



ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE

**EVALUATION OF PROJECT COST CONTROL SYSTEM
(A CASE OF DESALEGN ASRADE CONSTRUCTION PLC)**

**A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY SCHOOL OF
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IN PROJECT MANAGEMENT**

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Abstract

The purpose of this research is to assess the traditional status quo cost control system practiced in DAC PLC, evaluate how effectively the system measure performance, and predict the future project health based on the past performance. Identify gaps and limitations in the system, demonstrate EVM as an alternative cost control approach using a real time project data, show the effectiveness of EVM approach in terms measuring the project cost and schedule variances, efficiencies as well as predicating future performance trends along with the main parameters involves in the calculation. Consequently, recommend adoption of the Earned Value Management system to the construction firm so as to reap its comparative advantage over the traditional approach in minimizing project cost overrun and schedule delay.

The research used quantitative cost and schedule related data which put into an Excel template prepared for EVA calculations. The project variance, efficiency and forecast indicators generated by Excel tool, depicted in graphs, tables and dashboard and the interpretation of results provided. In the whole process of EVA determination of performance indicators as well as interpretations of results, the effectiveness EVM approach against the traditional method is clearly compared.

The findings showed that EVM approach has come more effective cost monitoring and control tool compared to the traditional system in order to identify potential schedule slippages and areas of budget overruns. In traditional project cost control system one determines the budget and measures the cost against that budget as project goes on while the EVM approach differs from conventional performance measurement practices by combining a project's cost and schedule parameters into a common framework, i.e. the measurement of the budgeted value of the work actually carried out, and its comparison with the budgeted value of the work that should have been carried out and what it actually costs. The study demonstrated the earned value technique, as it provides objective, realistic assessment of project status information for management using parametric generated with combination of (Earned Value), (planned Value), (Actual Cost), (Budget At Completion) and (Original Duration). So, it is an important component of any effective project management system, with its early warning status approach, resulting in

significant improvements to its performance and contributing to a company's competitiveness and overall profitability.

By adapting Earned Value concept DAC and similar construction projects will benefit the fast and accurate project performance indicators using the mathematical approach provided by Earned Value Management. Therefore, this easier and better accurate EVM method enables the project make periodic monitoring of the project health and to take prompt actions on performance discrepancies before problems grow to unrecoverable level or need major scope changes.

Key words: construction projects, cost control, project performance, earned value.

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LIST OF ABBREVIATIONS

ACWP---Actual Cost of Work Performed

BAC---Budget at Completion

BCWP---Budgeted Cost of Work Performed

BCWS---Budgeted Cost of Work Scheduled

CPI---Cost Performance Index

CV---Cost variance

EAC---Estimate at Completion

ETC---Estimate to completion

ETTC---Estimate Time to Completion

EVMA---Earned Value Analysis

EVM---Earned Value Management

EV---Earned Value

OD---Ordinary Time

PMBOK---Project Management Body of Knowledge

PMI---Project Management Institute

PM---Project Manager

SPI---Schedule Performance Index

SV---Schedule Variance

TCCPI---The 'To-Complete Cost performance index

TCPI---The To-Complete Performance Index

TCSPI ---The To-complete Schedule performance index

VAC---Variance at Completion

WBS---Work Breakdown Structure

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1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

The construction industry plays significant role in the economy of developing countries. In many developing countries, major construction activities account for about 80% of the total capital assets, 10 % of their GDP, and more than 50% of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next after agriculture (Ofori 2006, Jekale 2004). Despite the construction industry's significant contribution to the economy of developing countries and the critical role it plays in those countries' development, the performance of the industry still remains generally low. As Idoko (2008) noted, '...many projects in developing countries encounter considerable time and cost overruns, fail to realize their intended benefit or even totally terminated and abandoned before or after their completion...' Moreover, the development of the construction industry in developing countries generally lags far behind from other industries in those countries and their counter parts in developed nations. Generally, as Ofori (2006) and Jekale (2004) concluded, 'The construction industry in developing countries failed to meet expectations of governments, clients and society as a whole'. Among others lack of an effect cost control system the one of the major causes responsible to the problems of cost overruns and delays.

Olawale and Sun (2010) stated that in the construction industry, the aim of project cost control is to ensure the projects finish on time, within budget and achieving other project objectives as well. Cost control is an important aspect that is crucial to the economic growth of the construction industry. Therefore, it is vital for the contractors to operate an effective cost control procedure during the post contract stage of a project so as to keep the cost of the scheme within the building budget (Sanni and Hashim 2013). Moreover, every activity in construction implies cost and therefore it has to be controlled because low profits have been a realistic problem that the present construction industry is experiencing. Construction project success depends seriously on costs, especially in a country like Ethiopia which has over 100 million populations where which children and the young age constitute the larger share, who demands construction related good & services.

For instance as per the Ethiopian government plan, in 2014/15 fiscal year the sector was expected to register a 36.4 per cent annual growth and contribute 7.6 per cent to the country's gross domestic product. This goal was part of the country's Growth and Transformation Plan, which aims to lead the nation to the level of a middle income economy (Liege Africa 2015). In the country among others, the construction sector is instrumental in catapulting the nation to higher levels of development. Without the construction sector, the burgeoning of all the economic sub sectors such as modern agriculture and manufacturing is unthinkable.

In Ethiopia infrastructural facilities that have been put in place for decades and a half namely, roads, schools and universities, health centers and residential houses are part of growth (allAfrica.com 2017). At the same time they enable the tapping of the nation's human and material resources. The second Growth and Transformation Plan (GTP-II) also emphasizes achieving economic growth bringing structural change as its main objective. That means of transforming the agricultural-led economy to the industry led one, which needs shifting agricultural labor to that of manufacturing and service, enables the nation to obtain demographic dividend. This, in turn, indicates the vitality of the expansion of urbanization which needs more construction work. Currently, the construction industry has tremendous impact on the Growth Domestic Production by creating value chains with other sub sectors such as cement industries, small scale enterprises and the likes.

Individual project success depends on how it can achieve project objectives, which is to complete the project within the estimated budget, to the required quality within the pre-determined duration. For that planning of the project as well as the monitoring is essential. Cost overrun is a major problem encountered by many of the contractors which contribute to less secured profit for the contractor and many more problems for all the parties involved.

Angelo and Reina (2002) stated that the problem of cost overruns is critical needs to be studied more to alleviate this issue in the future. According to one very comprehensive research made on cost overruns in global construction, 9 out of 10 projects had overrun, overruns of 50 to 100 percent were common, overrun was found in each of the 20 nations and five continents covered by the study; and overrun had been constant for the 70 years for which data were available

(Flyvbjerg et al. 2004). It is believed that construction projects experience an increase in cost of about 33% on average (Hartley and Okamoto 1997).

Cost overruns are a major problem in both developing and developed countries (Angelo and Reina 2002). However, the trend is more severe in developing countries where these overruns sometimes exceeds 100% of the anticipated cost of the project. Project overruns due to time and cost result in delays during project execution in developing countries is a serious because implementation of project faces many uncertainties there. Consequently, it result in wastage of scare financial resources, delays in providing facilities, development and also make construction costlier (Turner 1999). With globalization and technology driven economic growth all over the world, a scientific and systematic approach to project management becomes imperative to ensure that project objectives are attained within the constraints of time and resources (Chithkara 2006 and Prabhakar 2008).

However, in many countries including Ethiopia, the funding for construction industry activities is used to regulate the economy. As the construction industry continues to grow in size, so do planning and budgeting problems, because it is common for projects to not be completed on time and within the initial project budget. There are quite a number of examples of this at the national and internal levels. If we take a local example, many mega projectiles like the sugar factories in the south border of the country, road construction projects and irrigation schemes in many regions have taken more time and cost than organically planed.

Consequently, the debate in the construction industry on how to minimize or eliminate delays and cost overruns has been on for some time among professionals, clients and/or end users, and the policy makers. However, the management is becoming a challenge to professional engineers and technical managers as competitions for business opportunities arise in an increasingly competitive market place for effective project management and control systems in compliance with clients' contractual requirements.

The nature, characteristics and management of the Construction industry and construction projects in developing countries, is different from that of the developed countries in many

aspects. According to Jekale (2004), the Construction industry in many developing countries is characterized by 'too fragmented and compartmentalized; Public sector dominated market; considerable government interventions; considerable foreign finance (dependency for public construction), and low development of indigenous technology' traditional way of cost monitoring and controlling system. Moreover, the construction industry in developing countries depends on imported input such as construction materials, machinery, and skilled manpower. In addition, the industry is dominated by foreign construction firms; which execute almost exclusively all the major construction works (Adams 1997). This is also the case in Ethiopia since majority of major power projects and most of large road projects are constructed mainly by foreign contractors.

If we consider the cost monitoring and controlling system, which is the main focus of this study, indigenous contractors in developing countries practicing the traditional approach. In the traditional project cost control approach the budgeted cost is evaluated by computing the difference between planned cost and actual cost incurred in a project. The focus is on planned expenditure and actual costs. In other words, in traditional project management approach the most important measurements are today's date and the actual amount of money spent on the project. However, this will never help us to measure the actual performance of the project except comparing the amount of money spent with the budgeted cost for the reached date.

This approach involves a time–cost analysis, the relationship between time and cumulative cost (money) using S-curve (Ray and Jeffrey 2008). In fact S-curves is simple to use and provide managers and project teams; to understand the correlation between project duration and budget expenditures, and provide a good sense of where the highest levels of spending are likely to occur, to provide the most current information on project status, because budget expenditures can be constantly revised and new values plotted on the graph and to serve as a more proactive control mechanism, because information can be immediately represented and continuously updated (Ray and Pinto 2008).

Despite these advantages, the traditional approach or S-curves have a number of significant shortcomings that must be taken into account when project teams contemplate their use. Beyond

identifying deviations between actual and budgeted expenditures (both positive and negative variances), the cause of these deviations cannot easily be determined (Ray and Pinto 2008). It does not clarify whether the deviation is an indication that the project is behind schedule, or that the project team has come up with more efficient methods of completing the tasks. Besides, it is cannot help to forecast project completion time & cost effectively. Therefore, in the traditional cost control approach there is potential for misusing S-curves as a project-monitoring tool. In the final analysis, simply evaluating a project's status vis - `a- vis its performance on time versus budget expenditures can easily lead to erroneous conclusions about project performance (Ray and Pinto 2008).

On the other, nowadays contractors with higher level of maturity in most of the developed countries and in some of developing nations adopted EVM system while monitoring and controlling project costs. EVM is the process of measuring performance of project work against a baseline plan. EVM application helps in providing performance standard for the evaluation of progress report of project and it also act as a control device to take care of time and cost schedule by responsibility defined in Organization Breakdown Structure (OBS). It provide better performance picture of project and gives better forecast of the final completion cost. Generally, Earned Value is an enhancement over traditional process of cost accounting (Bhosekar and Gayatri 2012).

Earned Value reveals future opportunities and it also examines actual accomplishment. With the help of EVM, project managers get sufficient help to keep deep intuitive understanding into potential risk areas. Hence, with the help of clearer picture of the project cost performances, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work. Thus it is like an alarm for the managers to identify and control problems by taking timely corrective actions before they become too great to overcome (PMI, 2005, Bhosekar and Gayatri 2012).

Accordingly, EVM provides better understanding of the project in terms of time and cost schedule. Earned Value Management System is a set of guidelines to provide satisfactory completion of project. It has been seen that to cover cost overrun, project team undergoes cost

reduction either by reducing the project scope and quality or by providing additional resources. Similarly in case of time overrun, they plan crashing of activities or fast track programs. Consequently, with the use of EVM system, project goals are achieved in better way (Tom and Sachin 2013, Bhosekar and Gayatri 2012).

Therefore, this paper attempts to show the limitations the traditional cost control system used in one of a private Grade-One construction company named 'Desalegn Asrade Construction (DAC) PLC'. To this end using real-time project data, the paper proposed EVM and demonstrated how effectively it could help to determine the project Cost and schedule performance across time, as well as to estimate cost expected to be spent at project completion. In addition, a simple and user friendly Excel Spreadsheet Tool has been developed and introduced so that DAC can easily adopt EVM approach. The tool includes speedy calculation of EVM performance and forecaster as well as early warning dashboard that can alert the project manager and his teams in DAC to take or propose timely actions. Besides the study might also initiate further study or extends effort to scale-up adopting EVM in similar construction firms based on acceptance and success story experimented here in DAC.

1.2. PROBLEM STATEMENT

Construction industry is an important industry at both the global level and national level. It is currently playing a significance role in the country's development and transformation, provides huge employment to the people and plays very significant role in country economy. However delay and cost overrun is most problem and among widely debated agenda at executive level. Project overruns result in wastage of scare financial resources, delays in providing facilities, development and also makes construction costlier (Turner1999). With globalization and technology driven economic growth all over the world, a scientific and systematic approach to project management becomes imperative to ensure that project objectives are attained within the constraints of time and resources (Chithkara 2006, Prabhakar 2008).

From a project management perspective, it has been argued that a successful project should fulfill the following criteria (Kerzner 2009): (1) completed within the as-planned time and cost;

(2) implemented at the specified levels of project performance; (3) delivered according to project stakeholder needs and expectations; and (4) completed within the defined and agreed scope. For that good planning of the project and well-established monitoring system is essential. However, cost overrun is a major problem encountered by many of the contractors which contribute to less secured profit for the contractor and many more problems for all the parties involved.

The absence of a well-established effective system for monitoring and controlling project cost is the main reason for cost escalation and delays in the project. Consequently, numerous construction projects in Ethiopia are still plagued by delays and cost overruns, which can frequently be traced to ineffective cost control system. As Creedy (2004) view, identification of the existence and influence of cost overrun risk factors in a project can lead to a better control on project cost and also can help in proposing solutions to avoid future overruns.

Traditionally the budgeted cost is evaluated by computing the difference between planned cost and actual cost incurred in a project. The focus was on planned expenditure and actual costs. However, Earned Value reveals future opportunities and it also examines actual accomplishment. With the help of EVM, project managers get sufficient help to keep deep intuitive understanding into potential risk areas. So that with the help of clearer picture of the project cost performances, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work. It is like an alarm for the managers to identify and control problems by taking timely corrective actions before they become too great to overcome (PMI 2005, Bhosekar and Vyas 2012). Therefore, this necessitates implementation of a cost monitoring and control system in a construction project and to adopt the most effective one out of all the known systems. This study considered Earned Value Analysis (EVA) or Earned Value Management (EVM) concept as the cost monitoring and control system which can be used to monitor a construction project in DAC.

In Ethiopia construction sector is an important sector. Although not working to its fullest potential and standard in many of homegrown construction companies are still of prime interest to the country. Therefore, growth in this sector is critical for growth in national income and realizes the country's ambitious multi-phase transformation plan. It is among the largest sector

that generates employment opportunities as well as a key enabling factor to the country's dream of transition from agriculture led to industrialization led economy.

In spite of its proven importance it is not uncommon to see a construction project failing to achieve its goal within the specified cost. Cost overrun is a very frequent phenomenon and is almost associated with all projects of construction industry in the country. There are several factors that are responsible for these cost overruns among these; lack of an effective cost control system is one of a major area of concern in this research.

Considering the above views from the literature, the following questions concerning the level of understanding of current practice of project cost monitoring and controlling system seems relevant to be answered. These are: is cost monitoring and controlling theories properly understood and effectively applied in practice? Once again, the measurement of project cost performances should consider more specific aspects and management issues concerned with evaluation of current project performance as well as forecast future performances. This is important in order to take timely and evidence based actions so as to minimize the occurrence of cost overrun and schedule delay. However, cost control system practiced in the construction project assessed in this study has shown gaps to respond to effectively measuring the cost and schedule variances and efficiencies as well as forecasting the future performance at a given time period.

Hence, a good project evaluation and control system should also provide project managers with advance warning of potential problems before it is too late to correct them. Without these systems, projects proceed aimlessly with very little oversight, without a clear understanding of status, and without a well-thought-out action plan to bring the project back on track in the event of obvious disruptions (Ray and Pinto 2008). Thus, the application of effective and reliable cost monitoring and control system in the studied construction company is an important area that needs further assessment to in order to scale-up to similar enterprises.

EVM is an application of cost monitoring and controlling system that involves identifying how much work was accomplished for the money spent, in addition to Value of work planned to be

done and actual cost of work performed. The earned value system uses the data from the work breakdown structure, the project network, and the schedule to compare time-phased budgets with scheduled activities. In the process, it enables meaningful comparisons to be made between actual and planned schedules and costs. Therefore, creating such a system could enable the project manager to make early detection of deviations of cost and schedules from the original plan, to initiate corrective actions and to forecast future trends or to forecast of the final completion cost and time extension.

1.3. RESEARCH QUESTIONS

In this study, I am going to answer and give conclusion of these following questions:

- 1) What is the status quo and existing issues of current construction cost monitoring and controlling system in DAC?
- 2) What are the limitations and constraints of the current cost monitoring and controlling process in the company?
- 3) How realistic and effective would be if the proposed EVM method used as cost monitoring and controlling system in terms measuring cost and schedule variances, efficiencies and make prediction of future performance expectation whereby minimizing the risk of cost overrun and schedule delay ? What are the comparative advantages of EVM approach over the current traditional system?
- 4) Can the company adopt the proposed EVM cost control system using a simple user friendly Excel spreadsheet template to make EVA calculations until it develop capacity to utilize the advanced software?

1.4. OBJECTIVES OF STUDY

This paper aims to investigate the level of effectiveness the traditional cost monitoring and controlling systems in the DAC PLC., and how it could be improved using EVM system. The general and specific objectives are:

General objectives

- Improve the project cost control system in DAC PLC to measure cost and schedule variances and efficiencies as well as provide early warning information about the future performances effectively
- Recommend a better project cost control system to similar construction firms based on review of proven global experiences of project cost control system

Specific objectives

- To assess the cost control method frequently used by a contractor (DAC) during the construction stage,
- To analyze the effectiveness of the cost monitoring and controlling system in the company and identify the main problem faced by the contractor in controlling the cost
- To evaluate EVM against the traditional approach in terms of showing the actual current and future performance of the project and its future anticipated potential future risks,
- To show the contribution of EVM cost monitoring and controlling system in minimizing the risk of cost overrun and schedule delay,
- To encourage DAC to adopt EVM approach by developing a simple and user friendly Excel spreadsheet template to make EVA calculations.

1.5. SIGNIFICANCE OF THE RESEARCH

The traditional cost-control approach, which is commonly used by many construction companies in the country, has limitation in effectively controlling project cost compared to the earned value technique. In their findings Fleming and Koppelman (2000) point out that there is an important distinction between Traditional Project Cost Management and EVM, where traditional performance measures compare only actual and budgeted costs, and EVM however, actual and budgeted costs are compared to the earned value.

Therefore, the purpose of this study is to show that the earned value is a reliable technique for project valuation and demonstrate how it could be utilized using a real project data. Show how EVM provides a means to forecast future performance of the project based upon its past

performance by utilizing a fundamental principle that patterns and trends in the past can be good predictors of the future. Another possible purpose is to provide the construction company with a user friendly Excel data tracking and analysis tool that is based on the earned value and can be used by the project managers when evaluating projects. This, user friendly Excel template for project evaluation can also be adapted to suit to other construction projects. Hence, the finding of the study contributes in creating awareness about the benefits of EVM and technics of how to apply. This expected to motivate the DAC and other similar construction firms to make use of EVM techniques and improve performance through better cost control and reduce project cost overrun and delay due to poor cost control.

1.6. RESEARCH SCOPE

The aim of this research is to evaluate the cost control method in one of Grade-One Construction Company, specifically a 40/60 Saving Houses (Condominium) project implemented by DAC in Bole Bulbula area in Addis Ababa. The assessment of project cost control in the company intended to improve the existing traditional cost control system. The existing system has limitation in measuring the current actual performance as well as proactively warns if the future trend suggests cost and/or time deviations. So, the study demonstrated the effectiveness of EVM using real time data.

However, prevention of cost overrun and schedule delay would not only be materialized by improving the cost control system alone. However, other important aspects such as quality, communication and cost management, etc., that has their own contributions, have not been included in the scope of this research. For instance the effectiveness of cost control process in comparing actual expenditures to the baseline cost plans and determining variances, evaluating possible alternatives, and enabling to take appropriate actions depends on quality of how cost plans are prepared with sufficient detail. Therefore, under this study all factors which contribute to project cost overrun and delay assumed to be controlled and the focus has been on adopting an effective cost control to minimize cost overrun and delay of construction projects during construction phase.

Furthermore, the research is based on analyses of the phenomena from the perspective of the selected project, company and staffs that are, by definition, closely involved in the project, i.e. contactors and their teams, rather than all categories of stakeholders like the client, sponsor. Thus, the research set out to provide analysis or profiling views about the research problems they reflect, relating to cost monitoring and control on the 40/60 Condominium project implemented at Bole Bulbula site by DAC. Therefore, the case study focuses on one case only. Though the case could have very varying extension but is still limited to that specific case. However, the overall aims of this study to provide a picture of the common approach for all similar cases.

