Jimma University

School of Graduate Studies

Jimma Institute of Technology

School of Civil and Environmental Engineering

Department of Civil Engineering

Construction Engineering and Management Stream

PERFORMANCE EVALUATION OF BUILDING CONSTRUCTION PROJECTS USING EARNED VALUE ANALYSIS (EVA): THE CASE STUDY OF JIMMA UNIVERSITY

A Research submitted to the School of Graduate Studies of Jimma University in Partial fulfillment of the requirements for the Degree of Master of Science in Civil Engineering

By:

Fitsum Alemayehu

October, 2016

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Advisor: Prof. Emer T. Quezon

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SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

PERFORMANCE EVALUATION OF BUILDING CONSTRUCTION PROJECTS USING EARNED VALUE ANALYSIS (EVA): THE CASE STUDY OF JIMMA ZONE

By: FITSUM ALEMAYEHU

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DECLARATION

I, the undersigned, declare that this thesis entitled **"Performance Evaluation of Building Construction Projects Using Earned Value Analysis (EVA): The Case Study of Jimma Zone."** Is my original work, and has not been presented by any other person for any award of a degree in this or any other University, and all sources of material used for these have been dually acknowledged.

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As Masters research Advisors, we hereby certify that we have read and evaluate this MSc research prepared under our guidance, by Fitsum Alemayehu entitled: **Performance Evaluation of Building Construction Projects Using Earned Value Analysis (EVA): The Case Study of Jimma Zone.**

We recommended that it can be submitted as fulfilling the MSc Thesis requirements.

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Co-Advisor Signature Date

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ABSTRACT

In broad classification of construction projects, building construction project is the one. In building construction project there are many activities should be done to change the drawing into tangible object. During execution of the construction problems are encountered as a consequence of engaged parties problems and/or natural problems. Due to those problems most of the time the best project performance is not achievable. The objective of this study was evaluation of building construction performance in terms of cost performance, time performance and forecast the future project cost by using earned value analysis next to that find out the major responsible causes for variations and to make recommendations for construction parties engaged in building construction projects to improve performance based on the outcome of the study. As a case study, six building construction projects were selected using non-probability purposive sampling, four of them are ongoing, during data collection, and two of them are finished. Data from six construction projects was analyzed using MS Excel and statistical RII formula. Based on the selected building construction projects, all projects showed poor in cost and schedule performances. In result dormitory II and classroom project noted the maximum and minimum schedule variance which was -78 and -35 percent behind schedule time. Similarly canteen and dormitory II projects showed minimum and maximum cost variance by scoring -1 percent and -29.93 percent over budgeted from original budget. The maximum Cost and Schedule performance index values were recorded on canteen and class room projects with values of 0.99 and 0.67. The lowest Cost and Schedule performance index values were recorded on both dormitory II project with values of 0.77 and 0.06. From all six projects, dormitory II project forecasted completion cost showed the highest difference with budgeted at completion. By using RII ranking design change, actual quantity of activity greater than planned and Shortage of skilled and unskilled labor has been top three major responsible causes by scoring RII of 0.912, 0.907 and 0.864 respectively. It is recommended that the owner should be set the scope, cost and time of the project according to actual. Design and material changes should be considered during planning. The contractor should also deliver construction materials and equipment as per schedule. Again the consultants should delivered the drawing as per schedule.

Key Words: Building construction, Building Performance Evaluation, Causes of variations, Cost indices, EVA, Forecasting project cost, Schedule indices

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ACRONYMS

ACWP	=	Actual Cost of Work Performed
BCWP	=	Budgeted Cost of Work Performed
BAC	=	Budgeted At Completion
COADOE	=	Committee for Oversight and Assessment of US Department of Energy
CPI	=	Cost Performance Index
CV	=	Cost Variance
DOE	=	Department of Energy
EAC	=	Estimate At Completion
ERA	=	Ethiopian Roads Authority
EU	=	European Union
EV	=	Earned Value
EVA	=	Earned Value Analysis
EVM	=	Earned Value Management
GTP	=	Growth Transformation Plan
IPT	=	Integrated Project Team
JU	=	Jimma University
KPI	=	Key Performance Index
M	=	Millions
OGC	=	Office of Government Commerce
OECM	=	Office of Engineering and Construction Management
PPI	=	Project Performance Indicators
PMB	=	Performance Measurement Baseline
RII	=	Relative Importance Index
SPI	=	Schedule Performance Index
SV	=	Schedule Variance
WBS	=	Work Breakdown Structure

CHAPTER ONE

INTRODUCTION

1.1 Background

As to the book written by Ahuja et.al (1994), "construction projects are undertaken by the government or other entity to change design in to tangible object and mainly comprises buildings, road network, bridges". In construction project performances life cycle (initiating, planning, implementing, controlling, and closing) project planning and implementation are the two major phases. Let us briefly examine each of them as below.

