistency of the data collected. Project data sheets, implementation and completion status reports and other reports (environmental assessment reports) were looked at keenly to see if there were any deviations of the data collected. The study ensured internal validity by fitting the filtered and computed data into the original EVM model and then into the EVM-ERM model to depict the nature of the research design that the study employed; quasi experimental.

Moreover, the study ensured external validity by looking at all the infrastructure projects in Kenya funded by the World Bank with an exclusion of; projects that had not run till closure, projects with links to other countries beyond Kenya, and projects which had US$ 0.00M as the commitment amount. Out of the 75 projects, 37 projects were looked into as they exhibited the attributes that the study considered for the target population. Finally, the study exhibited reliability by testing the model in various infrastructure projects in Kenya funded by the World Bank from different sectors and ministries. This showed that the document review instrument for data collection can still be used by other researchers and give the same implication as the one in this study. Thus, this reflected that the model will be able to forecast project performance in any type of project and in any type of environment (real and uncertain).

3.7 Ethical consideration

The study complied with every term that relates to compromising with the ethical standards for collecting and using the data. Documents reviewed with permission since data was collected from an open database. Data collected was used for research purposes only. Also, materials that were used were acknowledged fully to avoid the issue of plagiarism. Lastly, no alterations of the findings were made to suit the researcher's interest, but findings were presented in their true values.

CHAPTER FOUR: PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

The aim of this study was to strengthen the forecasting ability of Earned Value Management through extending its forecasting formulae for forecasting of project performance. For this reason, this chapter highlights the findings of the factors that influence forecasting of project performance, the practical efficiency of EVM in forecasting of project performance and the practical efficiency of a combined approach of EVM and ERM in forecasting of project performance. Both the EVM and EVM-ERM model were subjected to the infrastructure projects in Kenya funded by the World Bank. Further, the chapter looks at the source of data and the explored documents that resulted to the findings as per the objectives that guided the study.

4.2 Exploration of World Bank reports on infrastructure projects in Kenya

The study looked at various reports from the World Bank Open Database to get the necessary information categorized as; project data sheet, implementation completion and results report, project paper, project information document, and financiers' sheet. 37 of this individual documents were reviewed in regard to objective number one; which sought to examine the factors influencing forecasting of project performance, objective number two; which sought to analyze the forecasting ability of Earned Value Management with respect to project performance, and objective number three; which sought to develop a combined approach of Earned Value Management and Enterprise Risk Management in forecasting of project performance. The links of the individual project documents have been provided as part of the references for reference.

4.3 Risk factors that influence forecasting of project performance

The study sought to examine the factors that influence forecasting of project performance with a concentration to factors that relate to risk. Therefore, this section presents the factors that influenced forecasting of infrastructure projects in Kenya funded by the World Bank that relate to risk. The factors were quantified to represent the project risk factor that was incorporated into Earned Value Management.

According to the ERM classification of risk; Hazard, Operational, Financial, and Strategic risk, it was found out that all projects were affected by the financial risk

while the other classifications of risk was only experienced in some of the projects. Table 4.1 gives a summary of the representation of the factors that were found to be influencing forecasting of project performance; a practical scenario of infrastructure projects in Kenya funded by the World Bank. Appendix 2 shows a detailed representation on the same.

Table 4.1; Risk factors influencing forecasting of project performance

ERM Classification; Factors influencing forecasting of project		
Risk Factors	**No. of Projects**	**% of Risk Factor**
Operational Risk Factors	23	62.16
Strategic Risk Factors	21	56.76
Financial Risk Factors	37	100
Hazard Risk Factors	18	48.65

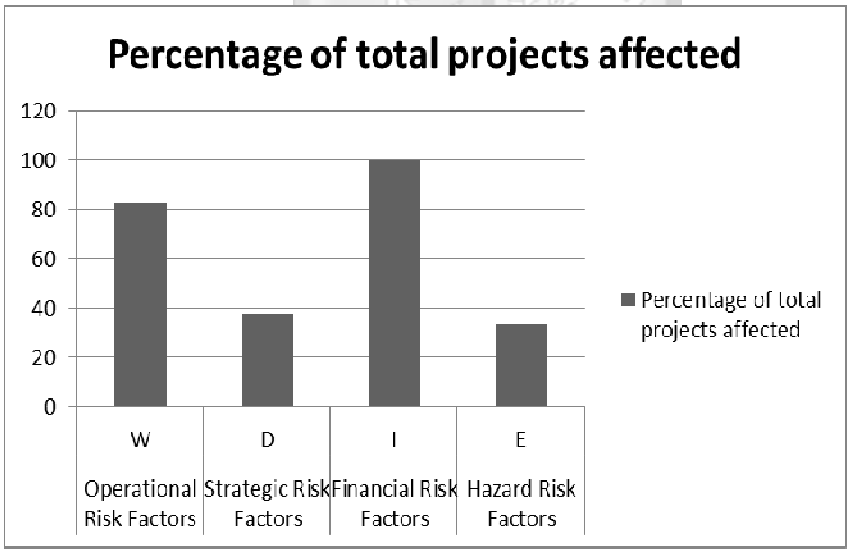
It was found out that the risk factors affect projects in different magnitudes reflecting overruns in completion time and cost as shown in table 4.2, but their individual magnitude is irrelevant.