1.7. LIMITATIONS OF THE RESEARCH

The study was mainly developed through deductive reasoning, with research questions formulated after surveying relevant literature relating to project cost monitoring and control theories and practices. The research questions were then objectively examined using real time data about a 40/60 Condominium construction project. Using these data EVM cost monitoring control technique applied to measure the current status and predict the future trend of the project it has been compared with the existing cost control system of the company. Then the effectiveness, reliability and early warning capability of the two systems compared to show how EVM can be a preferable cost monitoring and control system. However, from positivist view of the research, phenomenon investigated through the understanding and interpretation of a single project and individuals' perspectives might be considered insufficient for to judge the overall cost monitoring and control system of projects in the DAC.

In addition, the selection a single construction project out of six active projects running by DAC was not a random but chosen due to lower distance, the highest capital cost and other factors that made easier to apply EVA. However, this intentional selection may violet both statistical representativeness and equal chance of selection so as to make generalization to the greater population of constructions. Besides, the study focused the existing cost controlling system in one local private construction firm, the prevailing gaps in and challenges cost controlling and make recommendation to introduce an EVA/EVM as an effective cost controlling system.

However, the gaps in and challenges as well as the recommended technique may not apply to those high take foreign based and endogenous construction companies in the country.

In addition, due to limitation of resources especially time, this study is limited to focus only on lack of an effective cost control system as key reason to project cost overrun delay out of many other reasons. However, many studies in the area has showed that, poor communication, lack of experience by project manager, procurement delays, lack of planning, poor infrastructure, inadequate resources, lack of motivation, tendering methods, variations, project environment, poor project definition could be also some of the major contributors to time and cost overruns. The time and cost overruns on the projects, in this study were limited to those that occurred due to poor cost control system in implementation phase.

Similarly, I recognize the obvious link between earned value and risk management, and have noted that the concept of combining the two techniques has been addressed by (Hillson 2004a). I acknowledge that since both techniques deal with the uncertainty inherent in all projects (albeit more in some than others) it would be advantageous to produce a combined methodology. I expect that could be readily achieved, and I may do so in the future; however, this thesis does not do so. My objective was to increase the adoption of EVM by addressing its known issues, and simplifying its utilization by creating a simple Excel Template to for cost data entry and Earned value analysis. I felt that incorporating Monte Carlo simulations or other construction softwares into EVM would provide a further challenge to construction companies which are yet not reached higher level of maturity and thereby reduce acceptance of the core performance evaluation methodology.

Therefore, I believe that these limitations however, can be used as directives for future research on broader topic.

1.8. THESIS STRUCTURE

Chapter 1: Provides a background of the research, with regard to project cost monitoring control system. This is followed by a brief description of the statement of the problem, objectives as well as Significance limitations of the study, and finally presents the thesis structure.

Chapter 2: Provides a Literature Review. It offers an overview of the theories relevant to the study and provides literature previously done by other authors on the project cost monitoring and control system focusing the context of the developing countries, followed by an introduction to Project Cost Control in relation to traditional and Earned Value Management approaches. This is followed by topics concerned with Fundamentals of Earned Value, its benefit, issues in conducting Earned Value Management and application of Software for EVM cost control system.

Chapter 3: Presents introduction of the research methodology, its design, and discusses research strategy and type, research approach and techniques, data collection methods and the study population and sample to be used in the study, and finally, quality of the research and data analysis method that have been used in the research has been presented.

Chapter 4: Presents results of data analysis as well as discusses the results in relation to the research questions.

Chapter 5: Contains conclusions and recommendations where the findings will be summarized and recommendations and conclusions given based on the results.

2. LITERATURE REVIEW

2.1. INTRODUCTION

Construction industry is an important industry at both the global level and national level. It is currently playing a significance role in the country's development and transformation, provides huge employment to the people and plays very significant role in country economy. However delay and cost overrun is most problem and among widely debated agenda at executive level. Project overruns due to time and cost result in delays during project execution. In developing countries project overruns is a serious where implementation of project faces many uncertainties. It result in wastage of scare financial resources, delays in providing facilities, development and also make construction costlier (Turner 1999). With globalization and technology driven economic growth all over the world, a scientific and systematic approach to project management becomes imperative to ensure that project objectives are attained within the constraints of time and resources [Chithkara 2006, Prabhakar 2008).

The absence of a well-established effective system for monitoring and controlling project cost is the main reason for cost escalation and delays in the project. Consequently, numerous construction projects in Ethiopia are still plagued by delays and cost overruns, which can frequently be traced to ineffective cost control system. As Creedy (2004) view, identification of the existence and influence of cost overrun risk factors in a project can lead to a better control on project cost and also can help in proposing solutions to avoid future overruns.

Cost monitoring and controlling system practiced by many indigenous contractors in developing countries (including Ethiopia) is the traditional approach. In the traditional project cost control approach the budgeted cost is evaluated by computing the difference between planned cost and actual cost incurred in a project. Here the focus is on planned expenditure and actual costs. In other words, in traditional project management approach the most important measurements are today's date and the actual amount of money spent on the project. However, this will never help us to measure the actual performance of the project except comparing the amount of money spent with the budgeted cost for the reached date.

In traditional project cost management system the most important measurements are today's date and the actual amount of money spent on the project. The amount of money spent is compared to the budgeted cost for the reached date to measure the performance of the project, but the actual performance in this case is never measured (ANSI/EIA-748-A-1998). To determine the true performance of the project one would have to look not only at the budgeted cost and the actual cost to date but also the earned value of the budgeted work performed in the same format as the cost. This is done by a prominent project cost monitoring and control system called Earned value Management technique.

Ample literature available on the Earned Value Analysis (EVA) and Earned Value Management (EVM) and there are different ways to apply them in construction industry. Earned Value is a well-known project management tool that uses information on cost, schedule and work performance to establish the current status of the project. By means of a few simple rates, it allows the manager to extrapolate current trends to predict their likely final effect. The method is based on a simplified model of a project, but proved to be useful in practice of cost control. It is being developed to account better for schedule and time aspects (Agata 2008).

Earned Value can also use 'work in progress' to indicate what will happen to work in the future (Bhosekar and Vyas 2012). It is an enhancement over conventional accounting methods. Conventional approaches focus on planned expenditure and actual costs. Whereas Earned Value goes one step further and examines actual completion. This gives managers better understanding of probable risk areas. Hence with stronger picture, managers can create risk mitigation plans based on actual cost, schedule and actual development of the work.

Song and Shalini (2009) showed that the adoption of EVM by project practitioners is mostly voluntary. This suggests that EVA or EVM is recognized as a leading practice method for tracking project progress, as well as monitoring and controlling performance. In Project Management Institute (USA), Earned Value was applied and study was carried out by Lipke Walt. Author with a detailed study concluded that EVM provides incredible management information. The author applied a Decision Logic Diagram as a tool that gives the good connection of EV with the project status indicators.

Kendrick et al. (2004) Said that EVM seem complex but it has a simple foundation. It helps in tracking the performance of a project by simple arithmetical calculations. For larger projects these calculations become to tedious, so use of MSP, Primavera and other software is the solution. Author compared the three softwares and found accuracy by all the methods and concluded that by use of software in the construction project, EV work as a predictor within less duration of time.

EVM implementation can be seen as a pull factor that requires best project management practices to be in place in order for it to be used to monitor and direct projects. The level of project management excellence or development in an organization is referred to as 'project management maturity'. Most maturity models use a five-point scale to grade an organization's project management maturity (Lukas 2008, Marnewick 2013). It was found that organizations with a maturity level of three or higher are candidates for EVM (Lukas 2008).

Mee-Edoiye (2014) 'Project cost monitoring and control: A case of cost/time variance and earned value analysis' The paper therefore encourages the use of variance and earned value analysis to ensure cost and time compliance of all project activities. The comprehensive status framework provided by the variance and earned value analysis.

According to the IPMA EVM technique is a continuous measurement of project status is vital for effective time and cost control (Caupin et al. 1999). EVM enables disseminating performance information and to provide stakeholders with information about how resources are being used to achieve project objectives (PMBOK 2000). These two views suggest that regular reporting of the projects status is imperative to the knowledge of stakeholders hence for stakeholders to know whether the project has created value for the money invested. It is of this view that EVA is used to check the health of a project. Anderson (2006) in his project management binder pointed out some vital reasons why EVA should be used. Most importantly he pointed out that it provides an early warning signal for early recovery. Further, McCauley (2001) outlined some valuable points why EVA should be used. These are similar to Anderson view which is providing early

and accurate identification of trends and problems, accurate picture of project status, basis for correction etc.

In summary Earned Value is a proven project control technique which provides cost and schedule performance measurements. It is the most effective method to evaluate work progress in order to identify potential schedule slippage and areas of budget overruns. Thus, it enable managers better understanding of probable risk areas whereby managers can create risk mitigation plans based on actual cost, schedule and actual development of the work.

2.2. PROJECT COST CONTROL

Cost control is the process of comparing actual expenditures to the baseline cost plans to determine variances, evaluate possible alternatives, and take appropriate action. Project control systems can be classified as either one-dimensional or multi-dimensional according to an extensive review (Rozenes et al. 2006) of current literature on this subject. Both types include one or more predefined project control objectives, such as cost, time, quality, etc. In one-dimensional control systems, those objectives are not integrated in any way; however, in multidimensional systems several objectives are integrated. EVM is the most commonly used multidimensional project control method, as it integrates time and cost. Other types deal with risk management, statistical process control, etc. The authors conclude that a key disadvantage of EVM is that other project control dimensions – quality, design, technology, etc., are not integrated into it. They suggest that more research is needed to integrate additional control dimensions into the EVM approach.

Nevertheless, with either a one-dimensional or two-dimensional control system, an important factor is determining the best times to perform the control activity. One study (Raz & Erel, 2000) proposed an analytical framework for determining the optimal timing of project control points throughout the life cycle of the project. Thus, cost Control is a process in Monitoring and Control Process Group within Project Cost Management Knowledge Area in addition to Plan Cost Management Estimate Costs Determine Budget process of Planning Process Group (Rita 2013).

The cost monitoring and control process should measure project progress and performance against a project plan to ensure that the project is completed on time, within budget, and to the satisfaction of the customer (Ray and Pinto 2008). A good project cost control system should also provide project managers with advance warning of potential problems before it is too late to correct them. Without this system, projects proceed aimlessly with very little oversight, without a clear understanding of status, and without a well-thought-out action plan to bring the project back on track in the event of obvious disruptions (Ray and Pinto 2008).

Designing, implementing, and maintaining an accurate monitoring and control system is perhaps one of the most difficult challenges in project management, and more than a few organizations get it wrong. There are two reasons for this. First, very few project managers and project teams have a strong grasp on the essentials of project control. Subsequently, they do not know what warning signals to look for during the development process, or when to look for them. Second, they do not have the necessary know-how and training to develop systematic project cost control that is comprehensive, precise, and timely. The good news is that this can be easily remedied with some basic knowledge of the processes and procedures involved (Ray and Pinto 2008). However, depending on the level of project management maturity level and project policy environment in organizations and countries, project cost control may be undertaken in either of the traditional or modern (EVM) approaches.

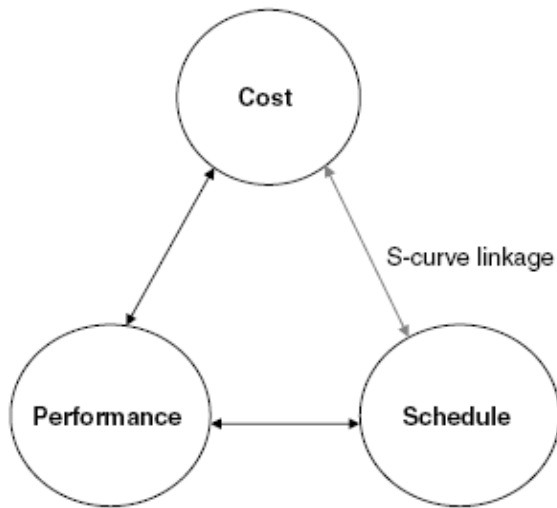
2.2.1. TRADITIONAL COST CONTROL APPROACH

In traditional cost control approach the most important measurements are today's date and the actual amount of money spent on the project. The amount of money spent is compared to the budgeted cost for the reached date to measure the performance of the project (commonly called S-Curve). S-curves are used in project management worldwide and for nearly one hundred years where records of their practical application can be traced back to 1928 (Vanhoucke et al. 2008). They are representation of 'cumulative effort' related with the project plotted against time. This effort is expressed in the same units for all tasks the project comprises, usually man-hours (labor consumption) or monetary units (cost or payments). Comparing the 'as planned' S-curve with records of actual effort, if done on regular basis, enables the manager to follow the development

of the project. S-curves are used both in the form of charts (to provide a one-glance insight into project performance) or tables (for easy data manipulation).

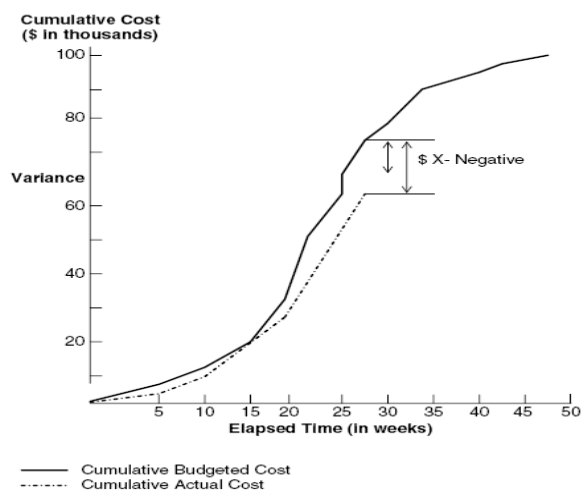
However, S-curves are a far going generalization of the modeled project. Interpreting them with no regard to the relationships between project tasks and reasons for deviations may lead to wrong decisions. Essentially, as shown in Figure 2.1, S-curves establish a linkage directly and solely between cost and schedule (Pinto 2007).

Figure 2.1: Project performance dimensions linkage in S-curve analysis



Source: Ray R. Venkataraman and Jeffrey K. Pinto *Cost and Value Management in Projects*, 2008

Figure 2.2: Project S-Curve showing x- Dollar negative



Source: Ray R. Venkataraman and Jeffrey K. Pinto *Cost and Value Management in Projects*, 2008

2.2.2. EVM COST CONTROL APPROACH

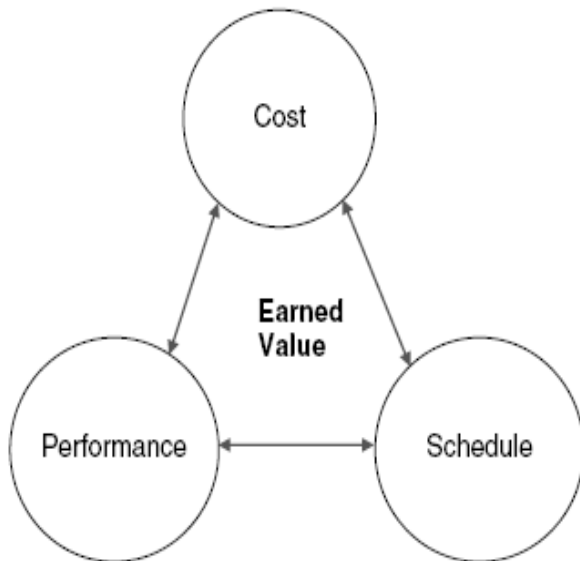
Earned value management is a mechanism that can determine how much work was accomplished for the money spent. The earned value system uses the data from the work breakdown structure, the project network, and the schedule to compare time-phased budget with scheduled activities. In the process, it enables meaningful comparisons to be made between actual and planned schedules and costs.

The use of EVM as a project monitoring and control mechanism began in the 1960s, when it was championed by the U.S. Government as a viable system for its agencies and contractors to track

project performance. The focus was to track the “value” performance of projects, in addition to cost and other traditional measures. In the 40 years since its origin, EVM has been used worldwide in a wide variety of settings, ranging from governmental agencies to a host of project based organizations in numerous industries.

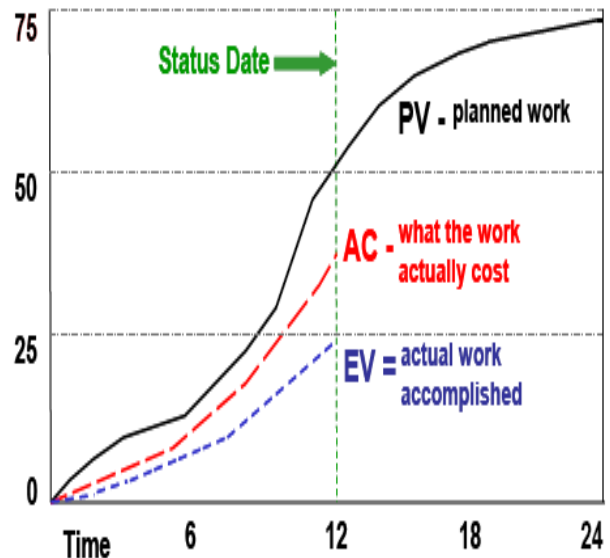
Unlike Gantt charts and S-curves, EVM evaluates a project by integrating the criteria of time, cost, and value. In other words, in addition to comparing actual and budgeted costs, EVM integrates the important element of time in determining what was accomplished (value realized) to draw conclusions about current project status. In essence, the earned value method measures the value of the work actually accomplished at the cost rates set out in the original budget. This quantity is known as earned value (EV). Furthermore, as EVM provides information about the efficiency with which budgeted money is used relative to the value realized, forecasts about the estimated cost and schedule to project completion can be made. As shown in Figure 2.3, it is only through earned value that the full nature of the association between the three success metrics of schedule, cost, and performance can be understood in relation to each other (Pinto 2007).

Figure 2.3: Project performance dimensions linkage in EVA



Source: Ray R. Venkataraman and Jeffrey K. Pinto *Cost and Value Management in Projects*, 2008

Figure 2.4: Typical Curve Showing PV, EV and AC



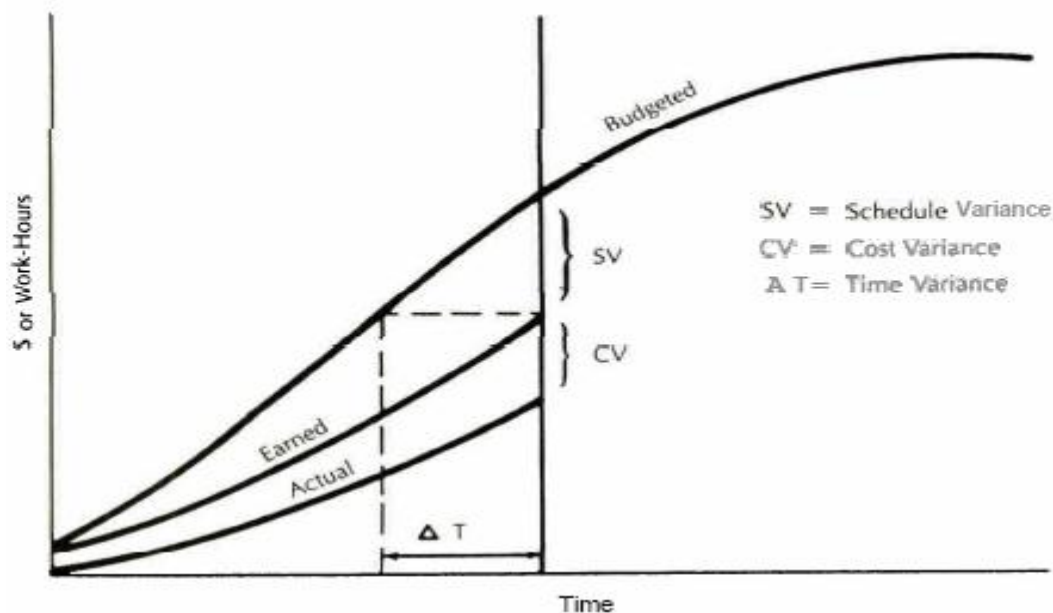
Source: Ray R. Venkataraman and Jeffrey K. Pinto *Cost and Value Management in Projects*, 2008

2.3. BENEFITS OF EVM SYSTEM

Following are some of the benefits of EVMS, described by Fleming and Koppleman (2000) as the legacy of using the criteria on government contracts for three decades. Note that they do not separate benefits of earned value data from the benefits of the criteria, perhaps because the reliability of data depends on the disciplined application of the management practices described by the criteria.

- 1) It is a better management control system that provides reliable data compared to the traditional approach,
- 2) It integrates work, schedule and cost using a work breakdown structure (WBS),
- 3) The associated database of completed projects is useful for comparative analysis,
- 4) The cumulative cost performance index (CPI) and schedule performance index (SPI) provides an early warning signal,
- 5) The CPI is a predictor for the final cost of the project,
- 6) It uses an index-based method to forecast the final cost of the project,
- 7) The 'to-complete' performance index allows evaluation of the forecasted final cost,
- 8) The periodic (e.g. weekly or monthly) CPI is a benchmark,
- 9) The management by exception principle can reduce information overload.