Project planning can be applied to the entire project, from commencement to completion. The construction phase of the project is generally the most expensive and fastest moving stage of a project; it is proactive action period which requires good anticipation used for appropriate planning often lay the basis for efficient and effective project performance control. Otherwise, absence of the suitable planning could expose a project performance for unanticipated complete failures (SMEC, 2008). For example, time and cost factors are major responsible factors for poor performance could be minimized through project planning period.

Project implementation, however, relies heavily on the action plans developed during the planning phase and is the continuation and practical time in realizing what is on paper. There is already enough work done within the implementation phase of the projects. In addition to that, works like reinventing ways of dealing with risks, change requests, training and resource issues that need active actions also supposed to be taken during project implementation phase (Garold, 2000).

On top of these, scholars believe that the role of the two major phases is great; because, these phases facilitate the delivery of good products to the client. In other words, they enable the quality of finished project, construction cost and construction time as per agreed contract could be maintained (David, 2013).

Thus, for successful project, successful performance is the most important project priorities. So, since, most factors failures in project performances are the consequences emerging from the failures in the mentioned phases - project planning and implementation - all other factors are dependent on the mentioned two phases (Mengesha and Eshetu, 2005).

Specifically, the performance of building will be determined in different performance criterion set by client. Those performance criterion will vary from project to project. However, the main considerations are (Emmitt and Gorse, 2005):

- space, determined by a figure for floor area
- thermal and acoustic performance
- design life and service life of the building and specific building elements
- cost of construction, cost in use
- quality of the finished building

Other specific performance criteria will relate to the use of the building, for example the provision of special work surfaces for catering establishments (Emmitt and Gorse, 2005).

Ethiopian government set growth strategy plan (GTP) to destine the country to developing country within ten successive years, however some criticizes rise over construction performances. In building construction, condominium housing construction, is constrained by problems and challenges the industry has been facing, namely; the difficulties in accessing land, sub-standard quality of construction raw materials and hence construction output, limited access to finance, widespread corruption, huge cost and time overrun, lack of periodically amended rules and regulations of the industry, absence of Construction Industry Policy and lack of effective rules and regulatory mechanisms that help ensure compliance of various actors in the construction (EEA, 2006/2007).

Thus, it is from such complains that the idea of this research has developed from. Thus, this research strives to address and evaluate major time and cost aspects of building construction projects through performance evaluation. Hence, this paper attempts to question how was the progress of building construction work of Jimma University was used to be performed, evaluate the performance of the building construction projects and identify and rank the root causes of the major variations.

1.2 Statement of the Problem

The failure of any project is mainly related to either controllable or uncontrollable causes. Most construction projects are attacked by performance problems either cost or time or both problems.

In Ethiopia, almost all building construction projects faced both time and cost performance problems. Most Ethiopian scholars argued that Ethiopian building construction projects performances were majorly challenged by time and cost overruns. So, since the case of Jimma University building construction projects performance in particular, cannot be different and could not be immune to the mentioned causes and obstacles. Despite of this general truth, all causes cannot equally be responsible at once; i.e. a cause can be on top in one but might be a least in another one. Therefore, this thesis is designed to address the dominant manmade and natural reasons for major cost and schedule variations and evaluate schedule and cost performance of the building construction projects. Thereby, improve performance of the construction projects by offering remedial recommendations. It is from that final result that owners of the projects, consultants and contractors could be made and realize that each will be beneficiaries from successful building construction project.

1.3 Research Questions

- How to apply EVA for building construction projects progress performance evaluation?
- How to apply EVA for building construction projects performance evaluation?
- Which factors show the major root cause of time and cost variation that affect the target completion cost and date of the projects?

1.4 Objectives

1.4.1 General objective

- The general objective of the study is to evaluate the performance of Jimma zone building construction projects using earned value analysis.