Table 4.2; Common Risk Factors Affecting Projects

ERM Classification	**Common Risk Factors**	**Total No. of projects affected**	**No. of Projects affected**	**Percentage of total projects affected**
Operational Risk Factors	Weak financial management, procurement, and audit systems. Staff turnover/ frequent changes of staff.	23	19	82.61
Strategic Risk Factors	Delays in procurement, financial management, contractual payments	21	8	38.10
Financial Risk Factors	Interest, charges, and fees.	37	37	100
Hazard Risk Factors	Election/Post-election crisis	18	6	33.33

Table 4.2 details the common risk factors that were found to affect projects resulting in time and cost overruns. The Operational risk factors tend to affect projects highly with the predominant ones being weak financial management, procurement, and audit systems. Additionally, staff turnover seemed a predominant risk factor under operational risk factors. 23 projects exhibited the operational risk factors with 19 of them exhibiting the predominant operational risk factors resulting to 82.61%. 21 projects were affected by the strategic risk factors with 8 of them being predominant (delays in procurement, financial management, and contractual payments) resulting into 38.10%. All projects (37) were affected by financial risk factors with the predominant ones being Interests, charges, and fees resulting to 100%. Finally, 18 projects were affected by the hazard risk factors with the predominant ones being election/post-election crisis (6) resulting into 33.33%

Additionally, the most critical factors affecting projects are reflected in the figure 4.1, showing the percentage of the total projects affected by the common risk factors.



KEY
W represents weak financial management, procurement, and audit systems and staff turnover.
D represents delays in procurement, financial management, and contractual payments.
I represent interest, charges, and fees, and
E represents election/post-election crisis.

Figure 4.1: Common risk factors affecting projects in Kenya

In figure 4.1, the findings do not reflect that all projects will exhibit these risk factors but note should be taken that every project is unique and thus this factors represent the infrastructure projects in Kenya funded by the World Bank between the periods 1969 and 2013. For instance, considering the election/post-election crisis is not a factor that may be experienced in all periods, and sometimes may not be experienced at all but

under the period that some of the projects were undertaken, Kenya faced this type of civil unrest and thus affecting the performance of projects undertaken within such periods (2007/2008).

4.4 EVM and EVM-ERM in forecasting of project performance

This section presents the research findings in regard to the sub components of EVM as per the original EVM forecasting model and the extension on the same. These findings show that, indeed EVM does not pay attention to risk factors affecting the performance of projects as stated in literature (Tabriz et al., 2013). Table 4.3 gives a detailed description of the EVM and EVM-ERM Findings and the analysis on the same for forecasting of project performance of infrastructure projects in Kenya funded by the World Bank. The values in the table are of utmost importance as they depict the EVM and EVM-ERM forecasting model on individual projects.

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Table 4.3 EVM and EVM-ERM Model findings for forecasting of project performance

NO.	Closed Infrastructure Projects in Kenya Funded by the World Bank														Modelling; Cost/Time Forecasting			
	PID	BAC (US$M)	PV (US$M)	%C	P%C	AC (US$M)	AC' (US$M)	PD (MONTHS)	ADU (MONTHS)	ADA	ED	OCD	ACD	PR	EVM		EVM-ERM	
	Projects with variations in both Time and Cost														BEAC (US$M)	SEAC (MONTHS)	ABEAC (US$M)	ASEAC (MONTHS)
1	**Natural Resource Management Project**																	
	P095050	68.5	68.5	112.64 (100)	100	78	87.86 (78.00)	75.1	66.67	3/27/2007	12/10/2007	6/30/2013	6/30/2013	1	78	66.67	76.86	65.7
2	**Development of the National Statistical System Project**																	
	P085414	20.5	20.5	75.2	100	50.5	37.98	45.37	60.33	3/20/2007	8/20/2007	12/31/2010	9/30/2012	1	50.5	60.33	48.04	57.38
3	**Educational Sector Support Program**																	
	P087479	80	80	110.42 (100)	100	1084	1196.97 (1084)	49.8	45.1	11/7/2006	3/28/2007	12/31/2010	12/31/2010	1	1084.01	45.1	1070.47	44.54
4	**Institutional Reform and Capacity Building Technical Assistance Project**																	
	P090567	25	25	94.79	100	35	33.18	58.2	61.4	1/24/2006	7/19/2006	11/30/2010	8/31/2011	1	35	61.4	33.6	58.94
5	**Energy Sector Recovery Project**																	
	P083131	80	80	64.19	100	225.52	144.76	68.6	106.87	7/13/2004	11/4/2004	3/31/2010	9/30/2013	0.5	225.54	106.87	224.13	106.2
6	**Agricultural Productivity Project**																	
	P082396	40	40	84.43	100	80.37	67.86	42.47	50.3	6/17/2004	10/21/2004	12/31/2007	12/31/2008	1	80.37	51.42	78.36	50.14
7	**Development Learning Centre Project**																	
	P078209	2.7	2.7	68.7	100	3.83	2.63	62.47	90.97	10/17/2003	2/2/2004	12/31/2008	8/31/2011	0.75	3.83	90.93	2.76	65.67
8	**Energy Sector Reform and Power Development Project**																	
	P001344	125	125	116.81 (100)	100	798.9	933.17 (798.90)	84.37	72.23	6/19/1997	6/23/1998	6/30/2004	6/30/2004	1	798.9	72.23	792.49	71.65
9	**Urban Transport Project**																	
	P001319	115	115	82.33	100	155	127.61	89	108.1	1/30/1996	6/27/1996	6/30/2003	6/30/2005	1	155	108.1	153.66	107.16
10	**Nairobi-Mombasa Road Rehabilitation Project**																	
	P035691	50	50	72.1	100	122	87.97	74.03	102.67	1/30/1997	4/11/1997	3/31/2002	10/31/2005	0.25	122	102.67	121.4	102.16