Figure 2.5: EVM-Cost and Schedule Performance Graph



Source: Hilson (2004) EVM and Risk Management: A Practical Synergy

2.4. FUNDAMENTALS OF EARNED VALUE

The two key elements involved in developing an earned value analysis are:

- **The work breakdown structure:** This provides, in a hierarchical structure, information regarding the individual tasks that need to be performed on the project and individual work packages. The WBS makes it possible to allocate necessary human resources that match task requirements. Subsequently, the project network derived from this information enables the correct sequencing of tasks to be identified, and provides the basis for developing a time-phased budget (Ray and Pinto 2008).
- **A time-phased budget for each work package:** With a time-phased budget in place, the project team can determine the timing of budget expenditures required to complete individual tasks. More importantly, the time-phased budget enables the project team to determine the points in the project when budget money is likely to be spent in pursuit of those tasks (Ray and Pinto 2008).

2.5. EARNED VALUE MANAGEMENT METRICS

EVM has three Basic and other multiple derived metrics. The three basic elements of EVM are Planned Value, Earned Value, and Actual Cost, while their derivatives include:

- CV, cost variance—Given by $(EV - AC)$.
- SV, schedule variance—Given by $(EV - PV)$.
- CPI, cost performance index—Given by (EV/AC) .
- SPI, schedule performance index—Given by (EV/PV) .
- OD, original duration.
- ETC, expected time to completion—Given by (OD/SPI)
- BAC, budgeted cost at completion—Represents the total budgeted cost of the project baseline.
- EAC, estimated cost at completion—Represents the sum of the costs incurred to date and the revised estimated costs for the work remaining, given by (BAC/CPI) .
- FAC, computed forecasted costs at completion.
- VAC, variance at completion—Given by $(BAC - EAC)$ or $(BAC - FAC)$, indicates expected positive or negative deviation at completion.

a) BASIC EVM METRICS

The early developers of earned value methodology established three measures (budget, accomplishment and expenditure) and used those to calculate variances and indices for both cost and schedule, and to forecast the total estimated cost at completion for the project, before it is completed. These are currently well known, established and accepted (PMI 2005).

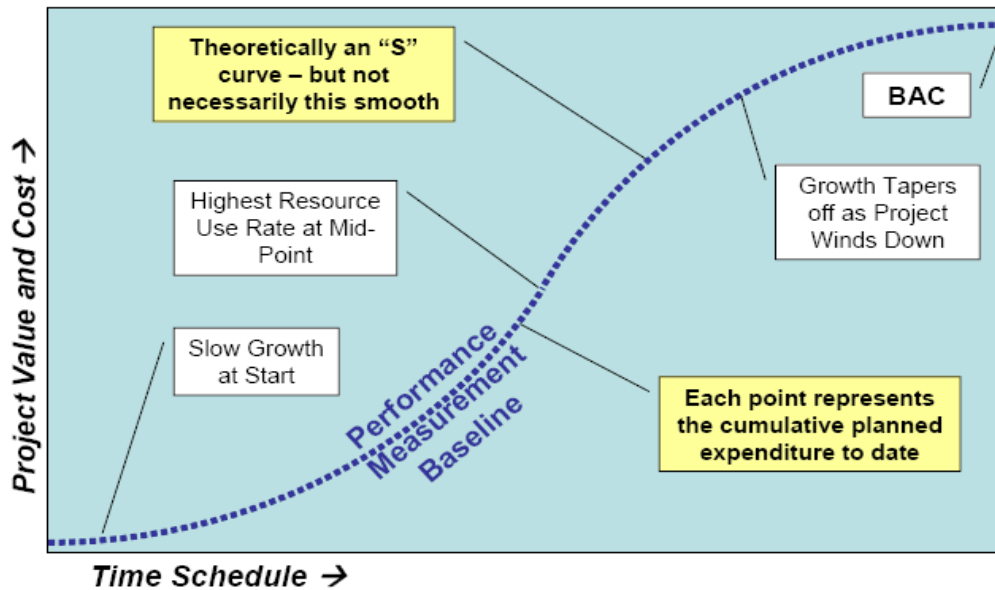
Planned Value (PV): What did we plan to achieve by now?

In the past this was called the Budgeted Cost of the Work Scheduled (BCWS=PV). This is defined as the portion of the approved cost estimate (budget) planned to be spent on the activity during a given period. Planned Value includes both direct and indirect costs. The Planned Value can be a portion of the budget for activities that should have been partly completed at the review date. The term can also refer to the total budget for an activity, and this can lead to confusion.

The cumulative budget for project activities should be termed the Performance Measurement Baseline (PMB). The total cost budget for a project is termed the Budget at Completion (BAC). In EVM the PMB is typically plotted on a chart with cumulative cost on the vertical (y) axis and time increments on the horizontal (x) axis.

Many projects start slowly and gradually increase their expenditures as the team grows and vendors are approved, such that the maximum spend (or burn) rate occurs near the mid-point of the project. Thereafter, the intensity of work subsides as deliverables are achieved and team members are transferred to other initiatives. This results in an S-curve when plotted, though that symmetrical curve shape is not a requirement – only an observation. This condition is shown in Figure 2.6. One author (Cioffi 2005) has developed a tool for analytic parameterization of the S-curve.

Figure 2.6: Integrated Performance Measurement Baseline (PMB)



Source: Hilson (2004) EVM and Risk Management: A Practical Synergy

Earned Value (EV): What have we achieved so far?

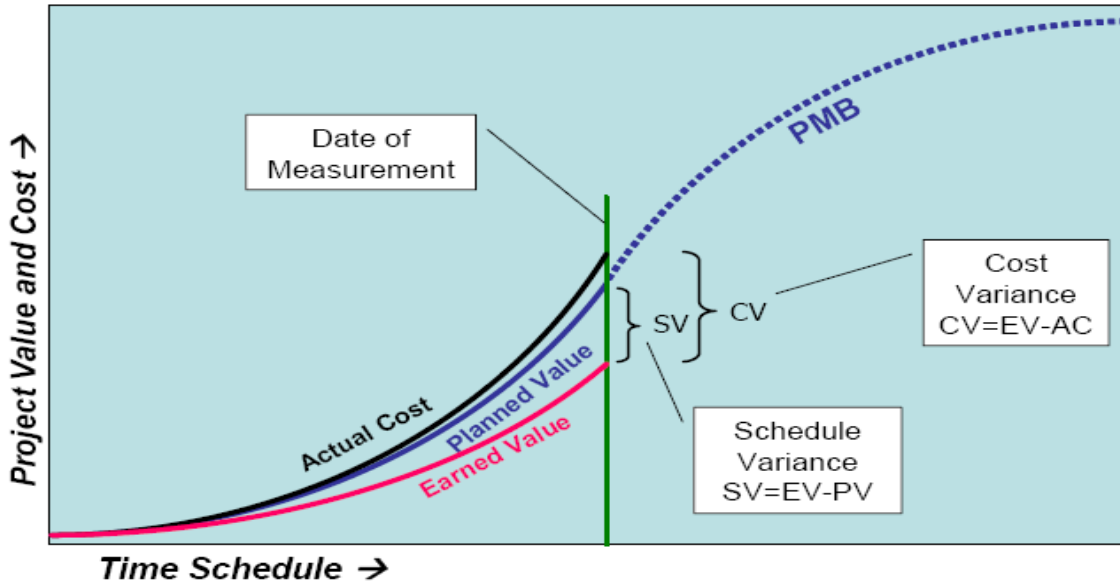
This has been called the Budgeted Cost of the Work Performed (BCWP = EV). This is a portion of the total budget equal to the portion of the work actually completed. This can include an estimated value for partly completed activities. The term earned value can have two meanings: this specific measure of performance, and also the overall EVM performance measurement concept. Normally, the correct meaning is clear from the context.

Actual Cost (AC): What have we spent so far?

Previously called the Actual Cost of the Work Performed (ACWP= AC), this is the total of direct and indirect costs incurred in accomplishing work on all activities that have been started in a given period. This can include an estimated cost for partly completed activities. These three measures, illustrated in Figure 2.7: Standard EV Methodology can be used to measure the value and cost of both internal work performed by staff, and external work performed by vendors. Many organizations find it easier to tabulate vendor costs rather than internal costs, and to determine the budget amounts for vendor contracts rather than internal work packages. Vendor contracts typically attract more corporate scrutiny than internal work, with their associated

bidding, negotiations and legal agreements. In many organizations, the cost of the work undertaken by internal staff, even that related to projects, is not estimated in advance nor tracked accurately as it is expended.

Figure: 2.7: Standard Earned Value Methodology



Source: Hilson (2004) *EVM and Risk Management: A Practical Synergy*

b) DERIVED EVM METRICS

- **Percent Complete (PC)**, is the level of scope completion at the moment of progress check, a figure that may be particularly useful in reporting:

$$PC = BCWP/BAC \quad \text{or} \quad PC = EV/BAC$$

- **Cost Variance (CV)** is a measure of deviation between the budgeted and the actual cost of works actually completed up to the date of progress check, expresses in monetary units. If negative, it indicates that the project is over budget:

$$CV = BCWP - ACWP \quad \text{or} \quad CV = EV - AC$$

- **Cost Performance Index (CPI)** also compares the planned and actual value of works done. As a relative measure, it is more informative than CV in terms of the scale of deviation from

the budget. If less than 1, it indicates that the project has consumed more money than planned:

$$\text{CPI} = \text{BCWP} / \text{ACWP} \quad \text{or} \quad \text{CPI} = \text{EV} / \text{AC}$$

- **Schedule Variance (SV)**, though expressed in monetary units, is considered to be the measure of deviation between the actual physical progress of works and their planned progress. It is the difference between the planned costs of work completed and planned cost of work that should have been done by the reporting date. If negative, it indicates a delay:

$$\text{SV} = \text{BCWP} - \text{BCWS} \quad \text{or} \quad \text{SV} = \text{EV} - \text{PV}$$

Like CV, the project's SV is a sum of SVs of particular tasks, so if there are some tasks delayed and some tasks accelerated; SV may show no deviation at all. The model is too simple to distinguish between critical and non-critical tasks.

- **Schedule Performance Index (SPI)** compares the planned cost of work done with planned cost of work scheduled. SPI less than 1 indicates a delay:

$$\text{SPI} = \text{BCWP} / \text{BCWS} \quad \text{or} \quad \text{SPI} = \text{EV} / \text{PV}$$

- **EAC, estimated cost at completion** – Represents the sum of the costs incurred to date and the revised estimated costs for the work remaining, given by (BAC/CPI). Several formulas are used (PMI 2005:21) (Christensen 1994:17), but one of the most common is based on the project's CPI at the date of performance check (PMI 2005:20):

$$\text{EAC} = \text{BAC} / \text{CPI}$$

- **Time estimate at completion EAC (t)**, is similar rough estimate of the total time required to complete the project, EA(t) made using SPI but SPI(t) in this case is time-related schedule performance index (rather than cost related), and the as-Planned Original Duration planned to complete the project 'OD'.

$$\text{EAC}(t) = \text{OD} / \text{SPI}(t)$$

This amendment came with measuring schedule variance (marked SV (t)) ‘horizontally’ and expressing it in time units. The new approach was introduced by Lipke (Lipke 2009) (Czarnigowska 2008) and called Earned Schedule. The method having established the ‘horizontal’ schedule variance SV(t), it calculates the ‘earned schedule’ (ES), on this base, time-related schedule performance index SPI (t) can be provided:

$SPI(t) = ES/t$, where ‘t’ is time assigned to accomplish the scheduled, and finally, a rough estimate of total duration, $EAC(t) = ES/ SPI(t)$

- **VAC, variance at completion**, indicates expected positive or negative deviation at completion. Given by:

$$VAC = BAC - EAC$$

2.6. ISSUES IN CONDUCTING EVM

Earned value management’s effectiveness as a performance metric depends on some important factors.

- 1) The first, and most important, is the availability of highly accurate, up-to-date information on the percentage of work packages completed, which is vital for determining the earned value at any point in time. The accuracy of the calculated earned value hinges on an honest reporting system, as well as the integrity of the project team members and managers.

The common methods for determining completion values are:

- **0/100 rule:** This rule assigns a value of zero to a project activity until it is completed and when fully complete 100 percent completion percentage is assigned. This rule is best suited for work packages that have very short durations.
- **50/50 rule:** This decision rule assigns a 50 percent completion value for any activity that has been started and carries this value until it is completed, where it switches to 100 percent. Like the 0/100 rule, this decision rule is most often used for work packages of very short duration.

- **Percentage complete rule:** With this decision rule, the project manager and team members mutually decide upon a set of completion milestones. For example, these predetermined completion milestones may be 25, 50, 75, and 100 percent, or 33, 67, and 100 percent, or any other set of values. Clearly, the viability and integrity of this process rests on an honest appraisal of the status of ongoing activities in terms of the actual percentage of the activities completed, regardless of the elapsed time or budget spent. The various gradients of completion must be acknowledged and used by all parties;
- 2) Defining ‘action thresholds’ The performance measures obtained at consecutive progress checks, showing deviation from the baseline, need to be assessed to determine if the scale of deviations is likely to affect the project in negative way and if some preventive actions should be undertaken. Defining ‘action thresholds’ for the project as a whole and for particular tasks is an important element of Earned Value Management (PMI 2005). Special care is needed with whole-project measures as, due to the nature of the model, poor performance of some tasks may be compensated by good performance of the other.
 - 3) A second issue when establishing accurate or meaningful EVM results is the “human factor” that comes into play when projecting project activity completion. In the interest of looking good for the boss, or due to implicit or even explicit pressure from project managers themselves, the tendency to downplay serious cost problems can arise. Despite these limitations, EVM is useful for enabling project managers and their teams to gain a better understanding of the “true” nature of project status midstream—specifically from the aspect of cost control (Christensen 1998). The real-time information provided by EVM can be invaluable in gathering the most up-to-date cost information and in developing realistic and meaningful plans for addressing and rectifying any systematic problems associated with project cost management. Ultimately, these cost management benefits stem from disciplined planning and the availability of metrics that show real variances from plan to generate necessary corrective actions.

4) In the final analysis, project cost control is fraught with many uncertainties. Therefore, it is imperative that top management take the time to periodically review budget and financial information. By using a formal review process, it is possible to prevent projects from going adrift or the escalation of costs without sanctions. A formal financial review process can also mitigate the risk of cost overruns, and ensure that the project stays on course. At the completion of the project, it is the project manager's responsibility to ensure that all costs are accrued and accounted for, that a financial balance sheet is produced for audit and signature, and that the financial procedures of the company are adhered to (McManus 2006).

2.7. APPLICATION SOFTWARE FOR EVM TECHNIQUE

Project control software enables real-time and historic job and project cost management designed for use by your operational teams. Project control provides performance indicators on all project cost areas providing valuable insight to make quick decisions resulting in profit margin increases on every job. Centralization of key information provides collaboration and reporting across multiple jobs, projects and organizational departments. The project control system is outside the company's sensitive accounting system providing the flexibility and manipulation capabilities required for testing alternatives and maximizing profit outcomes, saving personnel time and eliminating reproduction errors.

Although many construction companies are still using spreadsheets to manage their projects, the use of industry-specific project management software is becoming more prevalent. Depending on the maturity level Construction Companies, software like, Project Costing System (PCS), Construction Industry Software (COINS), and WinQS are used to control cost. However, the general purpose Microsoft Excel spreadsheet has been also effectively used by some professionals in developing countries.

Advantages of using Software in Construction Cost Control

1) Timesheets and Time Management Tracking

Enter timesheets and daily diary information for projects from wherever they happen to be. Record hours worked by cost code, quantities completed, and daily diary notes, and synch that information with the home office using a laptop or handheld device. Analyze fresh data to optimize resources for the next day and provide real-time integration with accounting to accelerate cash flow for faster project billing.

2) Direct Accounting Integration

Collect and store timesheet data from jobsites, while sharing data electronically with accounting systems to eliminate double entry. Maintain time sheet standards with labor classifications, and other user defined tags. Import timesheet data from third-party systems or to any accounting system. Record notes for each cost item including assumptions, jobsite observations, and more. Increase communication for issues that include staging and additional information to the field operators. Provides crew based timesheets with pre-defined data streamlining foreman or supervisor completion.

3) Field Resource Tracking

Manage field resources efficiently. Analyze information about productivity and accurately track customer information including account status, equipment usage and service history. Easily make changes when a resource is identified with high performance. Ownership costs and operation costs can include information on depreciation, insurance, and other unique resource costs in order to determine true ownership cost as well as operational use cost.

4) Anywhere Project Analysis

Web-based reporting and dashboards make it easy to get information from anywhere. Meet with customers on-site to discuss projects with total access to historical information, as well as the ability to develop preliminary budget estimates for project or job budget creation on the fly. Eliminate printing unnecessary reports by remotely focusing what the customer is looking for.

5) Provide Progress, Resource and 'Actual Cost' Updates

Updating Software with data from your other systems is easy when using the Software API. The Software API (Application Programming Interface) provides an automated method for updating Software with data from other systems to create new records, update existing records, or delete records automatically. By extracting the data from your other systems into an XML format supported by Software and submitting the XML data, Software will 'listen' for the data and automatically update the appropriate projects. Currently, the Software API supports two types of data, Resource Rates and Job Tracking Details.

6) Monitor 'Actual' Project Costs without Accounting Delays

Stay up to speed on job and project progress on a daily basis without waiting for accounting information. Preliminary and actual cost data is available daily to assess the need to make potential changes while there's still time to have an impact on the project's success and gross profit margin. Recognize time and other valuable information the moment it is entered without waiting for accounting and not having to re-enter data into multiple systems.

7) Remote Time Management Tracking

Control and monitor vendor commitments and activity, including original contract project components, insurance and bond monitoring status, change orders, invoices, requisitions, retention processing, and payments.

8) Collaboration and Updates

Save valuable man-hours eliminating the need to hand off estimates from one team member to the next. Allow last-minute updates until the bid is due, leveraging last minute pricing changes on materials and resources, while allowing multiple estimators to work on a single, or multiple estimates simultaneously.

9) Remote Data Access

Save gas, time and frustration by accessing information from anywhere including the office, remote offices, home, or client sites. Leverage untethered information access with synchronization, putting everything at your fingertips without being connected to the internet or

network. Updates are entered throughout the day into a laptop or handheld device, and when convenient, a connection is made to the network to receive and send changes. Entry straight from the field eliminates duplicate data entry into numerous systems. Provide remote project access to managers, foremen and superintendents providing complete access to critical information needed to manage jobs remotely in one central location. Track cost and productivity positions of projects, responsibilities of team members, related documents, and ongoing project activities.

10) Centralize Project Information

Eliminate storing project information on local drives and multiple network locations. Project job tracking data is conveniently stored in one location and shared for easy access to all team members. Multi-office estimating provides synchronization between team members to accommodate real-time estimation updates.

11) You can access it from anywhere

To many people, the biggest advantage of cloud software is that it's truly available on any computer or device anywhere in the world. This is particularly useful when the project team members are in the office, in the field and in a variety of geographical locations. There's no hassle with synchronizing data or uploading changes to a centralized server.

The Disadvantages of Software in Construction Cost Control

1) Has purchasing and training cost to use it

Most of these softwares are not free downloadable and need some cost to purchase and besides requires skill training to manipulate the data entry, analysis and interpretation of results so as to recommend appropriate corrective actions.

2) Disadvantages in Percentage-of-Completion

Points to problems in the percentage-of-completion method as a distinct disadvantage of cost control. This method, used to estimate costs under cost control, uses a mathematical formula to determine how much of a project a company can finish in a period, usually a financial quarter or year. Percentage-of-completion is based entirely upon estimation, meaning gross differences may

occur between projected goals and actual achievement, giving rise to misleading figures in cost control analysis.

3) Disadvantages in Interlocking Systems

Bhabatosh Banerjee, author of 'Cost Accounting Theory And Practice,' points to problems in interlocking cost control systems. These systems create cost control budget estimates and actual totals for different aspects of a company's business and production. The disadvantage of this lies in bookkeeping methods. If a single cost or expenditure applies to two areas of a company with separate cost control budgets, that cost or expenditure appears twice in the company's books.

4) Mismanagement of Cost Control

Mismanagement in cost control can lead to severe problems for companies. For instance, cost control requires the consideration of a broad palette of variables. If a company uses the wrong variables in creating estimates for cost control or when creating figures displaying total expenditure and total profit, the system produces widely inaccurate figures regarding the cost effectiveness of procedures and processes. What's more, human error may lead to severe inaccuracies – all employees involved in the process of calculating cost control, which includes managers, foremen and more, must understand the system and its requisite procedures

3. RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discussed the research design and methodology used in acquiring the necessary information to answer the research questions, how the information or data analyzed and the tool to be used for analysis and in what style will the finding report will be prepared. It specifically it tries to answer question including; What is the study about, Why is the study being made, Where will the study be carried out, What type of data is required, Where can the required data be found, What periods of time will the study include, What will be the sample design, What techniques of data collection will be used, How will the data be analyzed and which tool used for analysis as well as what style will the report be prepared.