1.4.2 Specific objectives

- To apply EVA for building project progress performance evaluation with respect to time and cost performances,
- To apply EVA for building project performance evaluation with respect to schedule and cost ,
- To rank and analyze the major root causes of time and cost variations that affect the target completion date and cost of the project.

1.5 Scope and Limitation of the Study

The study restricted only Jimma University building construction projects because of time and budget constraints. The reason behind the selection of Jimma University building construction projects, was Jimma zone massive building construction projects is being experienced in Jimma University. The study examined the cost of the project and time of the project as the independent variable and building construction projects performance as the dependent variable and tried to evaluate performance of building construction projects using selected evaluation tools listed in research methodology and give some suggestions about improvement for the future. The study focuses only on four ongoing and two finished building construction project. Next to that data used for performance evaluation purpose was very difficult in some cases to obtain.

1.6 Significance of the Study

After conducting the research the following results are expected.

- Identify and rank the major causes of cost and time variation for building construction projects in Jimma University.
- Evaluate the performance of building constructions located in Jimma University using EVA.
- Formulate recommendations to improve performance of building construction projects in Jimma University.

The result of the research will be used for Jimma University, Ethiopia Universities, Jimma zone and any building construction project as a reference material in order to improve the performance in building construction projects.

CHAPTER TWO

LITERATURE REVIEW

2.1 Building Construction Project

Construction project development involves numerous parties, various processes, different phases and stages of work and a great deal of input from both the public and private sectors, with the major aim being to bring the project to a successful conclusion (Takim and Akintoye, 2002). To come upon the required product or service, the construction project implementation process comprises two distinct phases: the first one is the preconstruction phase - a job which often accomplished between the period between the initial conception of the project and the signing of the contract; and the second stage is the construction phase - during which the contractor must complete construction subject to the conditions of the contract (Sweis, 2013).

Depending on the nature of the project and the kind of work to be performed, one need to be engaged in a variety of tasks it might be tackled and/or made ready for use in advance; because all are important to accomplish the project on timeline, at required quality and by specification-based dealt budget (David, 2013). Under construction industries, building construction is one of the major classification. Buildings are constructed, altered, upgraded, restored or demolished for a variety of reasons. Whether the aim is simply to provide more space or to make a financial gain from speculative development, all building projects need to fulfill a function and meet set performance requirements (Bennett, 2003).

2.2 Project performance overview

2.2.1 Performance problem in construction

Most construction projects are attacked by performance problems either cost or time or both problems. Ong`ondo et al. (2015) stated that on-time, within-budget and desired quality are common requirements for all construction projects among other performance related requirements. Unfortunately, in reality many projects suffer from delays, budget overspends, poor quality, safety concerns amongst other challenges. Similarly Abushaban et.al (2008) presented that the failure of any construction project is mainly related to the problems and failure in performance. In addition to many reasons and factors which attribute to such problem.

In most construction projects, best possible performance are unachievable resulting in time overrun and consequently cost escalation of the projects. The occurrence of time and cost overrun can impact the project completion date (Salunkhe and Pantil, 2014). Those failures to complete a construction project either by the original planned time or budget, or both, ultimately results in project performance (Abd El-Razek et al, 2008).

Asmah (2014) study identified that the performance problem of projects are originated from inadequate funds for the project, suspension of work by owner or contractor, cash problem during construction, inadequate planning of projects before commencement, client delay in payment certificates, inadequate planning and uncompromising attitude between parties. According to Navon (2005) study, the performance problems cause originated from two main reasons: first unrealistic target setting and/or second originating from the actual construction. Navon (2005) again remarked traditional project performance control is usually generic. It relies on manual data collection, which means that it is done at low frequency and quite some time after the controlled event occurred. Besides low frequency, manual data collection normally gives low-quality data.

2.2.2 Project success and project performance

The dynamic nature of the construction industry makes the concept of project success to remain ambiguously defined in construction industry. Simply, Arazi et.al. (2011) agreed every project target is success, and project success is an off shoot of project performance. Ali and Rahmat (2009) believed the success of project means achieving favorable and desired outcome for both clients and contractors and this success derived from identifying the performance measurement criteria as well as knowing the level of importance for each of the criterion. Similarly Abushaban et.al (2009) also clarified that all projects has its own objectives initiated from the needs of a client. If these objectives are achieved, the project is claimed to be successful. Those objectives can be evaluated through the project performance in terms of cost, schedule, and quality. Thus success of construction projects depends mainly on success of performance.