NO.	PID	BAC (US$M)	PV (US$M)	%C	P%C	AC (US$M)	AC' (US$M)	PD (MONTHS)	ADU (MONTHS)	ADA	ED	OCD	ACD	PR	EVM		EVM-ERM	
11	**Arid Lands Resource Management Project**																	
															BEAC (US$M)	SEAC (MONTHS)	ABEAC (US$M)	ASEAC (MONTHS)
	P001331	22	22	83.17	100	25.1	20.88	69.53	83.6	12/14/1995	7/12/1996	9/30/2001	6/30/2003	0.75	25.1	83.6	24.23	80.75
12	**Micro and Small Enterprise Training and Technology Project**																	
	P001353	21.8	21.8	175.23 (100)	100	24.2	42.40 (24.20)	92.87	53	4/5/1994	7/31/1998	12/31/2001	12/31/2002	0.75	24.2	53	23.37	51.17
13	**Emergency Drought Recovery Project (EDRP)**																	
	P001369	20	20	56.38	100	36	20.3	28.23	50.07	2/23/1993	4/28/1993	6/30/1995	6/30/1997	0.75	36	50.07	34.65	48.19
14	**Mombasa and Coastal Water Supply Engineering and Rehabilitation Project**																	
	P001361	43.2	43.2	69.52	100	48.7	33.86	52.63	75.7	2/11/1992	9/10/1992	6/30/1996	12/31/1998	0.75	48.7	75.7	47.86	74.39
15	**National Agricultural Extension Project (02)**																	
	P001300	24.9	24.9	111.87 (100)	100	47.9	53.59 (47.90)	87.37	78.1	12/20/1990	12/27/1991	3/31/1998	6/30/1998	0.75	47.9	78.1	46.46	75.75
16	**Forestry Development Project**																	
	P001322	19.9	19.9	129.03 (100)	100	83.8	108.13 (83.80)	81.33	63.03	12/20/1990	10/30/1992	9/30/1997	1/31/1998	0.75	83.8	63.03	80.63	60.66
	Projects with no variations in Cost but with variations in Time																	
17	**Emergency Power Supply Project**																	
	P071196	72	72	102.90 (100)	100	72	74.09 (72)	14.17	13.77	10/26/2000	11/8/2000	12/31/2001	12/31/2001	1	72	13.77	71	13.58
18	**El NinoEmergency Project**																	
	P056595	40	40	77.08	100	40	30.83	29.5	38.27	7/16/1998	10/23/1998	12/31/2000	12/31/2001	1	40	38.27	39	37.31
19	**National Agricultural Research Project (NARP) (02)**																	
	P001354	39.7	39.7	82.54	100	39.7	32.77	65.07	78.83	1/28/1997	6/6/1997	6/30/2002	12/31/2003	0.25	39.7	78.83	39.45	78.34
20	**Agricultural Sector Management Project (02)**																	
	P001342	19.4	19.4	106.08 (100)	100	19.4	20.58 (19.4)	60.5	57.03	12/15/1992	9/29/1993	12/30/1997	6/30/1998	0.75	19.4	57.03	18.65	54.83

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NO.	PID	BAC (US$M)	PV (US$M)	%C	P%C	AC (US$M)	AC' (US$M)	PD (MONTHS)	ADU (MONTHS)	ADA	ED	OCD	ACD	PR	EVM		EVM-ERM	
21	Protected Areas and Wildlife Services Project																	
															BEAC (US$M)	SEAC (MONTHS)	ABEAC (US$M)	ASEAC (MONTHS)
	P001345	60.5	60.5	91.73	100	60.5	55.49	67.63	73.73	2/11/1992	7/8/1992	9/30/1997	6/30/1999	1	60.5	73.73	59.5	72.51
22	Agriculture Sector Adjustment Credit Project (02)																	
	P001326	75	75	96.53	100	75	72.39	59.17	61.3	1/17/1991	5/21/1991	12/22/1995	6/30/1996	0.75	75	61.3	74.25	60.68
23	Coffee Project (02)																	
	P001325	46.8	46.8	98.56	100	46.8	46.12	93.6	94.97	9/12/1989	8/1/1990	6/30/1997	6/30/1998	0.75	46.8	94.97	46.05	93.45
24	Geothermal Development and Energy Reinvestment Project																	
	P001314	40.7	40.7	85.48	100	40.7	34.79	66.27	77.53	12/22/1988	11/4/1989	6/30/1994	4/30/1996	0.5	40.7	77.53	40.2	76.57
25	Railway Project (02)																	
	P001299	28	28	143.54 (100)	100	28	40.19 (28)	132.63	92.4	6/11/1987	4/19/1988	6/30/1998	12/31/1995	0.5	28	92.4	27.5	90.75
26	Highway Sector Project (02)																	
	P001292	90	90	80.88	100	90	72.79	79.77	98.63	5/8/1984	9/19/1984	12/31/1990	6/30/1993	1	90	98.63	89	97.53
27	Secondary Towns Project																	
	P001288	29	29	68.29	100	29	19.8	61.8	90.5	6/16/1983	6/16/1983	8/8/1988	12/31/1990	0.75	29	90.5	28.25	88.16
28	Telecommunication Project (02)																	
	P001282	44.7	44.7	107.72 (100)	100	44.7	48.15 (44.70)	64.17	59.57	5/25/1962	10/13/1962	9/30/1967	9/30/1967	0.75	44.7	59.57	43.95	58.57
29	Mombasa and Coastal Water Supply Project (01)																	
	P001251	35	35	73.19	100	35	25.61	56.77	77.57	10/7/1975	1/13/1976	6/30/1980	6/30/1982	0.5	35	77.57	34.5	76.46