In the study I focused my examination of new directions in project cost performance evaluation at a practical level as extension to the traditional form that limited to see a comparison (budget vs. actual) that majority of the local contractors perform on a regular basis. To simplify the calculations of EVM metrics where by encourage its acceptance I developed Excel Spreadsheet. Once the necessary cost data entered into this template, automated mathematical calculations are performed to easy the process. Thus, users can be able to harvest the performance and forecast indicators to make their interpretation. In other words: while EVM models appear complex, the template has made the operation is quite simple and display the output in tables and graph forms.

Thus, the case study involves an intensive investigation of the cost monitoring and control system used in one of local G-1 Construction Company, in construction project of a 40-60 Condominium (apartment dwelling complex) at Bole Bulbula area. A comprehensive review has been under taken to get a better understanding of cost control system in construction project of a 40-60 Condominium (apartment dwelling complex) at Bole Bulbula area. For the current research a case study has been conducted by assessing how the current cost control system is functioning, identifying its gaps and limitations, and providing recommendation for improvement.

Accordingly, the research illustrated the basic process used in cost control of construction project using EVM approach; in each process I explained the basic information need to this process and the form need to do the process (spreadsheets controls). The construction considered in the case study is a three years project, contract period of 2008-2010 EFY, contracted by Addis Ababa City administration Saving Houses Development Enterprise (AASHDE) with cost of Birr 300 million. Thus the research is exploratory or formative research in nature intended to gain familiarity with the use Earned value management technique as an effective cost controlling where the traditional cost control approach has many limitation to control cost effectively.

Many studies conducted in the area showed that poor cost monitoring and control system in construction industries is one of the factors contributing to cost overrun and delay of projects in many developing countries including Ethiopia. Progress on the project is required to be monitored and compared as the work proceeds in order to be able to identify and measure these differences. Though, there is a traditional system used in construction to monitor and report on the progress of the work, but there is no certainty implied for a construction project that its cost is adequately monitored and controlled. The effectiveness of cost monitoring and controlling system in showing deviations of project performances varies considerably from one system to another.

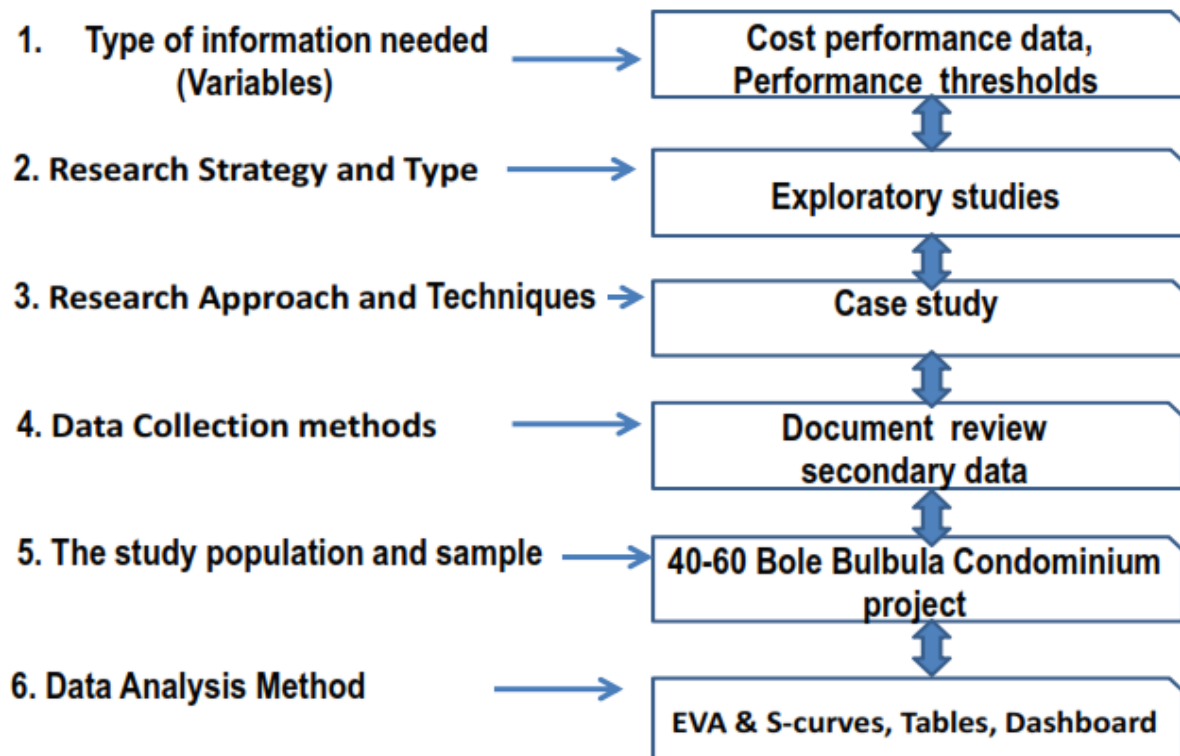
Earned Value analysis is a method of measuring performance which this research has focused. It is a program management technique that uses 'work in progress' to indicate what will happen to work in the future, where the problem lays (Bhosekar & Vyas, 2012). Earned Value is an enhancement over conventional accounting methods. However, the Conventional or the traditional approaches focus on planned expenditure and actual costs. Whereas Earned Value goes one step further and examines actual completion. This gives managers better understanding of probable risk areas. Hence with stronger picture, managers can create risk mitigation plans based on actual cost, schedule and actual development of the work.

In view of this, the study examined the limitations of traditional cost monitoring and controlling approach employed in DAC and compared it with the proposed Earned Value management technique in terms of effectiveness and multi-functionality. To do such comparisons, secondary

cost data was collected from real time data of an ongoing project regarding material, labor and other cost items. Consequently, using cost baseline (the amount budgeted for each work package), the actual cost of work performed and budgeted cost of work performed data the project performance metrics have been calculated using both the traditional and EVM approaches. Then the approaches have been evaluated based on how effectively could each measured the variance and forecast metrics as well as performance indices so as to make timely decisions. The EVM data analysis and subsequently the report has been done using an EXCEL template designed for the purpose.

3.2 RESEARCH DESIGN

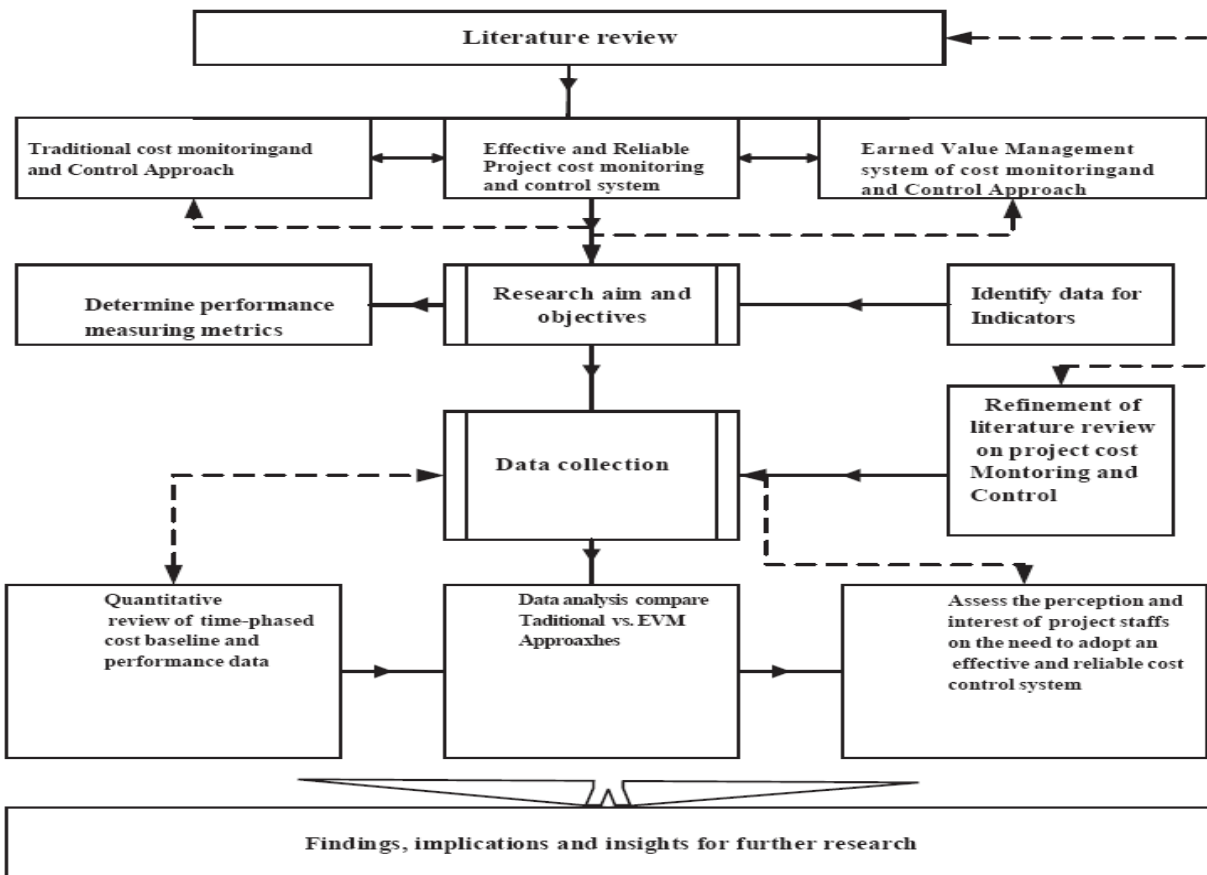
The research design was decided exactly how to achieve the stated objectives, i.e., what data needed to shed light on the problem selected, what research strategy or type followed, and how to collect and process these data. The questions in the flow chart below shows the major issues that are examined in developing the research design and the corresponding components of the research design.



The research design was initiated from a broad literature review which was refined and narrowed as the research progressed, and which resulted in the formulation of the first research question.

A critical literature review of project cost monitoring and control, with a particular focus on Earned Value Management and S-Curve (traditional Cost control) methods and EVA tools. Issue, challenges and constraints of cost monitoring and control experienced in developing country with similar feature to the case study were explored for formulation of research questions. So based on the information gathered from literature review problem of cost monitoring and control system identification and its impact on cost overrun and schedule delay examined. This showed the importance of having an effective and reliable cost control system to mitigate project cost overrun and delay happening due to poor control. Accordingly, based on this information, research objective to tackle the problem set, variables selected, and data collection, data sources, data analysis and reporting method identified

Figure: 3.1 The research progress flowchart



Source: Researcher, 2017

3.3 RESEARCH STRATEGY AND TYPE

I have taken a multi-faceted approach in addressing these questions. I have firstly reviewed the available academic and practitioner literature on the subject of EVM to identify perspectives that reinforce the acceptance of EVM as a best practice and preferable cost monitoring control system compared to the conventional one, and also compares and contrasts the two approaches in measuring current project performance and forecast the future status. I have also examined papers on related topics, such as risk management related to cost overrun and schedule delay, in order to consider how EVM relates to other key elements in project management.

On the other hand the research evaluated the traditional cost monitoring and control system used in one of local G-1 Construction Company, in construction project of a 40-60 Condominium (apartment dwelling complex). As poor project cost monitoring and controlling was among the reason for frequent cost overrun and delay in schedule in projects, this research explored the limitations the traditional cost control approach and demonstrate how the use Earned value management technique can effectively be used to monitor and control project costs. Consequently, historical records about the studied project were used for analysis in both traditional method and Earned value technique so as to show the advantage of EVM approach as an effective cost monitoring and control system. Accordingly, demonstrating the EVM method on real data, showed the advantage of EVM over the traditional cost monitoring and controlling system. The study also tried to show how EVM system would be adopted in the company's cost monitoring control system and beyond measuring performance helps to warn proactively the future deviation so that timely action could be taken. Consequently, by providing early warning information EVM helps to reduce the problem of cost overrun and schedule delays.

Therefore, the required cost data of the project were collected and feed into the Excel spreadsheet template. Hence from cost baseline and progress tracking, the Planned Value, Earned Value and Actual cost for each month were determined. Based on the information fed into the EXCLE tool, the system calculated automatically Variances, Performance Indices and Forecasting Estimates and results and tabulated and compared. In addition, the template depicted S-Curves including Earned Value as well as an early warning dashboard table that can alert the

project manager to take or recommend timely actions. Moreover, the existing control method of the company has been evaluated whether it allows doing such analysis.

While applying the EVM procedure the following metrics were evaluated: Project values/Data: planned Value (PV), Earned Value(EV), Actual Cost (AC) and Budget at Completion(BAC), Variances: Cost variance (CV), and Schedule Variance (SV), Performance Indices: Cost performance Index (CPI) and Schedule performance Index (SPI), Forecasting Estimates: Cost to Complete (ECT), Cost Estimate at Completion (EAC), and Estimated Time To Completion (ETTC). And other useful forecasts like; Cost Variance at Completion (VAC), To complete Cost Performance Index (TCCPI) and To complete Schedule Performance Index (TCSPI).

3.4 RESEARCH APPROACH AND TECHNIQUES

The research started with a literature review relating to the research questions established in Chapter 1. 'In the natural-sciences style one can study the literature and work out whether existing findings and theories are adequate and if one feels that certain data are not there or that existing theories need testing or challenging, he/she set up an experimental procedure to yield new data to test existing theory' (Bill Gillham, 2000).

However, this research went further to investigate the problem using real time data to be collected in ongoing project. It used both quantitative and qualitative data. The quantitative consist of time-phased budgets allocate costs across both project activities and the anticipated time in which the budget is to be expended, actual costs incurred for each task that is being performed and percentage of work packages completed. Analysis of these data using EVM technique has helped to measure the performance of the project at a given point in time and make forecast about the future status of the project. Examine how the existing cost control system in the company measures performance of the same project. Then the results of the two approaches were compared in terms of effectiveness and realistic to real situation. In addition, other early warning metrics including Variances, Performance Indices and Forecasting Estimates were calculated to show the present and future performance of the project.

Thus, based on these EVM metrics warning signs on the project performance have been identified for timely corrective actions before cost overrun or schedule delay comes. Finally, it is showed the limitations of the existing traditional approach to effectively and realistically monitor and control project costs as well as proactively anticipate the future failure. On the other hand, the study showed how the limitations of the traditional cost monitoring and control system can contribute to the project cost overrun and delay.

On the other hand some qualitative data were also tracked using interviewing key informants in the project on their perception on the effectiveness of the existing cost monitoring and control system. Furthermore, those informants were asked about their interest and readiness to adopt other more effective and reliable control system and how cost control information been used for decision.

3.5 DATA COLLECTION METHOD

The research uses secondary data collection methods to collect project cost data consisting cost baseline (the amount budgeted for each work package), the actual cost of work performed and budgeted cost of work performed through reviewing records of the cost baseline and periodic performance reports of the project studied. In this regard the planned value and the actual cost spent by work package were collected from the project cost baseline and expenditure record respectively. On the other hand data on the percentage of work actually performed were collected from the responsible engineer and from a consulting firm which has been assigned by the client to follow-up the construction project. In addition primary data on the current cost control experience and readiness to accept new and a better approach (EVM) were collected directly by interviewing key project staffs. The aim of this qualitative information is just to see their tendency to adopt EVM techniques and how cost control information been used for decision. Data regarding estimate of the percentage of work packages completed for each task were obtained from the responsible engineer as indicated in the responsibility matrix with triangulating from data obtained from the consulting firm . Generally, the required data for the study were the basic cost and schedule information of a 40-60 Condominium project implemented by DAC, which include time-phased budgets allocated to each activity, actual costs

incurred for each task and percentage of work packages completed at a given time for the 40-60 Condominium project in Bole Bulbula area.

3.6 THE STUDY POPULATION AND SAMPLE

As the case study focuses evaluation of on one case of project cost monitoring and control in DAC. Though the findings and recommendation could work for projects in similar context, but in this case the population is all projects of DAC. Similarly, the sample is still limited to that specific 40/60 Condominium project implemented at Bole Bulbula site.

3.7 QUALITY OF THE RESEARCH

Reliability is the probability of obtaining the same results if the research was conducted in the same way once again. High reliability means that the result would be pretty much the same. In this study since the study uses real time cost data and the mathematical calculations to determine project performance was computer assisted; therefore reliability problem has been made to be minimum. Similarly, to ensure reliability the primary data to be obtained through interview, variables and questions are comprehensively defined to ensure validity and reliability of the research, variables are comprehensively defined to reduce misunderstandings thus increase the reliability of the measuring instruments. Moreover, triangulation of results was employed to ensure reliability of the data collected.

The validity tells how well the research reflects the reality. A high level of validity indicates that the research reflects the reality in a good way. As the study used complete information about cost data of the project investigated, the findings drawn from the analysis of metrics reflects the actual situation.

3.8 DATA ANALYSIS METHOD

In this section, I reviewed the EVM formulas of performance, forecast, trend analysis and percentage comparisons which the conventional cost control approach doesn't have and the corresponding functions and data requirement. To this end, data analysis has been carried out first by organizing the relevant project data and conduct analysis using both by EVM approach and the traditional system which is currently used by the company. Moreover, to make the computation easier, faster and error free, an Excel Template was employed. Therefore, the

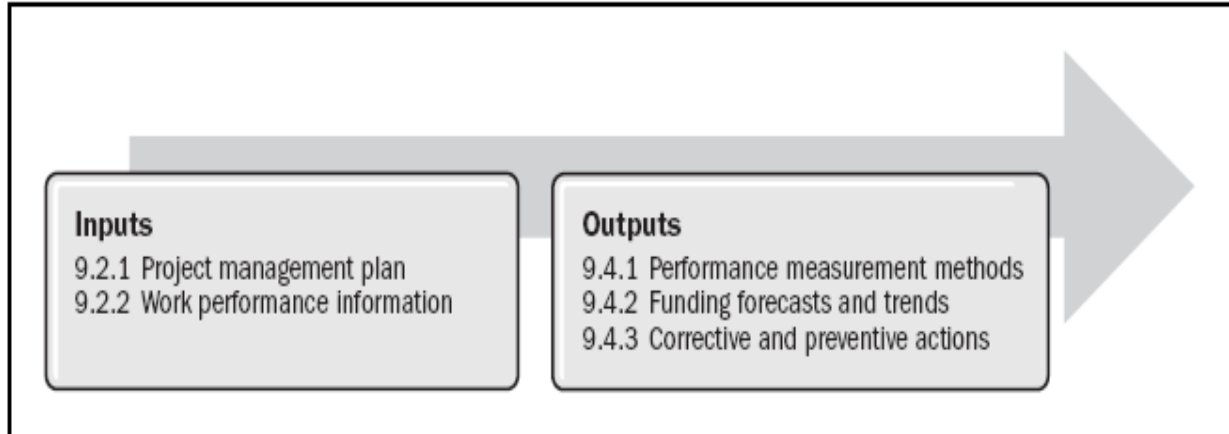
overall procedure followed herein helped me to make comparisons between the two approaches and demonstrate the multidimensional function of EVM cost monitoring and control system.

Analyzing Project Performance is the process of comparing actual project cost and schedule performance to the performance measurement baseline for the purposes of analyzing the current status of a project. The primary purpose of EVM in this case is to provide management with a rigorous and complete understanding of the project's cost and schedule performance, and a rational forecast of an anticipated end state for each. This understanding is essential for making good decisions while analyzing the project, exploring opportunities, and mitigating undesired variances. Another purpose of EVM data is to allow for early indication of expected final costs and schedule completion. This analysis provides a prediction of future project performance (PMI 2011).

By deploying an EVM system on the project, various metrics can be produced that address the project's cost and schedule for past, current, and future conditions. These metrics may be represented in many data forms and graphics and provide an effective means to communicate a common understanding of the project to all stakeholders (PMI 2011). (See Figure 3.2 for the inputs and outputs for this process).

However, as development and introduction the proposed EVM methodology is a new concept to the company, to adopt EVM beyond its current methodology the management and project staff may raise questions surrounding its validity. Therefore, in this section I identify a range of validation approaches: The first one is since the traditional S-curve track progress only in the dimension of time, it is possible to adapt and expand this by including the value of the work actually accomplished at the cost rates set out in the original budget and the actual cost of work performed to evaluate the validity of the EVM relationships. In addition, I demonstrated using the real data that the new approach beyond measuring the current performance better than the conventional system in forecasting the future trend. And secondly, after the demonstrating of EVM using the project cost data, results have been displayed to the project management and staffs so that to get their acceptance and to obtain direct feedback.

Figure 3.2: Analyze Project Performance: Inputs and Outputs



Source: PMI Practice Standard for Earned Value Management, 2011

A. Inputs

1) Project Management Plan

The following components in the project management plan are used to analyze project performance:

- **Performance measurement baseline (PMB):** The performance measurement baseline is used to compare planned performance with actual performance to determine project status.
- **Variance thresholds:** This indicates the acceptable range of variances.
- **Subsidiary management plans:** The cost management plan, schedule management plan, scope management plan, and any other management plans that are used to provide guidance in managing and controlling the project.

2) Work Performance Information

Work performance information includes information about project progress, such as which deliverables have started, what the progress of the deliverables is, and which deliverables have finished. This information is used to determine earned value. It also includes information on costs that have been authorized and incurred. This information is used to determine actual cost.