Outstanding performance of the construction project is directly interrelated with the definition of success is in order to make correct measures to achieve the goal. Without a general agreement on success, project managers still manage their resources by their perceiving intuition and they cannot ensure whether the instrument is correct or not (Chan, 2001). If success factors are implemented effectively definitely the project is successful i.e. the project is implemented efficiently means meets time, meets budget , meets technical Specification, Safety, Profitability, Absence of any legal claims & proceedings it means that the project is good performance (Takim and Akintoye, 2002). The level of success in carrying out construction project development activities will depend heavily on the financial, technical and performance of the respective parties, while taking into consideration the associated risk management, the business environment, and economic and political stability (Takim and Akintoye, 2002)

2.2.3 Factors affecting cost and time performance

Navon (2005) dictated that a control system is an important element to identify factors affecting construction project effort. For each of the project goals, one or more Project Performance Indicators (PPI) is needed. Construction parties participated in projects might be attempted by different factors. The nature of the project and the kind of work to be performed and made ready themselves for use in advanced construction methodology, equipment and man power; because all are important to accomplish the project on timeline, at required quality and by specification-based dealt budget (David, 2013). Otherwise, project underperformance would emerge and could initiates conflicts of interests that might lead the case to the court arbitrations (Muthoka, 2014).

Once implementation begins, a project's costs rarely remain static. Yet, even when a cost has become firmly fixed, there are numerous factors that can lead to the cost increasing. The major factor are delays. Whatever the reason, delays almost invariably increase budget costs. Many events may have contributed to the delay – some which could have been foreseen and unforeseen (DG XVI).

In the context of EU program funding, time and cost over-runs have obvious implications for the number of projects that can be funded within a program period, and for the scale of the outputs and impacts generated. Research carried out in the preparation of this manual has found that many projects experience a range of problems in both the pre-construction and implementation stages. These lead to projects over-running either in time or costs. As indicated above, delays generally translate into higher project costs (DG XVI).

A key consideration in the context of EU funding is the time at which an application for funding is actually made. Applications can be made at three main points in time (DG XVI):

- Very early in the construction cycle when broad cost estimates only are available;
- On the basis of tender prices for the work to be undertaken;
- Retrospective bids where the project has been completed but grant is still required.

The level of certainty about the final or outturn costs will vary for each of these three situations. Obviously, if an application comes forward very early in the project development cycle, then there is a much greater chance that the project will experience time and cost over-runs (DG XVI).

Auma (2014 concluded that common causes of time overrun are delay to deliver the site, financial problems of contractors, Improper planning, and Site management. And the most common causes of cost overrun are design change, fluctuation in the cost of materials and inadequate review for drawings and contract document. Chen and Liew (2003) also identified, time performance of construction can be affected by site preparation time, late payment for the completed work, Time needed to implement variation orders. Delays in contractor's payments, resemble the contractor's whole payment and the partial payments, indicate the contractor taking part of his payment on time and the remainder being delayed. Again Sweis (2013) concluded that change orders from owner, poor planning and scheduling of the project by the contractor, ambiguities and mistakes in specifications and drawings, slow decision making from owner, quality of materials and poor qualification of consultant engineers' staff assigned to the project are the major attacking factors for time performance of the project.

Generally, Abd El-Razek et al (2008) grouped the causes of underperformance into nine major groups: financing, materials, contractual relationships, changes, rule and regulation, manpower, scheduling and control, equipment, and environment. Likewise Amoah et al had also classified construction performance factors under the following themes: materials, manpower, equipment, financing, environment, changes, government action, contractual relationships and scheduling and controlling techniques. Amoah et al study result evidenced that lack of finance and credit facilities for contractors, delay in the payment of contractors for work done, design changes and/or variations, low morale and motivation of craftsmen, poor planning, supervision and low mechanization, as some of the important factors that could be affecting construction performance. Abushaban et.al (2009) also indicated availability of personals with high experience and qualification, quality of equipment's and raw materials in project and quality training/meeting. In Ethiopia, Tefera (1996), referenced in Mengesha and Eshetu (2005, "the causal factors for failure in performance of projects are: Failure on amicable agreements leading to disputes and arbitration; low capacity of domestic construction industry; overrun completion and expenditures; frequent scarcity of construction materials; critical shortage of skilled and professional personnel, risk sharing of contract conditions and tax rates together with customs procedures along his evolution of the construction industry."