NO.	PID	BAC (US$M)	PV (US$M)	%C	P%C	AC (US$M)	AC' (US$M)	PD (MONTHS)	ADU (MONTHS)	ADA	ED	OCD	ACD	PR	EVM		EVM-ERM	
															BEAC (US$M)	SEAC (MONTHS)	ABEAC (US$M)	ASEAC (MONTHS)
	Projects with no variations in Time and Cost																	
30	**Sugar Rehabilitation Project (02)**																	
	P001264	72	72	100	100	72	72	75.87	75.87	12/5/1978	12/5/1978	3/31/1985	3/31/1985	0.5	72	75.87	71.5	75.35
31	**Sites and Services Project (02)**																	
	P001261	50	50	100	100	50	50	104.43	104.43	4/18/1978	4/18/1978	12/31/1986	12/31/1986	0.25	50	104.43	49.75	103.91
32	**Sites and Services Project (01)**																	
	P001247	16	16	100	100	16	16	44.07	44.07	4/29/1975	4/29/1976	12/31/1982	12/31/1982	0.25	16	44.07	15.75	43.38
33	**Group Farms Rehabilitation Project**																	
	P001243	15	15	100	100	15	15	93.67	93.67	3/11/1975	3/11/1975	12/31/1982	12/31/1982	0.25	15	93.67	14.75	92.11
34	**Population Project (01)**																	
	P001241	12	12	100	100	12	12	69.4	69.4	3/19/1974	3/19/1974	12/31/1979	12/31/1979	0.25	12	69.4	11.75	67.96
35	**Highway Project (05)**																	
	P001242	29	29	100	100	29	29	82.53	82.53	8/14/1973	8/14/1973	6/30/1980	6/30/1980	0.25	29	82.53	28.75	81.82
36	**Nairobi Airport Project**																	
	P001235	29	29	100	100	29	29	43.03	43.03	5/30/1972	5/30/1972	12/31/1979	12/31/1979	0.25	29	43.03	28.75	42.66
37	**Combined Roads- Highway Project**																	
	P001231	23.5	23.5	100	100	23.5	23.5	69.23	69.23	9/23/1969	9/23/1969	6/30/1975	6/30/1975	0.25	23.5	69.23	23.25	68.5

Notes: PID represents Project Identification, BAC= Budget at Completion, PV= Planned Value, %C= Percentage Complete, P%C= Planned Percentage Complete, AC= Actual Cost, AC'= Actual Cost as per Planned Duration, PD= Planned Duration, ADU= Actual Duration, ADA= Approval Date (by board of directors), ED= Effectiveness Date, OCD= Original Closure Date, ACD= Actual Closure Date, PR= Project Risk, EVM= Earned Value Management, ERM= Enterprise Risk Management, ABEAC= Adjusted Budget Estimate at Completion, ASEAC= Adjusted Schedule Estimate at Completion, US$= United States dollars, M= Millions, BEAC= Budget Estimate at Completion, and SEAC= Schedule Estimate at Completion. N/B; Planned duration is calculated using AD and OCD, while Actual duration on ED and ACD.

CHAPTER FIVE: SUMMARY AND DISCUSSION OF RESULTS

5.1 Introduction

This chapter highlights a summary of findings for the study, discussions of the results of the research findings on each individual objective and goes forth to reflect how the objectives were answered by the analysis of such findings.

5.2 Summary of Findings

The study found out that risk was a fundamental aspect in forecasting of project performance but considering the classification of Enterprise Risk Management, financial risk factors were noted to be exhibited by all the projects that the study looked into. As well, Earned Value Management was found out to have a weakness in forecasting of project performance and finally the proposed EVM-ERM model was found out to be a better model compared to original EVM model with reductions in completion time and completion cost.

5.3 Risk factors influencing forecasting of project performance

The study found out that risk is an inherent component in every type of project. This confirms with literature that the risk component is an ever present attribute in every type of project (Hillson 2004; 2009, Vanhoucke & Shtub, 2011; Tabriz et al., 2013). In line with this, under the classification of risk management as outlined by Razali and Tahir (2011), the study found out that the financial risk factors are predominant and inherent in every type of project. This goes to confirm with literature that risk is an inherent attribute in every type of project (Vanhoucke $ Shtub, 2011). Most of the financial risk factors were noted to stem from the external project environment on which the project stakeholders have no control over (Hillson, 2009). Nevertheless, with an in-depth and careful incorporation of the risk factor at the planning stage of a project life cycle, it was ascertained that the estimated completion cost and time will reduce. Further, it was found out that 23 projects were affected by the operational risk factors with the predominant one being the weak financial management, procurement, and audit systems/ high rate of staff turnover. As well, 21 projects were affected by the strategic risk factors with the predominant one being delays in procurement, contractual, and processing payments.

Additionally, 18 projects were noted to be affected by the hazard risk factors with the predominant one being the election/post-election crisis. The election/ post-election crisis may not be a continual risk factor affecting projects, but from the projects that exhibited this type of risk factor, were undertaken within the period 2007/2008 when the Republic of Kenya faced civil unrest as a result of the election crisis and the after math of the same (post-election violence). Furthermore, the validity of this study when compared to prior researchers holds since the findings are not mere outcomes from theory but from a practical sense; infrastructure projects in Kenya funded by the World Bank.

Thus, the findings on this section regarding the factors influencing forecasting of project performance confirms with literature of the factors affecting project performance. For instance, Enshassi et al., 2009; Faridi and El- Sayegh 2006 found out that skills and manpower together with equipment breakdown affected the performance of projects. Regarding skills and manpower, this study noted that, in a big number of projects, there was high staff turnover which contributed to the project failures and concerning equipment breakdown, this study ascertained that there were market shortages of some equipment in certain projects. An example is the Development Learning Centre Project in this study, which was affected by such risk factors).

Additionally Enshassi et al., 2009 citing Hanson et al., 2003; Mbachu and Nkando, 2007, found out that incompetence of the contractors and the quality and attitude to service being the factors that affected the performance of projects. In agreement with this findings, this study ascertained that the poor performance of some contractors lead to failures in projects- an example of the Kenya El Nino Emergency Project. As well, the staff morale which was continually dwindling, sometimes due to lack of salary (an example of the Development Learning Centre Project contributed greatly to the poor performance of the projects under study. Finally, Gichoya (2005) and Belassia and Tukel (1996) noted that finance, poor systems, skilled personnel, and a combination of factors being attributed to project failures. In this study, it has been ascertained that individual projects and the combination of the same have an effect in the performance of projects.