Earned value management (EVM) relies on four key data points: *Planned value, Earned value, Actual cost and Budget at completion*

The planned value is represented in the performance measurement baseline, as is the budget at completion. The earned value and actual costs are updated as the project progresses. While it is most common to use monetary units to calculate and report earned value, it is possible to convert these to other units such as labor-hours for work to be issued and progressed.

Planned Value

Planned value (PV) is the authorized, time-phased budget assigned to accomplish the scheduled work. At any given point on a time line, PV describes how much of the project work was planned to be performed.

Earned Value

Earned value (EV) is the measure of work performed at a specific point in time, expressed in terms of the approved budget authorized for that work. The earned value of a project can be determined by various methods. The earned value methodology used to plan the baseline should be used consistently to determine the earned value. Figure 3.3 shows the earned value at ‘time now,’ and indicates that less work than planned has been accomplished.

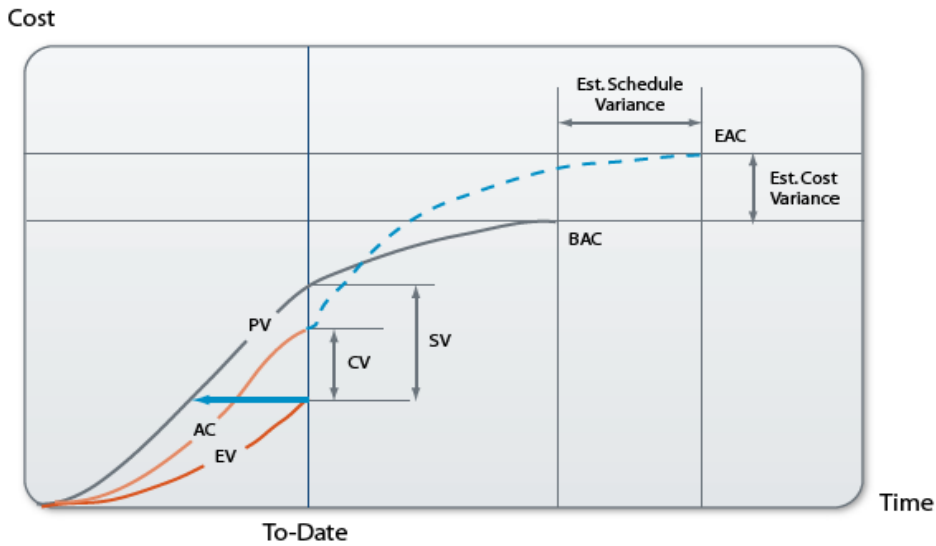
Actual Cost

Actual cost (AC) is the realized cost incurred for the work performed during a specific time period. In order for EVM analysis to be reliable, AC must be recorded in the same time period as EV and for the same activity or work breakdown structure component as EV. For example, recording AC for accomplished work several months after EV has been recorded for the same work could significantly distort the EVM data. Figure 3.3 shows the actual cost at time now, and indicates that the organization has spent more than it planned to spend in order to achieve the work performed to date.

Budget At Completion

Budget at completion (BAC) is the sum of all the budgets established for the work to be performed.

Figure 3.3: Graphic view of the EVM Data



Source: PMI Practice Standard for Earned Value Management, 2011

B. Output

1) Performance Analysis

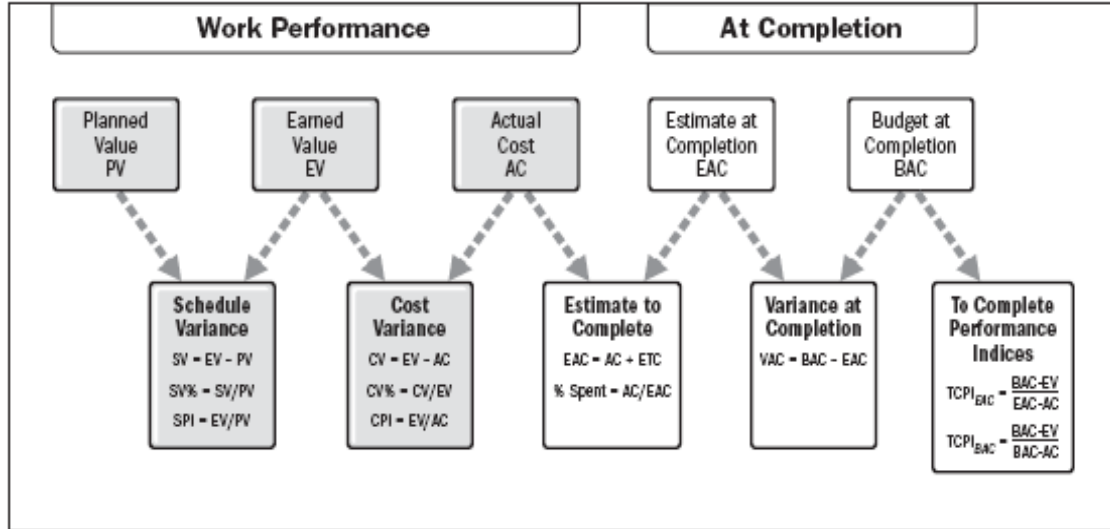
Earned value analyzes project performance by calculating performance variances and performance indices. These variances and indices are summarized below in Table 3.1 and Figure 3.4.

Table 3.1 EVM common Variances and Indices

Common Variances	Common Indices
▪ <i>Schedule variance (SV)</i>	▪ <i>Schedule performance index (SPI)</i>
▪ <i>Cost variance (CV)</i>	▪ <i>Cost performance index (CPI)</i>
	▪ <i>To complete performance index (TCPI)</i>

Source: Researcher, 2017

Figure 3.4 Basic EVM Variances and Index Calculations



Source: PMI Practice Standard for Earned Value Management, 2011

Performance Variances

After establishing the earned value (EV) the numerical difference between it and the other two values (PV and AC) gives two different products, the Schedule variance (SV) and the Cost variance respectively (CV). The SV indicates whether the project is behind schedule or on schedule in accomplishing work. A positive value indicates more work has been accomplished than planned; a negative value indicates that less work has been accomplished than planned. On the other hand, a negative CV means the project is spending more money on a particular activity or at a particular report period than what was budgeted.

The formulas for deriving these two variances and their percentage are:

- Schedule Variance (SV) = EV - PV
- Cost Variance (CV) = EV - AC
- The schedule variance can be expressed as a percentage by dividing the schedule variance (SV) by the planned value (PV): $SV\% = SV/PV$, and
- The CV can be expressed as a percentage by dividing the cost variance (CV) by the earned value (EV). $CV\% = CV/EV$

Cost and Schedule Variances can be calculated on either cumulative data or periodic (typically monthly) data (Webb 2003). Webb (2003) advised that variances should be computed at the lowest level of detail established within a project and progressively summed through the various levels of the project. This he said would make it possible to see where the cost and schedule variance problems occur and to take the appropriate actions or measures against their reoccurrence.

Performance Indices

Ascertaining figures for the two variances are very simple to do. It is just a basic arithmetic (subtraction of two variables) but reflects an important decision making tool in a projects life time. However, further numerical calculations can be derived which may be even more helpful (Webb 2003). These are the Cost performance Index (CPI) and the Schedule Performance Index (SPI). When these two index numbers are calculated it gives an instant measure of performance against both the cost plan and the schedule (Webb 2003).

Schedule Performance Index (SPI)

Webb (2003) defines SPI as the earned value created to the amount of value planned to be created at a point in time on the project. An SPI less than one indicate an unfavorable schedule variance. (Christensen 1999). Christensen (1999) further discussed that an unfavorable SPI does not necessarily mean that the project is behind schedule. For example, an SPI of 0.85 means that for every Birr or Dollar of work scheduled to be completed, only 0.85 has been achieve at the report point. Christensen (1999) pointed out that, an unfavorable SPI may be predictive of cost overrun, because schedule problems may require additional cost in the months preceding the report point, to make adjustments. The formula to derive the SPI is as follows:

$$\text{SPI} = \text{EV/PV}$$

Cost Performance Index

This is defined as the ratio of value created to the amount spent at a point in time (Webb 2003). In more simple terms, Christensen (1999) defines CPI as a measure of the budgeted cost of completed work against the actual cost. In this definition, the completed work refers to the value created (BCWP). The deriving formula for this index is:

$$\text{CPI} = \text{EV/AC}$$

If the CPI is less than one, an unfavorable cost variance is indicated (Christensen 1999). For example, if a CPI is 0.85 it means that for every Birr or Dollar spent, only 0.85 Birr or Dollar of work has been completed. Thus, CPI is one of the clearest indicators of the cost efficiency of a project. It shows what will happen if we continue to get the same level of productivity for every dollar spent for the rest of the project (Stephen A. Devaux, 2015). So, CPI gages how cost efficient the team is in using its resources.

The To-Complete Schedule Performance Index (TCSPI)

As depicted by its name the TCSPI indicates the level of schedule performance required to finish on time from the report point (Webb, 2003). That is a TCCPI of 1.2 means that the project must perform on a SPI of 1.2 from the report point to completion of the project. As explained by Newell (2003), there is a contrast here in the sense that the TCSPI is an index and hence should reflect favorable conditions when greater than one. On the contrary the TCSPI becomes unfavorable when it is greater than one. In this case, the further the SPI is from the TCSPI the more doubtful that the project is going to complete at the Estimate at Completion. The formula for deriving the TCSPI is as follows:

$$\text{TCSPI} = (\text{BAC} - \text{EV}) / (\text{BAC} - \text{PV})$$

The To-Complete Cost Performance Index (TCCPI)

Analogous to the TCSPI this index indicates the level of cost performance that will be necessary to complete the project within budget from the report point. A TCCPI of 1.5 means that the project has to perform with a CPI of 1.5 to complete successfully within the original budget stipulated. Like, the TCSPI it is also not accurate. The reason being that, when the CPI is less than one the, which indicates an unfavorable performance, the TCCPI on the other hand becomes greater than one, which is not reflective of a typical index.

According to Newell (2003) these indexes are rarely used due to its complications, but gives an idea as to what performance is needed to finish within budget and to finish on time. This made it an important factor to implement these two ‘controversial’ but important indexes in Earned Value analysis Technique. The formula for deriving the TCCPI is as follows:

$$\text{TCCPI} = (\text{BAC} - \text{EV}) / (\text{BAC} - \text{AC})$$

Cost Schedule Index (CSI)

The Cost Schedule Index determines whether a project can be continued or not. The further a project's CSI is less than 1.0 the more difficult it is for the project to be recovered. The formula for the CSI is as follows:

$$\text{CSI} = \text{SPI} * \text{CPI}$$

Figure 3.5: Interpretation of Basic EVM performance Measures

Performance Measures		Schedule		
		SV > 0 & SPI > 1.0	SV = 0 & SPI = 1.0	SV < 0 & SPI < 1.0
Cost	CV > 0 & CPI > 1.0	Ahead of schedule under budget	On schedule under budget	Behind schedule under budget
	CV = 0 & CPI = 1.0	Ahead of schedule on budget	On schedule on budget	Behind schedule on budget
	CV < 0 & CPI < 1.0	Ahead of schedule over budget	On schedule over budget	Behind schedule over budget

Source: PMI Practice Standard for Earned Value Management, 2011

2) Forecasting

As the project progresses, forecasts can be developed for cost and schedule performance. Common forecasting data includes: Estimate to complete, Estimate at completion, Estimate Time To Completion, Variance at completion and To-complete performance index.

These forecasts are summarized in Figure 3.5, above.

Estimated cost To Complete

This is an estimate of the additional money that would be necessary to complete the project (Newell, 2003). Newell (2003), explains that using the ETC predicts that the project will overrun or under run its budget at the end of the project and that it is a good thing to inform stakeholders and managers informed of danger, but not practical to get extra money for the project. The deriving formula is as follows:

$$\text{ETC} = (\text{BAC} - \text{EV})/\text{CPI} \text{ or } \text{ETC} = \text{EAC} - \text{AC}$$

Estimated time To Complete

This indicates the overall duration of the project (Webb, 2003). The formula for deriving it is as follows:

$$\mathbf{ETTC = OD / SPI}$$

Where OD = Original duration of the project

Estimate At Completion (EAC)

As described by Newell (2003), it is the forecast value of the project when the project is complete. The EAC shows the total schedule or projected cost. The formula for deriving the EAC is as follows:

$$\mathbf{EAC = AC + (BAC-EV)/CPI = BAC/CPI}$$

Table 3.2 is a summary of some of the independent EAC calculations that can be performed and the assumptions associated with each.

Variance at Completion (VAC)

VAC is the difference between the BAC and the EAC. VAC shows the team whether the project is forecasted to finish under or over budget. A negative VAC indicates an unfavorable variance and a positive VAC indicates favorable variance. The formula for the VAC is as follows:

$$\mathbf{VAC = BAC - EAC}$$

Percent complete

The Percent complete is the amount of work that has been completed over the budget at completion. This gives the formula:

$$\mathbf{\% Complete = (EV / BAC) * 100}$$

Newell (2003) pointed out that the percent complete can never be greater than 100. This is because the BAC is the sum of the budget in the project. The difference between the PV and The EV for an activity is whether or not the activity has been completed; at the end of the project the sum of all of the budgets must equal the sum of all the EV. If an activity has not claimed its EV, the project is not yet completed. As soon as all of the activities in the project have claimed their EV, the project is said to be completed.

Percent spent

This is simply the amount of the project budget that has been spent to date. It is computed by dividing the AC by the BAC. The formula is as follows:

$$\% \text{ Spent} = (AC / BAC) * 100$$

Percentage of Project Schedule to be achieved at a Report Point

This is also a simple EVA calculation. It indicates the percentage of the schedule that has been achieved at the report point. It is calculated by dividing the PV by the BAC.

$$\% \text{ of Project Schedule to be achieved at Report Point} = PV / BAC * 100$$

Table 3.2: Independent EAC assumptions and formulas

Assumption	Formula
Future cost performance will be performed at the budgeted rate	$EAC = AC + (BAC - EV)$
Future cost performance will be the same as all past cost performance	$EAC = AC + [(BAC - EV) / CPI] = BAC / CPI$
Future cost performance will be the same as the last three measurement periods (i, j, k)	$EAC = AC + [(BAC - EV) / ((EVi + EVj + EVk) / (ACi + ACj + ACk))]$
Future cost performance will be influenced additionally by past schedule performance	$EAC = AC + [(BAC - EV) / (CPI \times SPI)]$
Future cost performance will be influenced jointly in some proportion by both schedule and cost indices (e.g. 80% CPI & 20% SPI)	$EAC = AC + [(BAC - EV) / (0.8 \text{ CPI} + 0.2 \text{ SPI})]$
Future estimated time to completion	$\text{Original project length} / SPI = OD / SPI$

Source: PMI Practice Standard for Earned Value Management, 2011

These variances, indices, and forecasts can be used to answer key project management questions as listed in Table 3.3.

Table 3.3 EVM as it Relates to project Management Situation

Project Management Question	EVM Performance Measures
How are we doing time wise?	Schedule Analysis & Forecasting
▪ <i>Are we ahead or behind schedule?</i>	= <i>Schedule Variance (SV)</i>
▪ <i>How efficiently are we using time?</i>	= <i>Schedule Performance Index</i>
How are we doing cost-wise?	Cost Analysis & Forecasting
▪ <i>Are we under or over our budget?</i>	= <i>Cost Variance (CV)</i>
▪ <i>How efficiently are we using our</i>	= <i>Cost Performance Index (CPI)</i>
▪ <i>How efficiently must we use our remaining</i>	= <i>To-Complete Performance Index</i>
▪ <i>What is the project likely to cost?</i>	= <i>Estimate at Completion (EAC)</i>
▪ <i>Will we be under or over budget?</i>	= <i>Variance at Completion (VAC)</i>
▪ <i>What will the remaining work cost?</i>	= <i>Estimate to Complete (ETC)</i>
▪ <i>How long the remaining work takes?</i>	= <i>Estimate Time To Completion</i>

Source: PMI Practice Standard for Earned Value Management, 2011

C. Corrective and Preventive Actions

Based on the analysis of project performance and trends the study has identified areas which has caused deviations against the threshold limits that the company could tolerate to accept. In providing of warning the Excel template in addition to making easier EVM calculations and identification of indicators it also displayed major areas of concern in a dashboard form.

Subsequently, respective to the identified root causes and their level of deviation the paper recommended preventive actions to keep the project from crossing a performance threshold, or recommend corrective actions to bring performance back in line with expected performance. In connection to the whole EVM process and the resulted recommendations the study has tried to create impression on the company's management how EVM system could be an effectiveness and reliability cost monitoring and control tool as compared to the traditional approach.

4. ANALYSIS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter discussed on how to use real-time cost baseline and periodic performance cost and schedule figures to track the progress of a project. This has been done by using on real-time data collected from the 40/60 condominium apartment construction implemented by DAC inputted into the spreadsheet template and the results interpreted. Using these data effectiveness of EVM technique compared with traditional approach has been demonstrated. To this end the power of EVM system has been practically shown in terms of measuring performance and forecast the future using the appropriate EVM metrics. On the basis of the findings of the EVM performance and forecast analysis, conclusions have been drawn and recommended actions have been suggested which have been presented in chapter 5.

Therefore, this part the paper analyzed the project cost data using a spreadsheet template, explained the status of the project using earned value method, and made forecasts as to the probable project outcomes which entailed explaining the cost, schedule, and at-completion variances. In addition, while identifying the variances the study has also described the cause, impact, and proposed possible corrective actions associated with these variances. Having obtained this information the construction firm in general and the project manager in particular could be able to assign the responsibility for managing the corrective actions to concerned department, section or individual as required.

Using the EVM analysis method and formulas described in the previous chapter, the Excel template the project cost data analyzed and the outputs has been displayed using tables and S-curves as well as pie-charts (specifically to display percentage of complete and spent results). Before, starting manipulations of performance and forecast metrics the profile, WBS and cost baseline of the project has been presented below.

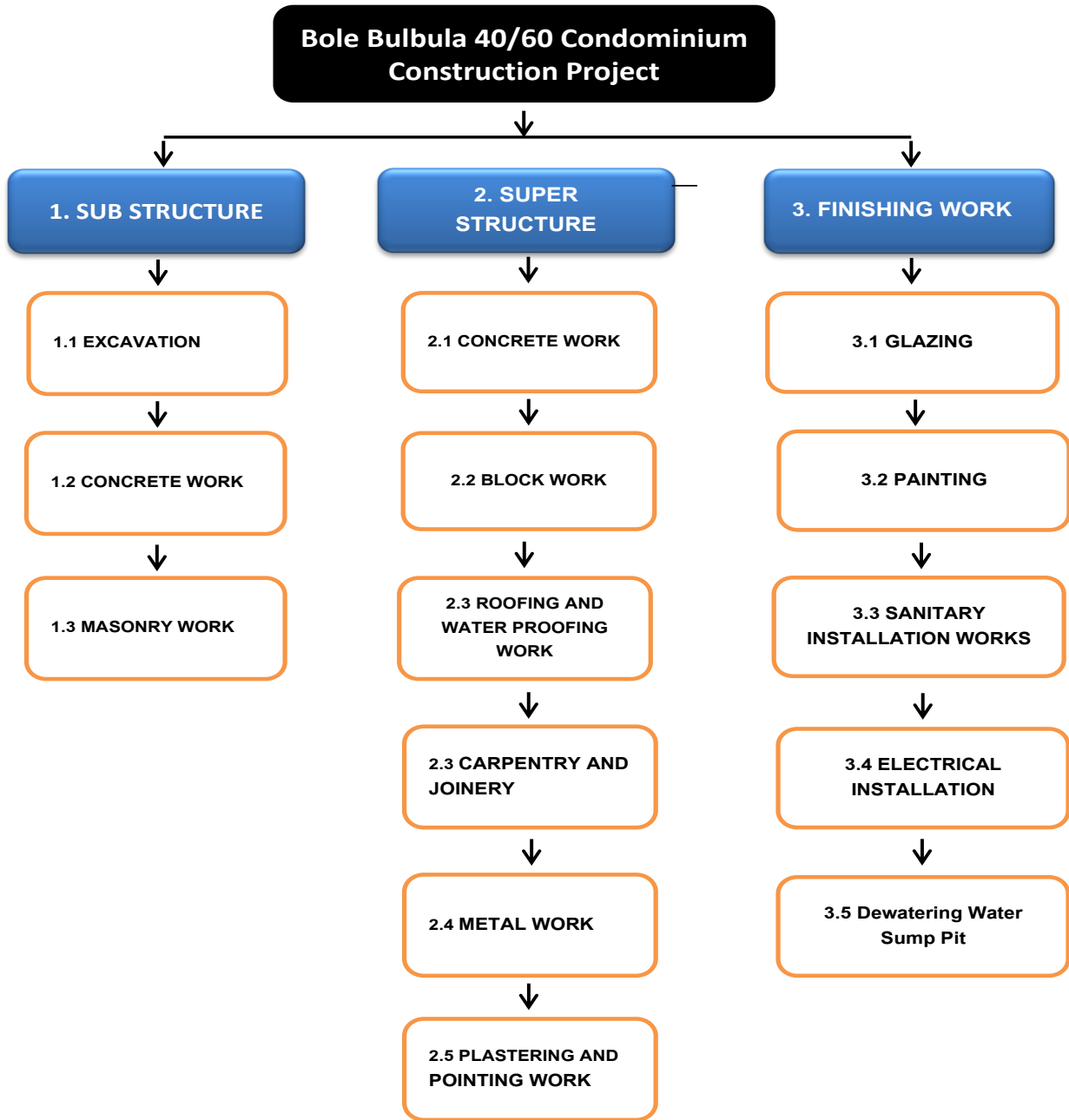
Profile of construction project

- It is a 40/60 condominium building, which include four blocks, each has two basements for car parking, and ground plus 15 floors consisting 130 houses in floors 3 to 15 and the lower

two floors and the ground are assigned for shops (altogether at the completion there will be 520 houses excluding the shops).