2.2.4 Key Performance indicators

Elattar (2009) defined Key performance indicator as measurable factor of extreme importance to the organization in achieving its strategic goals, objectives, vision, and values that, if not implemented properly, would likely result in a significant decrease in customer satisfaction, employee morale, and effective financial management. In relation to this, the UK working groups on Key Performance Indicators (KPIs) have identified ten parameters for benchmarking projects, in order to achieve a good performance. These consist of seven project performance indicators, namely: construction cost, construction time, cost predictability, time predictability, defects, client satisfaction with the product and client satisfaction with the service; and three company performance indicators, namely: safety, profitability and productivity (Takim and Akintoye, 2002). It used for evaluating performance of construction projects. These indicators can also be used for benchmarking purposes, and will be as a key component of any organization to move towards achieving best practice and to overcome performance problem (Auma, 2014) and identification of KPIs helps set a benchmark for measuring the performance of a construction project. A range of Key Performance Indicators (KPIs), measured both objectively and subjectively is developed (Chan, 2001).

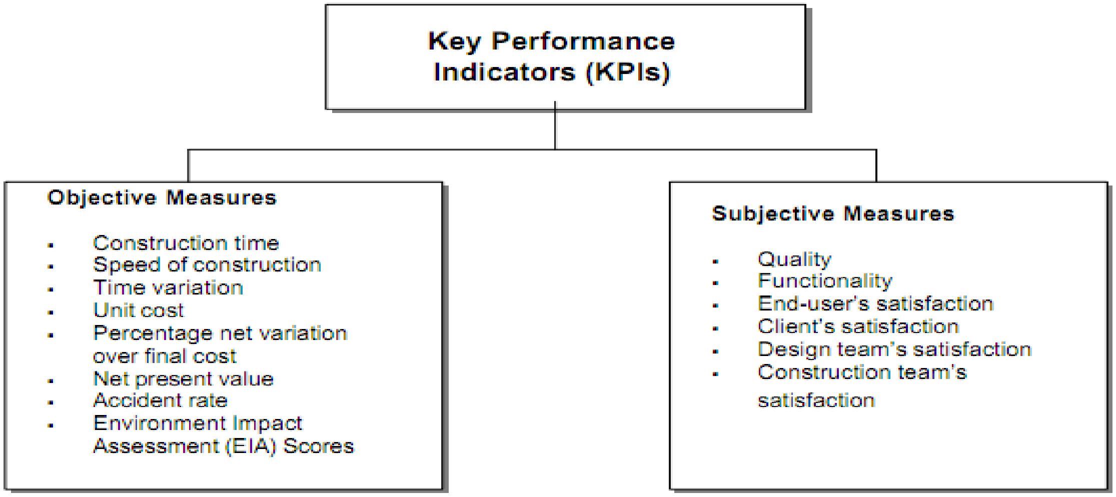

Figure 1: Key Performance Indicators

Source: Chan PC.A (2001). Framework for Measuring Success of Construction Projects

However, most of indicators, such as construction cost, construction time, defects, client satisfaction with the product and service, profitability and productivity, promote result-orientated thinking, whereas predictability of design cost and time, and predictability of construction cost and time, and safety can be regarded as process-orientated thinking (Takim and Akintoye, 2002).

OGC and the former Government Construction Clients' Panel have developed the Clients' Charter, a series of six input and twelve output Key Performance Indicators to measure performance during the life of the project. The Key Performance Indicators have been particularly useful to organizations with unsophisticated performance measurement systems. Some organizations have used the indicators selectively to measure aspects that are important to their business and to their clients, and to supplement their own performance measurement systems (OGC, 2007) and argued key performance indicators are not a substitute for more comprehensive performance measurement systems and benchmarking, which can provide more rigorous assessments. It enable organizations to gauge their performance in relation to other organizations. The indicators are less suitable as tools to manage projects, suppliers or companies, or as criteria for evaluating tenders or in evaluating the success of a construction project in reducing the operational costs of a building (OGC, 2007).

OGC (2007) presented KPIs ranges, which provide an effective method of making a comparison with how an organization performs against the rest of that sector. This again is a tool for allowing internal improvement within an organization and should not be used as a means of evaluation during the selection and award processes.