5.4 Ability of Earned Value Management in forecasting project performance of 37 World Bank projects in Kenya

From literature, it has been argued by various scholars (Vanhoucke & Shtub, 2011; Tabriz et al., 2013) that the validity and accuracy of the Earned Value Management in determining of completion time and cost has been questioned. This is because EVM does not attend to the possibility of risk factors that may affect a project in the cause of a project life cycle (Tabriz et al., 2013). For this reason, the study explored the efficiency of EVM with respect to forecasting of project performance with an aim of incorporating the risk factor into it, in the context of infrastructure projects in Kenya funded by the World Bank. The study noted that EVM exhibited the same values for estimated completion time and completion cost as the real actual costs exhibited for completion of the project. In regard to this, the findings of this study reflect that indeed Earned Value Management has a weakness in forecasting of project performance since if took care of the possibility of risk elements affecting the performance of a project then there could be reductions or an improvement in completion time and cost. This is similar to the findings of previous that the forecasting proficiency of EVM is in question (PMI, 2011; Tabriz et al., 2013).

In addition, the study found out that Earned Value Management forecasting model took the same trend in all the projects that it was subjected to; projects with variations in both time and cost, projects with no variations in cost but with variations in time, and projects with no variations in time and cost. For instance, the Natural Resource Management project showed the completion cost (adjusted budget estimate at completion) as US$ 78.00M same figure as the actual cost that was incurred for this project. However, the budget at completion (planned budget for the project) was US$ 68.50M. This shows that, if EVM paid attention to the possibility of elements affecting the project in the cause of a project life cycle, then there would be reductions in the completion cost and completion time, or better still, the actual cost would be same as the budgeted amount for completion. Table 5.1 gives a detailed summary of the behaviour of EVM forecasting model which is shown on the first columns of the table.

Table 5.1; Modeling of cost and time forecasting

Modeling; Cost/Time Forecasting								
		EVM			EVM-ERM		Deviations	
	PID	BEAC US$M	SEAC MONTHS		ABEAC US$M	ASEAC MONTHS	BEAC-ABEAC US$M	SEAC-ASEAC MONTHS
1	P095050							
		78	66.67		76.86	65.7	1.1	1.0
2	P085414							
		50.5	60.33		48.04	57.38	2.5	3.0
3	P087479							
		1084.01	45.1		1070.47	44.54	13.5	0.6
4	P090567							
		35	61.4		33.6	58.94	1.4	2.5
5	P083131							
		225.54	106.87		224.13	106.2	1.4	0.7
6	P082396							
		80.37	51.42		78.36	50.14	2.0	1.3
7	P078209							
		3.83	90.93		2.76	65.67	1.1	25.3
8	P001344							
		798.9	72.23		792.49	71.65	6.4	0.6
9	P001319							
		155	108.1		153.66	107.16	1.3	0.9
10	P035691							
		122	102.67		121.4	102.16	0.6	0.5
11	P001331							
		25.1	83.6		24.23	80.75	0.9	2.9
12	P001353							
		24.2	53		23.37	51.17	0.8	1.8
13	P001369							
		36	50.07		34.65	48.19	1.4	1.9
14	P001361							
		48.7	75.7		47.86	74.39	0.8	1.3
15	P001300							
		47.9	78.1		46.46	75.75	1.4	2.4
16	P001322							
		83.8	63.03		80.63	60.66	3.2	2.4

			Projects with no variations in Cost but with variations in Time					
		EVM Model			**EVM-ERM Model**			
		BEAC (US$M)	**SEAC (MONTHS)**		**ABEAC (US$M)**	**ASEAC (MONTHS)**		
17	**P071196**							
		72	13.77		71	13.58	1.0	0.2
18	**P056595**							
		40	38.27		39	37.31	1.0	1.0
19	**P001354**							
		39.7	78.83		39.45	78.34	0.3	0.5
20	**P001342**							
		19.4	57.03		18.65	54.83	0.8	2.2
21	**P001345**							
		60.5	73.73		59.5	72.51	1.0	1.2
22	**P001326**							
		75	61.3		74.25	60.68	0.8	0.6
23	**P001325**							
		46.8	94.97		46.05	93.45	0.8	1.5
24	**P001314**							
		40.7	77.53		40.2	76.57	0.5	1.0
25	**P001299**							
		28	92.4		27.5	90.75	0.5	1.7
26	**P001292**							
		90	98.63		89	97.53	1.0	1.1
27	**P001288**							
		29	90.5		28.25	88.16	0.8	2.3
28	**P001282**							
		44.7	59.57		43.95	58.57	0.8	1.0
29	**P001251**							
		35	77.57		34.5	76.46	0.5	1.1
			Projects with no variations in Time and Cost					
30	**P001264**							
		72	75.87		71.5	75.35	0.5	0.5
31	**P001261**							
		50	104.43		49.75	103.91	0.3	0.5
32	**P001247**							

		16	44.07		15.75	43.38	0.3	0.7
33	**P001243**							
		15	93.67		14.75	92.11	0.3	1.6
		EVM Model			**EVM-ERM Model**			
		BEAC (US$M)	**SEAC (MONTHS)**		**ABEAC (US$M)**	**ASEAC (MONTHS)**		
34	**P001241**							
		12	69.4		11.75	67.96	0.3	1.4
35	**P001242**							
		29	82.53		28.75	81.82	0.3	0.7
36	**P001235**							
		29	43.03		28.75	42.66	0.3	0.4
37	**P001231**							
		23.5	69.23		23.25	68.5	0.3	0.7

Borrowing from the original EVMs interpretation on its metrics (PMI, 2011), Project number 1-16 (Table 5.1), shows that there were overruns in cost which can be attributed to the risk factors that affected this project. Of the projects number 1-16, the Educational Sector Support Program and the Energy Sector Reform and Power Development Project had the greatest variations in comparing the budgeted amount for the project with the actual cost for the project/ estimated actual cost for the project. This is as a result of the magnitude of the risk factors that affected the individual projects. For example, in the Educational Sector Support program which had planned for US$ 80.00M and ended up using US$ 1084M, same case as the estimated amount using EVM, the study found out that this project was affected by the risk factors from all the classification of Enterprise Risk Management.