- The Key responsible actors in the project are: the contractor Desalegn Asrade Construction PLC (DAC), the Client the Addis Ababa City Administration Saving Houses development Enterprise and the Consultant ASPIRE AECOM CONSULTING ARCHITECTS AND ENGINEERS PLC.
- Total Contract cost is Birr 300, 000,000.00 (Three Hundred Million Ethiopian Birr)
- Original Contract Duration 720 workdays (excluding weekends) or a total of 144weeks (including weekends). The project was started on July 2008EFY and expected to end after 2 years around the three quarter of the 2010 EFY.

Figures: 4.1 Work Breakdown Structure (WBS) of a deliverable-oriented grouping of project components of the Bole Bulbula 40/60 condominium construction



Source: ASPIRE AECOM CONSULTING ARCHITECTS AND ENGINEERS PLC, 2016

Table 4.1: Time-phased Planned Budget, Actual cost and Earned Schedule of the project

ACTIVITY	ACTIVITY- DESCRIPTION	DURATION	DEPENDENCY	TOTAL FLOAT	2008 EFY				2008/ 2009EFY	2009EFY			2009/ 2010EFY	2010EFY			BUDGET AT COMPLETION(BAC)
					WEEK 12	WEEK 24	WEEK 36	WEEK 48	WEEK 60	WEEK 72	WEEK 84	WEEK 96	WEEK 108	WEEK 120	WEEK 132	WEEK 144	
A	EXCAVATION & EARTH WORKS	11			6,588,671.70	1,906,702.82			1,840,013.70								
B	CONCRETE WORK (Under Earth)	12.5	A			16,127,357.43	391,102.05		-								
C	MASONRY WORK	10	B			-	95,904.50		-								
D	CONCRET WORK (over Earth)	9	A			-	35,053,167.15	22,903,659.20	7,312,887.50								
E	BLOCK WORK	14.5	D			-		11,262,635.30	11,289,015.30								
F	ROOFING AND WATER PROOFING WORK	8	E			1,401,336.06		-	-								
G	CARPENTRY AND JOINERY	6.5	F						-	1,000,000.00							
H	METAL WORK	8	G						-	10,000,000.00	5,000,000.00						
I	PLASTERING AND POINTING	11.5	G					1,898,128.25	2,138,611.90								
J	FINISHING WORK	12	G,H							7,750,760.40	1,500,000.00	3,000,000.00					
K	GLAZING	8	J							11,386,228.40	2,000,000.00	2,000,000.00					
L	PAINTING	11	K								6,693,818.30						
M	SANITARY INSTALLATION WORKS	9	J									2,500,000.00					
N	ELECTRICAL INSTALLATION	6	J														
O	DEWATERING WATER SUMP PIT	7	J														
	Total	144															
	Budgeted Cost of work Scheduled (PV= BCWS)				6,588,671.75	19,435,396.30	35,540,173.70	36,064,422.75	32,580,528.40	25,136,988.80	10,193,818.30	7,500,000.00					
	Cumulative (PV= BCWS)				6,588,671.75	26,024,068.05	61,564,241.75	97,628,664.50	130,209,192.90	155,346,181.70	165,540,000.00	173,040,000.00					300,000,000.00
	Actual Cost of work Performed(AC=ACWP)				6,276,617.90	15,438,260.80	21,771,195.45	31,679,483.60	22,403,152.00	30,122,282.45	4,500,000.00						
	Cumulative (AC=ACWP)				6,276,617.90	21,714,878.70	43,486,074.15	75,165,557.75	97,568,709.75	127,690,992.20	132,190,992.20						
	% Planned work completed				0.92	0.69	0.71	1.10	0.84	0.89	0.60						
	Budgeted Cost of work Performed(EV= BCWP)				6,061,578.01	13,410,423.45	25,233,523.33	39,670,865.03	27,367,643.86	22,371,920.03	6,116,290.98						
	Cumulative (EV= BCWP)				6,061,578.01	19,472,001.46	44,705,524.78	84,376,389.81	111,744,033.67	134,115,953.70	140,232,244.68						
	Original project Duration (OD)	144			144	144	144	144	144	144	144	144	144	144	144	144	144

Source: Organized by the researcher from DAC PLC Bole Bulbula 40/60 Condominium project data

4.2 DETERMINATION OF RESULTS AND INTERPRETATIONS

The time-phased budget data and performance reports are used to get PV, AC, PCT (Percent completion of tasks), the BAC and OD (shown in Table below) which will input to the Excel template for further calculation of performance and forecast metrics(as of the first week of May 2017). Summary of Input from cost and performance records and Output generated by the Excel Template is given below.

INPUT

Table 4-2: a) Input data of the project

Month	Budget at Completion (BAC)	Budgeted Cost of Work Performed (BCWP=EV)	Budgeted Cost of Work Scheduled (BCWS=PV)	Actual Cost of Work Performed (ACWP=AC)	Original project Duration (OD)
Week 12	300,000,000.00	6,061,578.01	6,588,671.75	6,276,617.90	144
Week 24	300,000,000.00	13,410,423.45	19,435,396.30	15,438,260.80	144
Week 36	300,000,000.00	25,233,523.33	35,540,173.70	21,771,195.45	144
Week 48	300,000,000.00	39,670,865.03	36,064,422.75	31,679,483.60	144
Week 60	300,000,000.00	27,367,643.86	32,580,528.40	22,403,152.00	144
Week 72	300,000,000.00	22,371,920.03	25,136,988.80	30,122,282.45	144
Week 84	300,000,000.00	6,116,290.98	10,193,818.30	4,500,000.00	144

Source: Organized by the researcher from DAC PLC Bole Bulbula 40/60 Condominium project, 2017

Table 4-2: b) Input data of the project based on cumulative (EV, PV and AC)

Month	Budget at Completion (BAC)	Cum.EV	Cum.PV	Cum.AC	Original project Duration (OD)
Week 12	300,000,000.00	6,061,578.01	6,588,671.75	6,276,617.90	144.00
Week 24	300,000,000.00	19,472,001.46	26,024,068.05	21,714,878.70	144.00
Week 36	300,000,000.00	44,705,524.78	61,564,241.75	43,486,074.15	144.00
Week 48	300,000,000.00	84,376,389.81	97,628,664.50	75,165,557.75	144.00
Week 60	300,000,000.00	111,744,033.67	130,209,192.90	97,568,709.75	144.00
Week 72	300,000,000.00	134,115,953.70	155,346,181.70	127,690,992.20	144.00
Week 84	300,000,000.00	140,232,244.68	165,540,000.00	132,190,992.20	144.00

Source: Organized by the researcher from DAC PLC Bole Bulbula 40/60 Condominium project, 2017

Putting the above data in the template have resulted the following performance and forecast output indicators (as of week 84 or 1st week of May 2017) shown in Table 4-3.

OUTPUT

Table 4-3: Variances and Performance Indices

Month	Variances			Performance Indices			
	Cum. Cost Variance (CV)	Cum. Schedule Variance (SV)	Cum. Variance at Completion (VAC)	Cum. Cost Performance Index (CPI)	Cum. The To-Complete Performance Index for Budgeted Cost TCCPI	Cum. Schedule Performance Index (SPI)	The To-Complete Performance Index for Schedule TCSPi
Week 12	(215,039.89)	(527,093.74)	10,642,767.76	0.97	1.00	0.92	1.00
Week 24	(2,242,877.24)	(6,552,066.59)	34,555,419.19	0.90	1.01	0.75	1.02
Week 36	1,219,450.63	(16,858,716.97)	(8,183,221.02)	1.03	1.00	0.73	1.07
Week 48	9,210,832.06	(13,252,274.69)	(32,749,085.66)	1.12	0.96	0.86	1.07
Week 60	14,175,323.92	(18,465,159.24)	(38,056,592.69)	1.15	0.93	0.86	1.11
Week 72	6,424,961.50	(21,230,228.00)	(14,371,805.86)	1.05	0.96	0.86	1.15
Week 84	8,041,252.48	(25,307,755.32)	(17,202,717.88)	1.06	0.95	0.85	1.19

Source: Organized by the researcher from DAC PLC Bole Bulbula 40/60 Condominium project, 2017

Table 4-4: Forecast and other Indicators

Month	Estimate of Project's Future			Other Calculations				
	Cum. Estimated Cost At Completion (EAC)	Cum. Estimate To Complete (ETC)	Cum. Expected Time To Complete (ETTC)	Cum. Schedule Variance as a % of the Schedule Achievement (SV%)	Cost Variance as a % of the Earned Value (CV%)	% of Project Schedule to be Achieved at the Report Point	% Complete at the Report Point	% Spent at the Report Point
Week 12	310,642,767.76	304,366,149.86	156.5	-8.0	-3.5	2.2	2.0	2.1
Week 24	334,555,419.19	312,840,540.49	192.5	-25.2	-11.5	8.7	6.5	7.2
Week 36	291,816,778.98	248,330,704.83	198.3	-27.4	2.7	20.5	14.9	14.5
Week 48	267,250,914.34	192,085,356.59	166.6	-13.6	10.9	32.5	28.1	25.1
Week 60	261,943,407.31	164,374,697.56	167.8	-14.2	12.7	43.4	37.2	32.5
Week 72	285,628,194.14	157,937,201.94	166.8	-13.7	4.8	51.8	44.7	42.6
Week 84	282,797,282.12	150,606,289.92	170.0	-15.3	5.7	55.2	46.7	44.1

Source: Organized by the researcher from DAC PLC Bole Bulbula 40/60 Condominium project, 2017

Table 4-5: Project status dashboard

Month	PROJECT STATUS				PROJECT RECOVERABILITY
	Project StatusBased on SPI	Project StatusBased on CPI	Project StatusBased on TCCPI	Project Status Based on TCSPi	Cost Schedule Index (CSI)
Week 12	WATCH OUT!	WATCH OUT!	UNFAVOURABLE	UNFAVOURABLE	WATCH OUT!
Week 24	WARNING!	WATCH OUT!	UNFAVOURABLE	UNFAVOURABLE	WARNING!
Week 36	WARNING!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WARNING!
Week 48	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!
Week 60	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!
Week 72	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!
Week 84	WARNING!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!

Source: Researcher (Earned Value calculator Excel Template), 2017

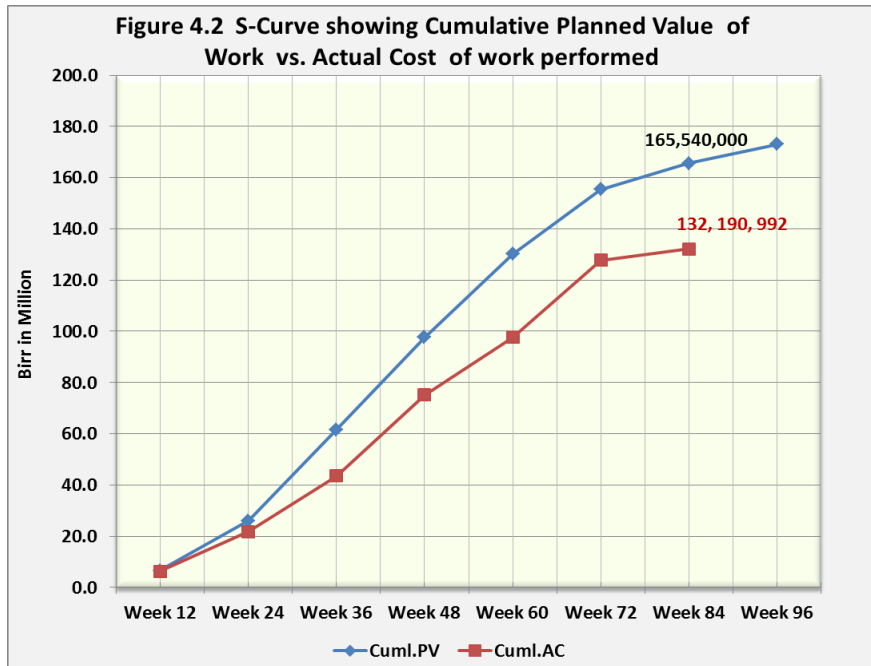
Interpretation of the Results

a) Traditional approach

The traditional cost monitoring and evaluation only show actual expenditure vs. planned budget using S-Curve. As shown below in the figure 4.2 at week-12 the actual expenditure (AC) was started at about Birr 6 Million equivalent to the budgeted cost of work to be performed (PV). Subsequently the actual spending fall short compared to the budget scheduled. The difference has grown from Birr 0.3 Million at the beginning to over Birr 33 million at the reporting time (first week of May 2017). At the report time of Week 84, the planned value was Birr 165,540 while the actual expenditure was Birr 132,190,992.2. This may suggest that some activities might be pending, cost of material and labor found lower than the estimated during planning or performance increase has shorten the duration of some activities whereby decreased indirect costs.

However, without further investigation looking at the trends of PV vs. AC alone would not tell exactly the causes of deviations so as to take appropriate counter measures. Besides the system does not show the “value” performance of projects despite comparing the actual cost against

originally planned. Thus, merely knowing about the actual expenditure relative to the planned could not be able to warn and forest the fate of the project if it continues with the current performance.

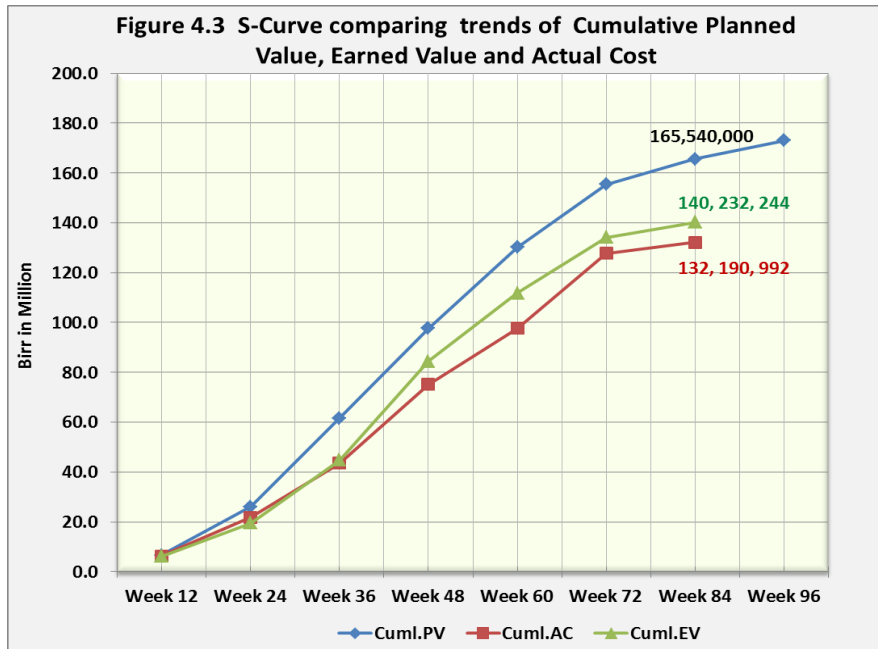


Source: Researcher (Earned Value calculator Excel Template), 2017

b) EVM approach

Unlike the traditional cost monitoring and control approach, EVM provide a number of key indicators which can inform about the present and future status of the project. For instance the inclusion of Earned value (EV) in EVM approach shown in Figure 4.3, suggests that despite actual expenditure found lower than the planned value by above Birr 33 Million beginning of May 2017, the value of work performed was more than the expenditure by about Birr 8 million. Thus it reduces the fears of the project manager and the team that the project is not out of track in at each of particular period (see Table 4.5 dashboard) rather the project is on track on basic of CV and CPI. Furthermore, after the required data put in to the spreadsheet template, the template has generated performance and forecast metrics showed more information about the overall health of the project. Therefore, it should be noted that figures produced by the template alone would not be meaningful unless interpreted into what they stand for. In this respect this section

interpretation of the figures given out by EVM system has been made. Thus, results have been viewed using the appropriate display method so that it would be understandable by the ordinary person.



Source: Researcher (Earned Value calculator Excel Template), 2017

1) Interpretation of the CV

At Week-12, the project was scheduled to cost Birr 6.5 Million and it has actually earned Birr 6.0 Million while the actual expenses incurred amounts to Birr 6.3 million. The results produces a CV of Birr negative Birr 0.2 million meaning the project at this point is over budget and similarly at Week-24 it was also over budgeted by about Birr 2.2 million. However, from Week 36 onwards it is showing positive variance of Birr 1.2, 9.2, 14.1, 6.4 and 8.4 million respectively, meaning that the project is under budgeted. That is more resources are used than budgeted in those periods. (Refer to Table 4-3 and Figure 4.4)

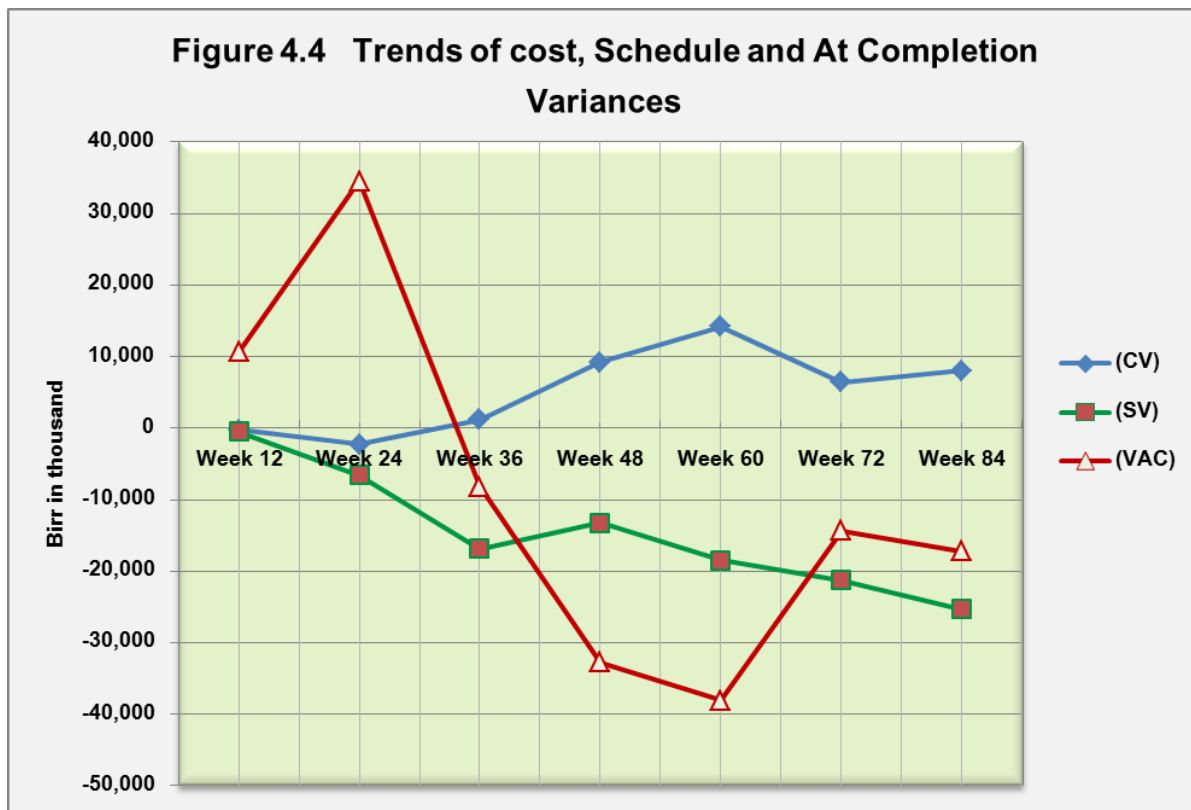
2) Interpretation of the SVs

As depicted in Figure 4.4, from project start to the reporting time at Week-84 all values calculated for SV (EV minus PV) are negative. This negative schedule variance indicating that the project is behind schedule. The highest schedule variance amounting over Birr 14.1 millions

was occurred in Week-60 whereas the least variance of Birr 0.2 million was occurred at the beginning of the project in Week-12. Generally, if we look at the trends on SV (Figure 4.4), we can observe that except between Week-36 and Week-48, in all other periods, the more the project lag behind schedule as the project progress in implementation time.