2.2.5 Benchmarking and Project Performance

In recent years, the construction industry has recognized benchmarking as a possible catalyst for aiding the performance of the industry and improving its competitive edge in the global market. Benchmarking aims at comparing the performance of firms relative to each other, allowing these firms to recognize their weaknesses and strengths compared to the industry. It aids in the identification of industry leaders who exhibit superior performance as a result of using best industry practices. Since the time when the construction industry recognized benchmarking in this way, there have been several benchmarking models proposed (El-Mashaleh et.al). According to OGC (2007) guidelines benchmarking is a management tool that can help organizations to understand how their performance measures up to their peers and drive improvement up to 'world class' standards. It is also an important aid to clients, helping them to compare their own internal processes with those of similar organizations, in order to identify priorities for improvement.

Benchmarking of the organization can be internal or external. When benchmarking internally, organizations benchmark against their own projects. When benchmarking externally, organizations seek projects from other companies from separate program offices for comparative analysis. External benchmarks are generally considered to provide the greater advantage; however, internal benchmarking can be useful where no external benchmarks are available. Internal benchmarks are often the starting point for quantitative process examination. Trends can be identified by examining these data over time, and the impact of performance-improving processes can be assessed. External benchmarks provide the added advantage of comparing against competitors. Without external benchmarks, an organization and its managers may lack an understanding of what constitutes "good" performance (COA DoE, 2005).

Benchmarking is used to compare the performance of the organization as a client with that of similar organizations, or the performance of different suppliers in the same industry. For construction projects it can be used to (OGC, 2007):

- Assess performance objectively
- Expose areas where improvement is needed
- Identify other organizations with processes resulting in superior performance, with a view to their adoption
- Test whether improvement programs have been successful (OGC, 2007).

Moreover, it can and should also be used at various levels throughout the organization, but if project improvement is the goal, data will typically be entered at the project level. Program- and department level measures can be provided by roll-ups of the project-level data (COA DoE, 2005).

Benchmarking is also used for post project. Post project benchmarking is usually used to assess performance of a project delivery system to provide for lessons learned and feedback that can be used to establish benchmarks for future comparisons. Most organizations tend to begin with post project comparisons and later progress to the earlier uses as confidence in the benchmarking process builds. Over time, when sufficient data are available, trends can be analyzed to provide insight into the performance of project management systems. Since integrated project team members will normally have moved on to new projects, trend analyses of project-level cost and schedule metrics would typically be used at program and department levels (COA DoE, 2005). According to COADoE (2005) report it can also be applied during various phases of a project for different purposes. When applied early on, such as at project authorization, it can be used to identify characteristics that may be associated with potential future problems and to identify aspects of project management (e.g., risk management) that need special attention to ensure project success. When applied during project execution, it can serve as a project management tool to guide project decisions.

OGC (2007) guidelines illustrated how to implement benchmarking in four basic construction stages: planning, analysis, action and review.

Planning

Planning includes:

- selecting the broad business process or function to benchmark
- within that process, defining the activity to be benchmarked

- confirming the key performance measures or indicators to measure the performance in carrying out the activity
- documenting the existing way in which the activity is carried out
- drawing up a preliminary list of potential benchmarking partners with whom to exchange information
- Identifying possible sources of information and methods of collection to confirm the suitability of potential partners.

Analysis

Analysis includes:

- collecting information to identify the most likely potential benchmarking partner to contact
- confirming the best potential benchmarking partner and making a preliminary assessment of the performance gap
- contacting and visiting them, if appropriate, to validate and substantiate the information
- comparing the existing process with that of the benchmarking partner to identify differences and innovations
- Agreeing targets for improvements that are expected as a result of adopting the benchmarking partner's way of doing things.

Action

Action includes:

- communicating the results of the study throughout the relevant parts of the organization and to the benchmarking partner
- planning how to achieve the improvements
- Implementing the improvement plan, monitoring progress and reviewing as necessary.

Review

Review includes:

- Reviewing performance when the changes have been 'bedded in'
- Identifying and rectifying anything which may have caused the organization to fall short of its target

- Communicating the results of the changes implemented to the organization and the benchmarking partner
- Considering benchmarking again to continue the improvement process.

Benchmarking needs buy-in at various levels of an organization in order to be successful. Most often, benchmarking is driven from the top. Senior management commitment is critical if resources are to be made available for the process. While benchmarking may succeed with senior management support alone, it is far more likely to succeed if it has the support of middle management and the project team (COADoE, 2005).