Moreover, in the projects 1-16 (Table 5.1), all the projects except projects number 1, 3, 8, 12, 15, and 16 had time overruns attributed to the risk factor that they faced during the project life cycle. The rest of the projects in this category- number 1, 3, 8, 12, 15, and 16 had reductions in the completion time as compared to the planned duration. This was the same case with the estimated completion time compared to the planned duration. This can be attributed to the high cost expended on them in

comparison to the budgeted amount which confirms that when cost is higher, the time goes down.

In projects number 17-29 (Table 5.1), where the budgeted amount was the same as the estimated completion cost and same as the actual cost, the study found out variations in terms of the estimated completion time/ actual completion time and the planned duration. 13 of the projects from this category had overruns in terms of time while four of the projects had reductions in terms of estimated completion time/ actual completion time compared to the planned duration. Further, projects number 30-37 (Table 5.1), there were no completion cost and time overruns. In regard to this, the study found out that this projects only experienced the burden of the financial risk factor and thus not heavy enough to affect the performance of such projects.

In accordance to Anbari (2003; PMI 2011; Vanhoucke $ Shtub, 2011; Tabriz et al., 2013), and the findings and discussions of this study regarding the efficacy of Earned Value Management in forecasting of project performance, table 5.2 gives a summary of the cost and time behaviour of the infrastructure projects in Kenya funded by the World Bank on which Earned Value Management was subjected

Table 5.2: A summary of the proficiency of EVM on infrastructure projects in Kenya funded by the World Bank

Over Budget	On Budget	Under Budget	Ahead of Schedule	On Schedule	Behind Schedule
16 Projects	21 Projects	0 Projects	19 Projects	8 Projects	10 projects

In accordance with table 5.2, the over budget, on budget, under budget, ahead of schedule, on schedule, behind schedule represents the projects that were ahead of budget compared to the budgeted amount, estimated completion cost was same as the budgeted amount, less than the budgeted amount, took more time than the planned duration, were on time compared to the planned duration, and those that took lesser time compared to the planned duration respectively. This is as per the effectiveness of the original Earned Value Management model.

The results of the analysis of Earned Value Management confirms with literature, that there is need to strengthen the forecasting ability of EVM which is in question (PMI, 2011; Vanhoucke & Shtub, 2011; Tabriz et al., 2013), and this paves way for the extended EVM model which incorporates the risk element into its forecasting metrics

to produce the Earned Value Management-Enterprise Risk Management model discussed in section 5.5.

5.5 Earned Value Management/Enterprise Risk Management

This section presents the final EVM-ERM model under study. Referring to Table 5.3 in the section EVM-ERM model under the section of modelling; time and cost forecasting column, it was found out that when the risk element is incorporated in EVM, reductions in completion cost and time were exhibited. This confirms the theory from previous scholars such as Hillson (2004; 2009) which states that if risk is known in advance and factored in the planning stage, the cost and time overruns will reduce (Hillson 2009; Tabriz et al., 2013). The original EVM that is currently in use does not have the risk element which predisposes its major weakness of predicting the future performance of a project from its past. Thus, the study's extension of the EVM model confirms with literature and hence a better model for forecasting of project performance. Table 5.3 displays a summary of the projects depicting the efficiency of the EVM-ERM model; infrastructure projects in Kenya funded by the World Bank.

Table 5.3: A summary of the proficiency of EVM/ERM on infrastructure projects in Kenya funded by the World Bank

Over Budget	On Budget	Under Budget	A head of Schedule	On Schedule	Behind Schedule
16 Projects	0Projects	21 Projects	0 Projects	0 Projects	37 Projects

Table 5.3 depicts (in line with section 3.5.2) that with incorporating the risk element into the original EVM, there is an improvement in the forecasted values in terms of completion cost and completion time. This goes on to confirm with literature that risk is an important element in every type of project that need be factored into the Earned Value Management to strengthen its forecasting ability (Hillson 2004; 2009; Tabriz et al., 2013). Thus, in comparing the performance of the original EVM model compared to the proposed EVM-ERM model on the ability to determine the completion time and cost of a project, the latter model stands out in the forecasting of project performance. Hence, it can be deduced that, risk is an inherent component in every type of project and needs to be factored into the EVM technique at the planning stage

of the project life cycle to cater for the possibility of the risk elements affecting the project earlier enough leading to better project performance at the end of the project life cycle. Refer to Table 5.4 for the comparison between EVM and EVM-ERM.

5.6 Comparison of EVM and EVM-ERM model for forecasting of project performance

Following the discussions in section 5.5, table 5.4 reflects the comparisons between the original Earned Value Management model and the proposed Earned Value Management-Enterprise Risk Management model in forecasting of project performance. This is an extract from table 4.3. The first part in table 5.4 shows the original EVM model results subjected to 37 infrastructure projects in Kenya funded by the World Bank and the second part shows the extended EVM model (EVM-ERM Model) results after subjection on the same. The trend of both models can be seen from the table to depict the comparison aspect the study sought to bring out for purposes of enhancing the performance of projects in terms of completion time and cost.