3) Interpretation of the VAC

The VAC is computed by subtracting the EAC from the BAC. Since the EAC is the lower than BAC which is Birr 300 million in Week-36, 48, 60, 72 and 84, VAC at these period shows a favorable condition. However, in early periods of Week-12 and 24, EAC exceeds BAC that produced a negative variance indicating an unfavorable condition. This indicates the final overrun of the project. These three variances are depicted on a graph in the template and shown in the graph on figure 4.4 below.



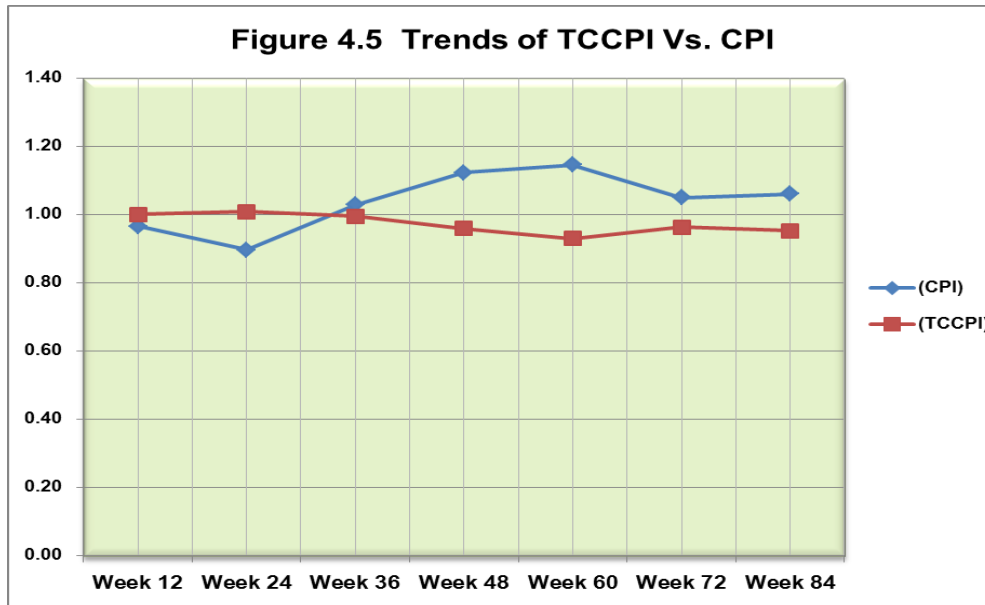
Source: Researcher (Earned Value calculator Excel Template), 2017

4) Interpretation of the CPI

From chapter four we have seen that the CPI measures how well the project's budget has been spent. When a project is following its plan, the amount of work accomplished and the amount of money spent to accomplish it are the same, and the resulting value of CPI will be one. So, an index of one means the project is following its project plan (Newell, 2003). In this regard, if we see the situation in the project evaluated in this study the project has CPI below one in Week-12 and Week-24 respectively 0.97 and 0.9 showing an unfavorable condition. This means for every Birr spent only Birr 0.97 and Birr 0.9 of work has been completed respectively. On the other hand, in the remaining periods CPI is following Week 24 the CPI was changed to above one showing budget spent in a favorable fashion where every Birr spent produce work that worth bigger than a Birr. In this respect the highest or the most favorable CPI was registered on Week-60 where a Birr spent has generated a Birr plus 15 cents followed by Week-48 where a Birr spent produced Birr 1.12. Hence, in both periods CPI which is a measure of Cost efficiency index show the project at these periods has performing well, meaning the activities planned during the periods were executed below the budget allotted for.

Similarly, on the project status dashboard table (Table 4.5) the signal indicates the yellow color and displays the wording 'WATCHOUT!' in Week-12 and Week-24. The signal and the corresponding alerting color are indications of the calculated value of CPIs for Week-12 and Week-24 was more than 0.85 but less than one. These limits show how bad the project is over budget and gives quick alerting information to the project manager to take immediate actions before it passes to more severe statuses i.e. "WARNING!" and "DANGER!".

However, at Week-36 and periods onwards CPI improved where the CPI trend line is laid above the index bench mark of one showing the project is under budget. Below the graph (fig. 4.5) is clearly indicates the CPI trend line lied below one at earlier two periods (Week-12 and Week-24) indicting the project run over budgeted. On the other hand in the later five periods starting Week-36, the CPI trend line shifted to position above the bench mark CPI index of one implying the project is performing under budgeted or a Birr spent has produced more than a Birr value of work.



Source: Researcher (Earned Value calculator Excel Template), 2017

5) Interpretation of the SPI

The SPI indicates how well the project is on schedule and a SPI less than one indicates an unfavorable schedule variance. It is a comparison of the project tasks that were planned to be accomplished to the work that was really accomplished (Newell 2003). From Table 4-3: we can see that SPI on seven periods was below one indicating unfavorable condition or it means that for every Birr of work scheduled to be completed below a Birr has been completed in these periods.

On the corresponding Warning signal dashboard (Table 4.5), the yellow color at Week-12, Week-48, Week-60 and Week-72 is shown and displaying the word ‘WATCHOUT!’ meaning that the SPI is less than 1 but not less than 0.85. Similarly at Week-24, 36 and 84 unfavorable situation signaled by a red color “WARNING!” sign in the dashboard, which has registered SPI below .85 and above 0.65. Accordingly, the project manager should consider actions in on the basis of the alert level priority on the warning dashboard. Failure to timely respond to these early warning signals will cause deterioration project performance and final project cost overrun and delay will be imminent. At the same time late response will also cost more and problem might grow to a stage of unrecoverable.

6) Interpretation of the TCCPI

As discussed in chapter four this performance index indicates the level of cost performance that would be necessary to complete the project from within budget. Accordingly, in the analysis made here the TCCPI at week-12 and Week-36 was one which was favorable at these periods and Indicating the project was performing within budget in Week-12 and week-36.

However, the TCCPI at Week-24 was a bit above one indicates 1.01, which is an unfavorable condition and tells the project manager that the project has to perform beyond one at CPI of 1.01 in order bring the project on track and complete within the originally planned budget. Therefore, the higher the TCCPI is from the CPI the more unfavorable the project becomes and hence becomes doubtful that the project would finish at EAC.

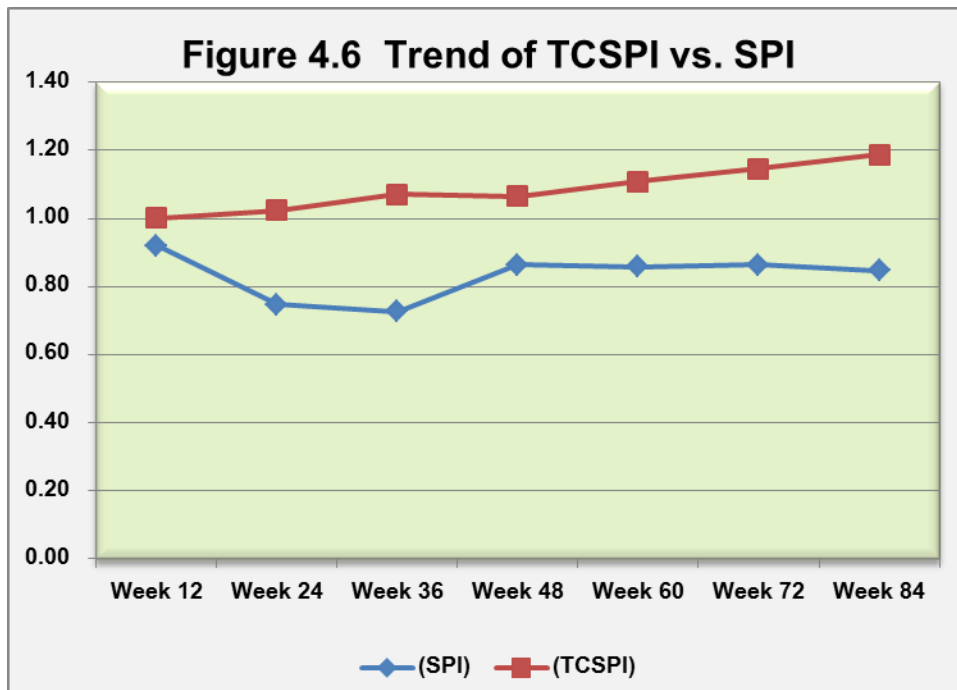
On the other hand, for the value of TCCPI was found to be below one in periods from Week-48 to Week-84, it is more favorable TCCPI and the cost performance of the project in these periods was efficient. So the project has to perform respectively with a CPI of 0.96, 0.93, 0.96 and 0.96 to complete successfully within the budget stipulated.

Similarly, from (figure 4.5) it can be seen that the trend line of CPI crossed above the TCCPI starting from Week-36 up to the reporting period of week-84 showing favorable cost efficiency. Again on the corresponding warning signal dashboard (Table.4.5), it is indicated a red color with the message unfavorable in Week-12 and Week-24 whereas in Week-36 and periods after the dashboard displayed the green color with the message favorable.

7) Interpretation of the TCSPI

This index acts the same way as the TCCPI only that this (TCSPI) is based on schedule and the former is on cost. It can be seen that as a project's schedule performance index moves below one, the TCSPI will increase and hit greater than the bench mark SPI of one. As indicated in the dashboard Table-4.5 and (figure 4.6), all periods except Week-12, have produced unfavorable TCSPI higher than SPI, which means that the project should use an SPI above 1.00 to complete the project from the report point on schedule. On the graph (figure 4.6) one can find that the trend line of TCSPI is laid above the curve of SPI and the gap is going wider and wider through

time. This tells that contrary to good performance of the project in terms of cost efficiency, the project running at low schedule efficiency. So the project manager and stakeholders has to act to bring the project within the schedule. Similarly, the Dashboard Table 4.5 displayed the red color at all periods as indicator for unfavorable schedule performance or poor in terms of schedule efficiency.



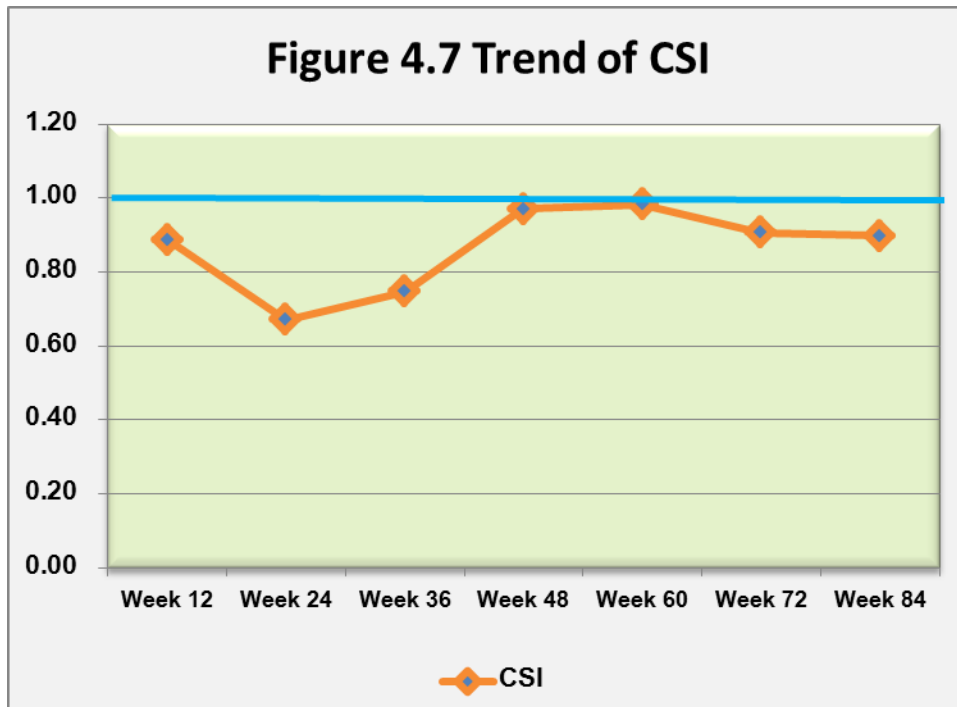
Source: Researcher (Earned Value calculator Excel Template), 2017

8) Interpretation of the CSI

CSI is a product of CPI and SPI and therefore it measures the combined efficiencies of cost and schedule performance of the project. Thus it indicates the recoverability of the project from the report periods. The further CSI moves away from one the more unlikely the project is going to be recovered. In our case as shown in Table-4.3 the project was running in an unfavorable CSI value in all the seven periods.

The most unfavorable efficiency of 0.67 and 0.75 was recorded in Week-24 and week-36, meaning in these periods the index is more away from the bench mark index of one. Consequently, the project status dashboard has showed a red color “WARNNING!” signals since CSI value fall between 0.65 and 0.85, meaning the project is approaching to the danger of

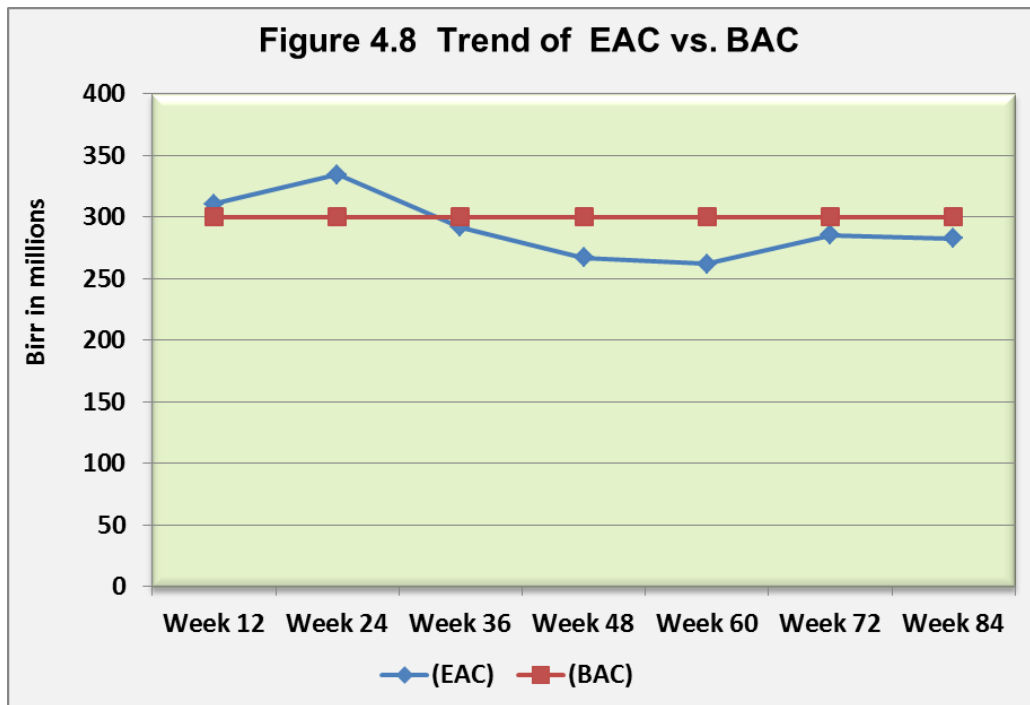
irrecoverability. In rest of periods though CSI value was below one and unfavorable, the values lay below 1.0 but above 0.85. Thus, the severity on the project status dashboard for these periods displayed as “WATCHOUT!” yellow color to show possibility of recovery. So, the project manager and concerned stakeholders should respond accordingly.



9) Interpretation of the EAC

The EAC indicates what the project would cost at the end from the report point. From the figure the project was budgeted to be completed at Birr 300 million (Table 4.2, a & b) but from Week-12 and 24 with its performance with respect to CPI, SPI, TCSPi and TCCPI produced an EAC of Birr 310 million and Birr 334 million respectively. This means if the project performance had been continued at the same efficiencies cost variance at completion would have about 10 million and 34 million respectively. If this happened, the contractor needs to spend above the contract cost. However, beginning to Week-36 the project performance efficiency has lowered the EAC below the planned budget at completion which was Birr 300 million. The EAC trend line depicted below on figure 4.8, has also indicate that beginning to Week-36 the EAC line crossed down below the bench mark line of BAC. In general when the trend line of EAC lays above

BAC would produce positive variances at completion, which is unfavorable, while the line falls below the bench mark it result favorable negative variance at completion.



Source: Researcher (Earned Value calculator Excel Template), 2017

10) Interpretation of the ETC

The ETC is simply the expected additional cost to complete the project at EAC. From the Table-4.4, we can see that the to-complete costs expected to be incurred to at the various Periods are Birr 304.3 million and 312.8 million respectively in Week-12 respectively. But as the project progress with improvement of performance efficiency the additional cost to complete at EAC brought continuously down to below 300 million, from Birr 248.3 million at Week-36 to Birr 150 million at Week-84.

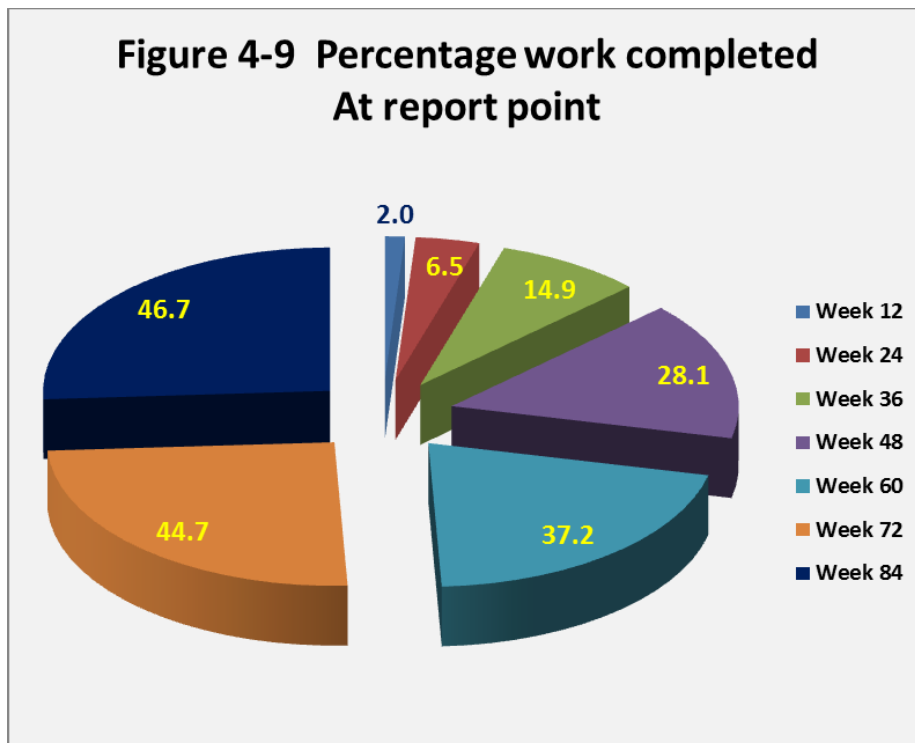
11) Interpretation of the ETTC

This is the estimated additional time that would be needed to complete the project from the report point. Based on the project data, ETTC calculated for periods Week-12 to Week-84 revealed that the project is likely to be completed in more additional weeks than 144 weeks that initially scheduled for completion. For instance as of Week-12 performance the estimated completion time was 156 weeks which is 14 weeks more than the original duration. Similarly,

based on Week-84 estimation the estimated time of completion would go as much as 240 weeks or 96 more weeks than previously thought.

12) Interpretation of the percentage Complete

The percentage complete indicates the amount of that has been completed over the budget at completion. In the template, it was put in a pie chart (Figure 4.9) to enable the user to know the chunk of work completed at a particular Month. Accordingly, it is showed that only 2% work was completed at Week-12 and it has increased to 6,5% at Week-24 and likewise at Week-72, work completion reached to 44.7% and at reporting time (Week-84) the final status of completion increased to 46.%.