Furthermore, the project team is far more likely to support the benchmarking initiative if it is understood that the goal is system improvement and not individual or team performance appraisal. The IPT members should be confident that data submitted for benchmarking will not be used for performance appraisals if accurate data are to be obtained (COADoE, 2005).

El-Mashaleh et.al indicated that, generally, there are four benchmark implementing stages. First, the existing benchmarking models are project-specific. This limited view communicates a single metric performance on a single project and by no means translates to the overall performance of the firm. Second, as a consequence of being project-specific, the existing benchmarking models do not allow the measurement of the impact of certain technological and managerial attributes on overall firm performance. Third, the current benchmarking models do not support an understanding of the trade-offs among the different metrics of performance. Fourth, the relationship between how much was expended on the metrics and the performance of those metrics (basically a return on investment) is absent.

The metrics of performance are the outputs to be used in conjunction with the proposed benchmarking model. Two inputs are accounted for in this part of the model: expenses on safety as a percentage of total sales and expenses on project management as a percentage of total sales. By considering these two inputs, the benchmarking model is relating the effort expended on the metrics of performance to the performance in the areas of those metrics. Firms that spend more on project management are expected to have better schedule performance, cost performance, customer satisfaction, and profit. Similarly, firms that spend more on safety are expected to have better safety performance (El-Mashaleh et.al).

2.3 Why measure performance?

Throughout measuring the performance of the construction projects many questions are raise. Why measure performance? Because measuring performance is good. But how do we know it is good? Because business firms all measure their performance, and everyone knows that the private sector is managed better than public sector. Unfortunately, the kinds of financial ratios the business world uses to measure a firm's performance are not appropriate for the public sector. So what should public agencies measure? Performance, of course. But what kind of performance should they measure, how should they measure it, and what should they do with these measurements? (Behn, 2003).

Ralph and Irwin (1998) explained the aim of measuring the performance of the construction and they believed that, planning serves no purpose if the plan of the project is not followed correctly. Therefore, the responsible parties should be regularly keeps checking on the schedule and cost performance of the project. Regularly, collect and analyze data to ensure that plan and reality match as closely as possible. If a variance exists, one determines whether to take corrective action. Of course, a variance can exist for quality as much as it does for cost and schedule. The authors study result showed that to track down or minimize this variances the project status should be measured consecutively. Similarly Chen et.al (2015) also argued that due to the limitation of resources and to avoid cost overruns the project performance should be measured. In addition to that, performance measurement used for monitoring project time. The reason for time monitoring is to assess how well the project adheres to the planned schedule over a period of time and it is used to show how well the project adheres to the agreed budget.

Mengesh and Eshetu (2005) also explained the reasons why evaluating and measuring the performance of the project. Their enumerated reasons were: to improving performances and assists in providing accountability and learning in all business administrations and it serves a variety of functions in project management. These reasons include the establishment of probable targets, the tracking of performances and feedback to management. As well as performance measurements can be used for rewarding/punishing behaviour, and modelling and predicting project performances. In addition to controlling the current status of the projects Navon (2005) reasoned performance measurement is needed to update the historic database. Such updates enable better planning of future projects in terms of costs, schedules, labor allocation, etc.

The real reason is that managers plan, or make decisions, or modify programs is to either reallocate resources or to improve future performance. Similarly, the reason that managers set performance targets is to motivate, and thus to improve. To compare performance among jurisdictions is-implicitly but undeniably-to evaluate them. Recognizing good performance is designed to motivate improvements. Informing stakeholders both promotes and gives them the opportunity to evaluate and learn (Behn, 2003).

2.4 Performance Measurement and Evaluation

Performance is highly related to measurement (Mengesha and Eshetu, 2005). Performance measurement is the activity of checking actual performance against targets throughout the life of the project, during construction and through the operational life of the completed facility (OGC, 2007) and project evaluation is an ongoing check of how well the project is performing. Formal reviews such as project evaluations and Gateway reviews are carried out at Gateways and other major decision points. Informal checks are carried out on a continuous basis as part of normal project and contract management procedures. These reviews include assessments of how well members of the integrated project team perform, how well the facility is performing in terms of realising identified benefits, progress against quality, cost and time, assessment of the client's capability and seeking opportunities to improve over time (OGC, 2007).