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Table 5.4 Comparison of the EVM and EVM-ERM forecasting model

Modeling; Cost/Time Forecasting								
		EVM			EVM-ERM		Deviations	
	PID	BEAC US$M	SEAC MONTHS		ABEAC US$M	ASEAC MONTHS	BEAC-ABEAC US$M	SEAC-ASEAC MONTHS
1	P095050							
		78	66.67		76.86	65.7	1.1	1.0
2	P085414							
		50.5	60.33		48.04	57.38	2.5	3.0
3	P087479							
		1084.01	45.1		1070.47	44.54	13.5	0.6
4	P090567							
		35	61.4		33.6	58.94	1.4	2.5
5	P083131							
		225.54	106.87		224.13	106.2	1.4	0.7
6	P082396							
		80.37	51.42		78.36	50.14	2.0	1.3
7	P078209							
		3.83	90.93		2.76	65.67	1.1	25.3
8	P001344							
		798.9	72.23		792.49	71.65	6.4	0.6
9	P001319							
		155	108.1		153.66	107.16	1.3	0.9
10	P035691							
		122	102.67		121.4	102.16	0.6	0.5
11	P001331							
		25.1	83.6		24.23	80.75	0.9	2.9
12	P001353							
		24.2	53		23.37	51.17	0.8	1.8
13	P001369							
		36	50.07		34.65	48.19	1.4	1.9
14	P001361							
		48.7	75.7		47.86	74.39	0.8	1.3
15	P001300							
		47.9	78.1		46.46	75.75	1.4	2.4
16	P001322							
		83.8	63.03		80.63	60.66	3.2	2.4

			Projects with no variations in Cost but with variations in Time					
		EVM Model			**EVM-ERM Model**		**Deviations**	
		BEAC (US$M)	**SEAC (MONTHS)**		**ABEAC (US$M)**	**ASEAC (MONTHS)**	**BEAC-ABEAC**	**SEAC-ASEAC**
17	**P071196**							
		72	13.77		71	13.58	1.0	0.2
18	**P056595**							
		40	38.27		39	37.31	1.0	1.0
19	**P001354**							
		39.7	78.83		39.45	78.34	0.3	0.5
20	**P001342**							
		19.4	57.03		18.65	54.83	0.8	2.2
21	**P001345**							
		60.5	73.73		59.5	72.51	1.0	1.2
22	**P001326**							
		75	61.3		74.25	60.68	0.8	0.6
23	**P001325**							
		46.8	94.97		46.05	93.45	0.8	1.5
24	**P001314**							
		40.7	77.53		40.2	76.57	0.5	1.0
25	**P001299**							
		28	92.4		27.5	90.75	0.5	1.7
26	**P001292**							
		90	98.63		89	97.53	1.0	1.1
27	**P001288**							
		29	90.5		28.25	88.16	0.8	2.3
28	**P001282**							
		44.7	59.57		43.95	58.57	0.8	1.0
29	**P001251**							
		35	77.57		34.5	76.46	0.5	1.1
			Projects with no variations in Time and Cost					
30	**P001264**							
		72	75.87		71.5	75.35	0.5	0.5
31	**P001261**							
		50	104.43		49.75	103.91	0.3	0.5
32	**P001247**							

		16	44.07		15.75	43.38	0.3	0.7
33	**P001243**							
		15	93.67		14.75	92.11	0.3	1.6
		EVM Model			**EVM-ERM Model**		**Deviations**	
		BEAC (US$M)	**SEAC (MONTHS)**		**ABEAC (US$M)**	**ASEAC (MONTHS)**	**BEAC-ABEAC**	**SEAC-ASEAC**
34	**P001241**							
		12	69.4		11.75	67.96	0.3	1.4
35	**P001242**							
		29	82.53		28.75	81.82	0.3	0.7
36	**P001235**							
		29	43.03		28.75	42.66	0.3	0.4
37	**P001231**							
		23.5	69.23		23.25	68.5	0.3	0.7

Notes: EVM refers to Earned Value Management, ERM= Enterprise Risk Management, BEAC= Budget Estimate at Completion, ABEAC= Adjusted Budget Estimate at Completion, SEAC= Schedule Estimate at Completion, ASEAC= Adjusted Schedule Estimate at Completion.

In comparing EVM and the EVM-ERM model, the latter model depicts an improvement in project performance which is reflected in table 5.4 with reductions in completion time and cost. Similarly, Tabriz et al., 2013, found out that with an incorporation of the risk element/factor into the EVM model there were improvements in completion time and cost. Column three and four of the Table 5.4 reflects the forecasted completion cost and time using the original EVM model and columns six and seven depicts forecasted completion cost and time using the proposed EVM-ERM model. Columns eight and nine show the deviations of both forecasted completion cost and time using EVM and EVM-ERM model. From the table, the results shows that, by incorporating the risk element into EVM, the completion time and cost will reduce as a risk is catered for earlier enough and thus not passed through to the final stages of a project life cycle. For instance, looking at project Number 37 (P001231), if a risk element was incorporated to EVM, the project cost would have gone down by US$ 300,000M and the completion time would have gone down by 8.4 months. Thus, risk is an important element to be incorporated into the EVM model.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter introduces the conclusions drawn from the study, recommendations for the study, and the directions for future research.

6.2 Conclusion

This study sought to extend the EVM technique by incorporating a risk component into it to factor for risks at the planning stage of a project life cycle in order to reduce the cost and time overruns. This was made possible by using Enterprise Risk Management in quantifying risk which resulted in a project risk factor that was factored into EVM. The study looked at two theories that underpin the concept of EVM in regard to forecasting of project performance (the past determines the future and the uncertainty theory). This gave leeway for the factors that influence the performance of projects that the study analysed carefully according to the classification of ERM.

From the literature, a conceptual framework was formulated showing the relationship between the variables. As well, the study employed a quasi-experimental research design and looked at 75 infrastructure projects in Kenya funded by the World Bank. Of these projects, the study concentrated on 37 of them that had run from the initiation stage of a project life cycle all through closure. The data for these projects were collected from World Bank reports and then filtered and computed in favour of the final model. Further, the study presented the findings of such data and an analysis on the same together with its interpretation. From the findings, the study was in agreement with prior researchers such as Vanhoucke and Shtub (2011), that risk is an inherent component in every type of project. Further, the study noted that in deed EVM has a weakness in forecasting of project performance as stated by PMI (2011). Thus, it can be concluded that risk is a major component in the project management world for the enhancement of project performance from the roots. This was evidenced by a comparison of the EVM model and the EVM-ERM proposed model as shown in table 6.1.