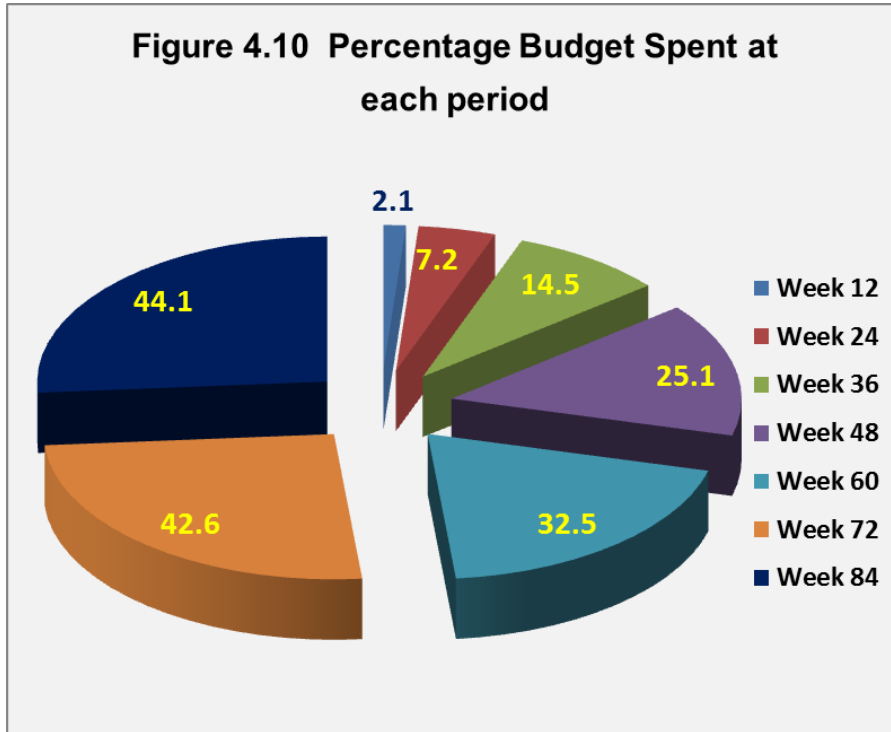


Source: Researcher (Earned Value calculator Excel Template), 2017

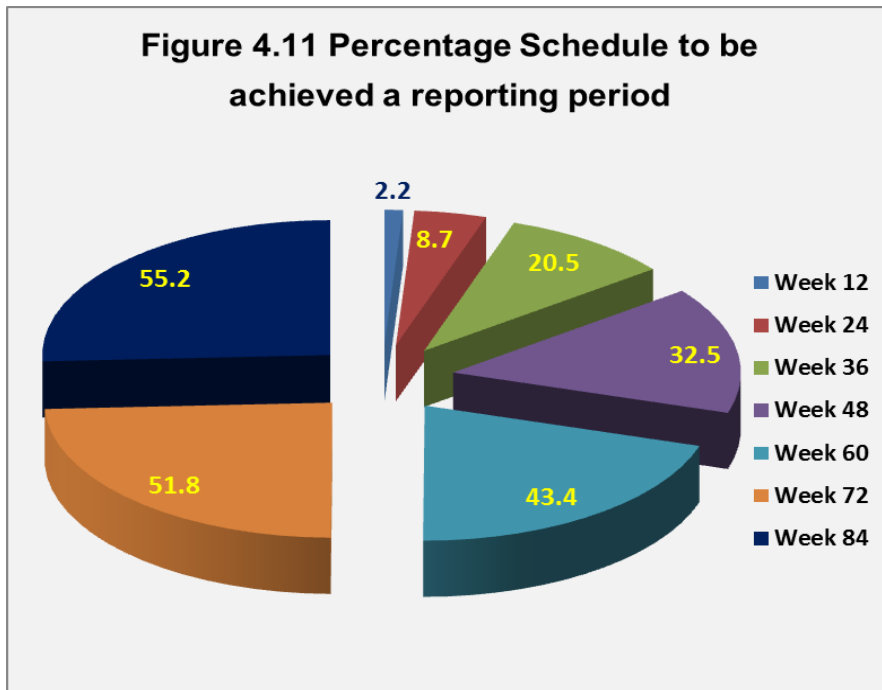
13) Interpretation of the percentage Spent

This indicates the amount of the budget that been spent in a particular reporting week respective to budget at Completion (BAC). Therefore, in Week-12 it was 2.1% budget spent which progressed to 7.2%, 14.5%, 25.1%, 32.5%, 42.6% and 44.1% respectively in the following periods. From this one can note that the progress made in spending across the periods by and large similar to the percentage of work completed displayed above in Figure 4.9. This shows a

positive situation that spending is made in accordance with progresses of works accomplished. So the project manager can also use this to monitor the percentage physical work completed against the percentage money spent within a particular period.



Source: Researcher (Earned Value calculator Excel Template), 2017



Source: Researcher (Earned Value calculator Excel Template), 2017

14) Interpretation of the Percentage of project schedule to be achieved at the report point

This represents the schedule achievement expressed in percentage at a report point. This refers to time unlike the percent complete and the percent spent. Table 4-4 calculated 2.2%, 8.7%, 20.58%, 32.50%, 43.4%, 51.8%, and 55.2% of schedule achievement respectively at Week-12, Week-24, Week-36, Week-48, Week-60, Week-72 and Week-84 (See figure 4.11). From this we can see that the percentages of project schedule to be achieved at the various time points are above the percentage of work completed and money spent. It also agrees with our earlier findings that this project is not efficient in terms of schedule. Therefore, this shows the project manager has to do a lot to reconcile the expected schedule and the work actually completed otherwise the project will delay in schedule.

5. CONCLUSIONS AND RECOMMENDATION

5.1 CONCLUSIONS

In this final chapter, I attempted to arrive at conclusions regarding project cost control in general, and show the limitations the existing cost control system practiced in DAC PLC at Bole Bulbula 40/60 Condominium construction project. Moreover, I indicate how the company could mitigate the limitations of the current cost control system by adapting EVM approach and the comparative advantages of EVM cost control over the traditional one. My research proposes the adoption of Earned value approach as effective and reliable control system that will hopefully be beneficial to the construction company evaluated. In addition, the findings of this study could initiate other wide research in the area so as to scale up EVM as a standard to the construction industry in the country. In addition, in this part of the paper I revisited the research problem and questions that I posed in Chapter 1, and provided brief answers that are drawn from the content of this thesis.

As presented in the preceding chapter the cost control method used by DAC PLC at Bole Bulbula 40/60 Condominium project was the traditional cost monitoring and control approach. So, based on the demonstration made using actual data and literature reviews searched, the traditional approach can only show actual expenditure vs. planned budget which only helps to determine the budget and measures the cost against that budget as project goes on. This method does not show the “value” performance of projects despite comparing the actual cost against originally planned by using S-Curve. Consequently, relying on the traditional status quo the project manager in DAC PLC would not be able to confidently tell about the real status of the project in relation to schedule and cost performance or cost and schedule efficiencies at any point in time. Besides, it could not help to reforecast how much additional costs will be required to complete the project based on the existing performance.

However, as demonstrated in the earlier chapter EVM system goes further and assigned finished work a value. This additional dimension of assigning value for a finished work helped to determine a project’s status (is it behind or ahead of schedule? is it over or under budget?) and the scale of current variances from the plan and many more indices showing the project current

and future health. Specifically, it can allow to measure efficiency at any given time to make inferences on the final effect of the project in terms of cost and, to some extent, in terms of duration, by extrapolating current trends. Moreover, due to project status dashboard element incorporated in this paper, the project manager can get early warning on a specific area which has deviated from expected progress so that he should take measures to bring the progress on track.

Thus, in this case study EVM approach has proven to be more effective and reliable project cost monitoring and control system compared to the traditional approach. The demonstration made on EVM approach using real-time data of the condominium construction project has indicated the project has a number of concerning issues in terms of cost and schedule efficiencies which the existing cost control system has not detected. The variance, performance and forecast indicators presented in tables, graphs and dashboard can indicate that if DAC had been used EVM approach for cost control, actions would have been taken in earlier periods and therefore, the warning signals appeared in the later periods could have not been occurred.

Moreover, during reflection of EVA results at construction site office the project manager and key team members has admitted the limitation and gaps on the existing system and inspired by the EVM generated performance outputs from their own data. Through all the practical demonstrations on EVM approach and comparisons made with the traditional approach the key staffs in the project team become convinced on the effectiveness of EVM approach. As result they have shown their interest and readiness to adopt EVM if the required training and tools fulfilled.

Therefore, through adopting EVM system, DAC would be able to gain benefits in terms of accurate display of project status, Early and accurate identification of trends and problems whereby get basis for course corrections. Consequently, the system would help the project manager and the project team to answer; what is true of the project, what are the problems, what can be done to fix the problems, what are the impacts (consequences) of each problem, as well as what are the present and future risks.

5.2 RECOMENDATION

As concluded in the above sections project cost control system in DAC PLC's Condominium construction project has so many shortcomings to measure performance, detect concerning deviations identify causes as well as make forecasts. So, relying on such ineffective system imminently leads to cost overrun and schedule delay. Besides, in current dynamic nature of the construction industry competition is growing involving foreign high-tech construction companies to competing for contract without boarder. So, in order to not to get out of the market it is imperative to DAC PLC as local contractor to equip itself with the technology and the tools of project control that the time demands.

Therefore, DAC PLC should take steps in adopting EVM as effective cost control tool that enables not only measure project performance but also alert project manager before the danger comes. To this end, it is essential to train staff to have better understanding about formulas to get the variances, efficiency and forecast so as to make manipulations of EVM template and interpretation of results. It should also be noted that earned value variances and performance indices when used in the right way would help the project manager and the project team in diverse ways such as: giving them the chance to make reallocation of resources to improve upon the current situation, showing a good picture of as to where the project is heading towards, whether to success or discontinuity, a good way to manage risks in a project, keeps them on alert on any mishaps, and serves as a precedent for other future projects, i.e. project managers learn from the mistakes in their current projects and try to avoid them in future projects through the figures ascertained through EVA.

Moreover, regarding the EVM calculator Excel template, users of the template should note that earned value demands a lot of proper integration of planning, effective costing and monitoring systems of project activities to ascertain the input figures needed for calculating earned value. Hence the use of a work break down structure and an appropriate accounting system would be of immense help in making earned value work effectively for a project. On the other hand, due to the growing realization of the importance of earned value, the implementation of earned value using the demonstrated Excel Spreadsheet will help the DAC PLC as an experience and an initial step in transition to a more advanced software capabilities to be acquired in the long run.

5.3 Further research

The findings of these study identifies suggests three areas for further future research.

First in this thesis, I focused on the cost control more on quantitative data using the concerning project as only source of information. Thus, my first suggestion for further research is to additionally improve attention to the cost management requirements in involving both qualitative and quantitative data from statistically adequate sample of diverse stakeholders like the client, suppliers, consultants and contractors. This will improve the accuracy of the findings as well as enable to generalize the findings to a larger target group of construction firms in the country

Secondly, this thesis analyzed the cost control in the processes of the project at implementation stage of the project after project schedule, planning and budgeting. However, these earlier stages have prime importance to produce a good plan and they are stages where precautionary measure should be taken to minimize problems of cost overrun and schedule delay which may happen later. Thus, my second suggestion for further research is considering these areas while assessing project cost control methods.

Finally, this research just focused only on one project implemented by a local contractor in Addis Ababa. If research of this kind conducted involving more companies (both local and foreign), wider area and different projects, Comprehensive result would be found which might produce more data, which also could be used to compare cost control across areas, type and local and foreign.

APPENDIX 1: FORMULAS USED IN EVM CALCULATIONS

Note that the formula is described here for the first period (week-12) and its should be dragged downward for the rest of the time periods

- Cost Variance (CV) - =E10-I10
- Schedule Variance (SV) - = E10-G10
- Variance at Completion (VAC) - = S10-C10
- Cost Performance Index (CPI) - = IF(I10,E10/I10,"")
- Schedule Performance Index (SPI) - = IF(G10,E10/G10,"")
- To-Complete Cost Performance Index (TCCPI) -
= IF(C10,IF(E10,IF(I10,(C10-E10)/(C10-I10),""),""))
- To-Complete Schedule Performance Index (TCSPI) –
= IF(C10,IF(E10,IF(G10,(C10-E10)/(C10-G10),""),""))
- Cost Schedule Index (CSI) - = IF(E10,N10*P10,"")
- Estimate at Completion(EAC) – = IF(E10,IF(I10,C10/N10,""),"")
- Estimate To Complete(ETC) – = IF(D10,IF(H10,S10-I10,""),"")
- Estimate Time to Completion(ETTC) - = IF(P10,J10/P10, "")
- Schedule Variance as a% of the Schedule Achievement (SV%) –
= IF(E10,IF(G10,L10/G10*100,""),"")
- Cost variance as a % of the Earned Value (CV%) – t
= IF(E10,IF(I10,K10/E10*100,""),"")
- % of Project Schedule to be Achieved at the Report Point –
= IF(G10,IF(C10,(G10*100)/C10,""),"")
- % Complete at the Report Point - = IF(E10,IF(C10,E10/C10*100,""),"")
- % Spent at the Report point - = IF(I10,IF(C10,I10/C10*100,""),"")

Project Status

- Project Status Based on SPI –
=IF(F10,IF(H10,IF(P10<0.65,"DANGER!",IF(P10<0.85,"WARNING!",IF(P10<1,"WATCH OUT!","ON TRACK"))),))
- Project status Based on CPI –
=IF(D10,IF(H10,IF(N10<0.65,"DANGER!",IF(N10<0.85,"WARNING!",IF(N10<1,"WATCH OUT!","ON TRACK"))),))
- Project Status Based on TCCPI –
=IF(C10,IF(D10,IF(H10,IF(N10=1,"FAV",IF(N10<0.10,"UNFAVOURABLE","FAVOURABLE")),""))
- Project Status based on TCSPI -
= IF(C10,IF(F10,IF(H10,IF(P10>=Q10,"FAVOURABLE","UNFAVOURABLE"))),"")
- Cost schedule Index –
=IF(D10,IF(F10,IF(H10,IF(R10<0.65,"DANGER!",IF(R10<0.85,"WARNING!",IF(R10<1,"WATCH OUT!","OK"))),))

Formatting of the Project Status Area

CPI and SPI

<i>SPI Condition</i>		Format
<i>SPI</i>	<i>CPI</i>	
=M10<0.65	=K10<0.65	Black Color
=M10<0.85	=K10<0.85	Red Color
=M10<1	=K10<1	Yellow Color
=M10≥1	=K10≥1	Green color

TCCPI and TCSPi

<i>SPI Condition</i>	Format
Cell value is "FAVOURABLE"	Green color
Cell value is "UNFAVOURABLE"	Red Color

CSI

<i>SPI Condition</i>	Format
Cell value is "DANGER!"	Black Color
Cell value is "WARNING!",	Red Color
Cell value is "WATCH OUT!"	Yellow Color
Cell value is "OK"	Green color

APPENDIX 2: Template for EVM inputting source data and performing calculation of Indicators

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N			
2	PROJECT EARNED VALUE ANALYSIS																
3																	
4	BOLE BULBULA 40/60 CONDIMUNIUM PROJECT							PROJECT EARNED VALUE ANALYSIS TEMPLATE									
5	Jul.2008 EFY - Mar-2010 EFY																
6																	
7	INPUT DATA									OUTPUT							
8										Variances			Performance Indices				
9	Month	Budget at Completion (BAC)	Budgeted Cost of Work Performed (BCWP=EV)	Cum.EV	Budgeted Cost of Work Scheduled (BCWS=PV)	Cum.PV	Actual Cost of Work Performed (ACWP=AC)	Cum.AC	Original project Duration (OD)	Cum.Cost Variance (CV)	Cum.Schedule Variance (SV)	Cum.Variance at Completion (VAC)	Cum.Cost Performance Index (CPI)	Cum.The To-Complete Performance Index for Budgeted Cost TCCPI	Cum.Schedule Performance Index (SPI)	The To-Complete Performance Index for Schedule TCSPi	Cum.Cost Schedule Index(CSI)
10	Week 12	300,000,000.00	6,061,578.01	6,061,578.01	6,588,671.75	6,588,671.75	6,276,617.90	6,276,617.90	144	(215,039.89)	(527,093.74)	10,642,767.76	0.97	1.00	0.92	1.00	0.89
11	Week 24	300,000,000.00	13,410,423.45	19,472,001.46	19,435,396.30	26,024,068.05	15,438,260.80	21,714,878.70	144	(2,242,877.24)	(6,552,066.59)	34,555,419.19	0.90	1.01	0.75	1.02	0.67
12	Week 36	300,000,000.00	25,233,523.33	44,705,524.78	35,540,173.70	61,564,241.75	21,771,195.45	43,486,074.15	144	1,219,450.63	(16,858,716.97)	(8,183,221.02)	1.03	1.00	0.73	1.07	0.75
13	Week 48	300,000,000.00	39,670,865.03	84,376,389.81	36,064,422.75	97,628,664.50	31,679,483.60	75,165,557.75	144	9,210,832.06	(13,252,274.69)	(32,749,085.66)	1.12	0.96	0.86	1.07	0.97
14	Week 60	300,000,000.00	27,367,643.86	111,744,033.67	32,580,528.40	130,209,192.90	22,403,152.00	97,568,709.75	144	14,175,323.92	(18,465,159.24)	(38,056,592.69)	1.15	0.93	0.86	1.11	0.98
15	Week 72	300,000,000.00	22,371,920.03	134,115,953.70	25,136,988.80	155,346,181.70	30,122,282.45	127,690,992.20	144	6,424,961.50	(21,230,228.00)	(14,371,805.86)	1.05	0.96	0.86	1.15	0.91
16	Week 84	300,000,000.00	6,116,290.98	140,232,244.68	10,193,818.30	165,540,000.00	4,500,000.00	132,190,992.20	144	8,041,252.48	(25,307,755.32)	(17,202,717.88)	1.06	0.95	0.85	1.19	0.90

Cont. - Part of the above Template to be fitted at right side of it

1	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	
2															
3															
4															
5															
6															
7															PROJECT
8	Estimate of Project's Future				Other Calculations						PROJECT STATUS				RECOVERABILITY
9	Month	Cum.Estimated Cost At Completion (EAC)	Cum.Estimate To Complete (ETC)	Cum.Expected Time To Complete (ETTC)	Cum.Schedule Variance as a % of the Schedule Achievement (SV%)	Cost Variance as a % of the Earned Value (CV%)	% of Project Schedule to be Achieved at the Report Point	% Complete at the Report Point	% Spent at the Report Point	Project StatusBased on SPI	Project StatusBased on CPI	Project StatusBased on TCCPI	Project Status Based on TCSPI	Cost Schedule Index (CSI)	
10	Week 12	310,642,767.76	304,366,149.86	156.5	-8.0	-3.5	2.2	2.0	2.1	WATCH OUT!	WATCH OUT!	UNFAVOURABLE	UNFAVOURABLE	WATCH OUT!	
11	Week 24	334,555,419.19	312,840,540.49	192.5	-25.2	-11.5	8.7	6.5	7.2	WARNING!	WATCH OUT!	UNFAVOURABLE	UNFAVOURABLE	WARNING!	
12	Week 36	291,816,778.98	248,330,704.83	198.3	-27.4	2.7	20.5	14.9	14.5	WARNING!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WARNING!	
13	Week 48	267,250,914.34	192,085,356.59	166.6	-13.6	10.9	32.5	28.1	25.1	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!	
14	Week 60	261,943,407.31	164,374,697.56	167.8	-14.2	12.7	43.4	37.2	32.5	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!	
15	Week 72	285,628,194.14	157,937,201.94	166.8	-13.7	4.8	51.8	44.7	42.6	WATCH OUT!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!	
16	Week 84	282,797,282.12	150,606,289.92	170.0	-15.3	5.7	55.2	46.7	44.1	WARNING!	ON TRACK	FAVOURABLE	UNFAVOURABLE	WATCH OUT!	

APPENDIX 3: GLOSSARY OF DEFINITION OF TERMS

Baseline – The original approved plan (for a project, a work package, or an activity), plus or minus approved scope changes. Usually used with a modifier (e.g., cost baseline, schedule baseline, performance measurement baseline). (PMI, 2004)

Budget at Completion – The sum of the total budgets for a project

Cost Performance Index – The cost efficiency ratio of earned value to actual costs. CPI is often used to predict the magnitude of a possible cost overrun. (PMI, 2004)

Duration – the number of work periods (not including holidays or other nonworking periods) required to complete an activity or other project element. (PMI, 2004)

Earned Value – The physical work accomplished plus the authorised budget for this work. The sum of the approved cost estimates (may include overhead allocation) for activities (or portions of activities) completed during a given period (usually project-to-date). (PMI, 2004). This is known in this thesis work as Budgeted Cost of Work Performed.

Earned Value Management (EVM) – a method for integrating scope, schedule, and resources, and for measuring project performance. It compares the amount of work that was planned with what was actually earned with what was actually spent to determine if cost and schedule performance are as planned. (PMI, 2004)

Estimate – An assessment of the likely quantitative result. Usually applied to project costs and durations and should always include some indication of accuracy. (PMI, 2004)

Estimate at Completion (EAC) – The expected total cost of an activity, group of activities, or the project. (PMI, 2004)

Estimate to Completion (ETC) – The expected additional cost needed to complete an activity, group of activities, or the project. (PMI, 2004)

Percent Complete – An estimate, expressed as a percent, of the amount of that work that has been completed on an activity or group of activities. (PMI, 2004)

Schedule Performance Index (SPI) – The schedule efficiency ratio of earned value accomplished against the planned value. The SPI describes what portion of the planned value schedule was actually accomplished. (PMI, 2004)

Schedule Variance – Any difference between the schedule completion of an activity and actual completion of that activity. (PMI, 2004)

Scope – The sum of products and services to be provided as a project. (PMI, 2004)

Stakeholder – individuals or organisations that are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or project completion. They may also exert influence over the project and its results. (PMI, 2004)

Work Breakdown Structure (WBS) – A deliverable-oriented grouping of project elements that organises and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work. (PMI, 2004)

Work Package – A deliverable at the lowest level of the work breakdown structure, when that deliverable may be assigned to another project manager to plan and execute. This may be accomplished through the use of a subproject where the work package may be further decomposed into activities. (PMI, 2004)

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