Table 6.1 Comparison of the EVM model and the EVM-ERM model

Modeling; Cost/Time Forecasting								
		EVM			EVM-ERM		Deviations	
	PID	BEAC US$M	SEAC MONTHS		ABEAC US$M	ASEAC MONTHS	BEAC-ABEAC US$M	SEAC-ASEAC MONTHS
1	P095050							
		78	66.67		76.86	65.7	1.1	1.0
2	P085414							
		50.5	60.33		48.04	57.38	2.5	3.0
3	P087479							
		1084.01	45.1		1070.47	44.54	13.5	0.6
4	P090567							
		35	61.4		33.6	58.94	1.4	2.5
5	P083131							
		225.54	106.87		224.13	106.2	1.4	0.7
6	P082396							
		80.37	51.42		78.36	50.14	2.0	1.3
7	P078209							
		3.83	90.93		2.76	65.67	1.1	25.3
8	P001344							
		798.9	72.23		792.49	71.65	6.4	0.6
9	P001319							
		155	108.1		153.66	107.16	1.3	0.9
10	P035691							
		122	102.67		121.4	102.16	0.6	0.5
11	P001331							
		25.1	83.6		24.23	80.75	0.9	2.9
12	P001353							
		24.2	53		23.37	51.17	0.8	1.8
13	P001369							
		36	50.07		34.65	48.19	1.4	1.9
14	P001361							
		48.7	75.7		47.86	74.39	0.8	1.3
15	P001300							
		47.9	78.1		46.46	75.75	1.4	2.4
16	P001322							
		83.8	63.03		80.63	60.66	3.2	2.4

			Projects with no variations in Cost but with variations in Time				
		EVM Model		**EVM-ERM Model**		**Deviations**	
		BEAC (US$M)	**SEAC (MONTHS)**	**ABEAC (US$M)**	**ASEAC (MONTHS)**	**BEAC-ABEAC**	**SEAC-ASEAC**
17	**P071196**						
		72	13.77	71	13.58	1.0	0.2
18	**P056595**						
		40	38.27	39	37.31	1.0	1.0
19	**P001354**						
		39.7	78.83	39.45	78.34	0.3	0.5
20	**P001342**						
		19.4	57.03	18.65	54.83	0.8	2.2
21	**P001345**						
		60.5	73.73	59.5	72.51	1.0	1.2
22	**P001326**						
		75	61.3	74.25	60.68	0.8	0.6
23	**P001325**						
		46.8	94.97	46.05	93.45	0.8	1.5
24	**P001314**						
		40.7	77.53	40.2	76.57	0.5	1.0
25	**P001299**						
		28	92.4	27.5	90.75	0.5	1.7
26	**P001292**						
		90	98.63	89	97.53	1.0	1.1
27	**P001288**						
		29	90.5	28.25	88.16	0.8	2.3
28	**P001282**						
		44.7	59.57	43.95	58.57	0.8	1.0
29	**P001251**						
		35	77.57	34.5	76.46	0.5	1.1
			Projects with no variations in Time and Cost				
30	**P001264**						
		72	75.87	71.5	75.35	0.5	0.5
31	**P001261**						
		50	104.43	49.75	103.91	0.3	0.5
32	**P001247**						
		16	44.07	15.75	43.38	0.3	0.7

33	**P001243**							
		15	93.67		14.75	92.11	0.3	1.6
		EVM Model			**EVM-ERM Model**		**Deviations**	
		BEAC (US$M)	**SEAC (MONTHS)**		**ABEAC (US$M)**	**ASEAC (MONTHS)**	**BEAC-ABEAC**	**SEAC-ASEAC**
34	**P001241**							
		12	69.4		11.75	67.96	0.3	1.4
35	**P001242**							
		29	82.53		28.75	81.82	0.3	0.7
36	**P001235**							
		29	43.03		28.75	42.66	0.3	0.4
37	**P001231**							
		23.5	69.23		23.25	68.5	0.3	0.7

Notes: EVM refers to Earned Value Management, ERM= Enterprise Risk Management, BEAC= Budget Estimate at Completion, ABEAC= Adjusted Budget Estimate at Completion, SEAC= Schedule Estimate at Completion, ASEAC= Adjusted Schedule Estimate at Completion.

Table 6.1 shows a comparison of the EVM and EVM-ERM models. The third and fourth columns denote the EVM model and the sixth and seventh columns denote the EVM-ERM model. The last two columns reflects the deviations of both completion time and completion cost with the EVM model and the EVM-ERM model indicating that there is need to incorporate risk at the planning stage of a project life cycle in forecasting of project performance. From the table, the results shows that, by incorporating the risk element into EVM, the completion time and cost will reduce as a risk is catered for earlier enough and thus not passed through to the final stages of a project life cycle. For instance, looking at project Number 37 (P001231), if a risk element was incorporated to EVM, the project cost would have gone down by US$ 300,000M and the completion time would have gone down by 8.4 months. Thus, risk is an important element to be incorporated into the EVM model.

6.3 Recommendations

From the conclusions in section 6.2, the following recommendations were made;

1. In order to enhance the performance of projects in terms of completion cost and completion time, incorporating the risk element at the planning stage of a project life cycle is imperative since this will lead to a reduction in cost and time overruns.

2. Embracing Enterprise Risk Management in the management of uncertainties is paramount in the project management world; this is in combination with the existing Project Management techniques so as to enhance the performance of projects especially in completion time and cost.

6.4 Areas of Further Research

The following are some of the directions for future research concerning Earned Value Management in forecasting of project performance:

1. Further research could concentrate on developing a more comprehensive model in forecasting project performance. A model that will be able to quantify risk (inform of both opportunities and threats) using ERM in form of opportunities and threats. The risk factor obtained from such model should be used to adjust the EVM forecasting formulae and then the EVM-ERM model should be subjected to any type of projects to test its practicality and efficiency.

2. The study looked at only four knowledge areas (scope, time, cost, and risk) in regard to project performance out of the nine knowledge areas. This calls for a more thorough study to cover the entire project performance in line with the Project Management knowledge areas.

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