Progress measurement according to Verzuh (2005) can be defined "progress measurements are the tools we use to identify problems when they are small—when there is still time to catch up. Since cost and schedule progress comprise two-thirds of the cost-schedule-quality equilibrium, they are the primary focus of progress measurement." Navon (2005) also defined performance measurement as a comparison between the desired and the actual performances. For example, when a deviation is detected, the construction management analyzes the reasons for it. The reasons for deviation can be schematically divided into two groups: (a) unrealistic target setting (i.e., planning) or (b) causes originating from the actual construction (in many cases the causes for deviation originate from both sources).

Lehtonen (2001) classified performance measures into two groups based on the use of measures. The first group of measures is improvement measures that are vital when starting new development and cooperation projects. The need for that kind of measures is obvious: if you do not know your current practices, you cannot develop your operations further electively. Objective information about current situation is necessary when starting co-operation with different players of business processes. Additionally, development measures can be used for benchmarking different practices. By comparing different practices one can find out best current practices and cost saving potential of different practices. The improvement measures are applied infrequently and their aim is to find out the present logistical performance level and improvement potential. The second group of measures consists of monitoring measures. These measures are needed for screening and controlling companies' every-day actions continuously. Usually, the set of measures is tailor-made for each company and the data collection, as well as the reporting procedures are planned for regular use.

Garold (2000) illustrates different techniques to measure the performance of construction projects. The Units Completed method of measuring progress during construction is applicable to tasks that are repetitive and require a uniform effort. Generally, the task is the lowest level of control so only one unit of work is necessary to define the work. Jin and Ling (2005) stated there are thirteen performance metrics that may be used to measure the success level of construction projects and they defined and categorized into four groups namely cost, schedule, and quality and relationship performance.

According to OGC (2007) report, the performance measurement includes:

- External benchmarking – assessing client's performance against other major purchasers of construction through participation in a number of benchmarking initiatives. In EU, those initiatives are Clients' Charter, the European Construction Institute, the Business Excellence Model and Construction Best Practice Programme
- a framework for performance measurement – including:
    - primary performance measures that compare performance of the client's projects with that of the construction industry as a whole, covering measures such as time predictability, cost predictability, number of defects, accident frequency and client satisfaction (service and product)
    - secondary measures that compare different projects in the client organisation, including the number of changes to project requirements, final cost against initial estimate and end-user satisfaction

- Tertiary measures that are project specific and relate to the achievement of targets to improve the performance of the project – for example, reductions in construction cost, lower maintenance and operational costs.

To measure construction effectiveness, the client needs to accumulate reliable data on quality, cost (design, construction and in-use costs) and time taken to deliver, together with data on health and safety, sustainability and design quality (OGC, 2007).

The performance measuring framework can also enhance clients', contractors', as well as designers' understanding of running a successful project and set a base for them to improve the project performance (Chan, 2001). The performance measurement criteria as well as knowing the level of importance for each of the criterion is important to achieve the most favorable and desired outcome for both clients and contractors. Arazi et.al (2011) concluded quality of finished project, construction cost and construction time were the three most important criteria considered crucial by the respondents for evaluating project performance from current practice.

Therefore, project performances have developed its measurement and evaluation overtime and so far two major approaches were developed with regard to completion time and cost performances. These are Variance or Deviation Analysis based on direct differences or Earned Value analysis between planned and actual conditions. This study called these two project performance analysis approaches as Simple Deviation Analysis and Earned Value Deviation Analysis. (Mengesha and Eshetu, 2005). Garold (2000) repeated that the performance can be measured based on earned-value concepts and S-curve analysis. The most widely used managerial methodology that supports project monitoring and control in practice is Earned Value Analysis. It uses monetary units as a common basis to measure and communicate the progress of a project and it uses to compare the actual and the budgeted values of the work performed, the time taken, and the costs incurred (Sabry, 2014).

2.5 EVA as Performance Evaluation Tool

Suresh and Ramasamy (2015) "earned value analysis (EVA) is a method of performance measurement in evaluating and forecasting construction projects." Earned value management technique that uses "work in progress" to indicate what will happen to work in the future. However, the output is only as good as the input date and the appropriate tracking of costs and changes.

PMBOK (1996) also illustrated earned value analysis in its various forms is the most commonly used method of performance measurement. It integrates scope, cost (or resource), and schedule measures to help the project management team assess project performance. Earned value analysis in its various forms is the most commonly used method of performance measurement. It integrates scope, cost, and schedule measures to help the project management team assess project performance.

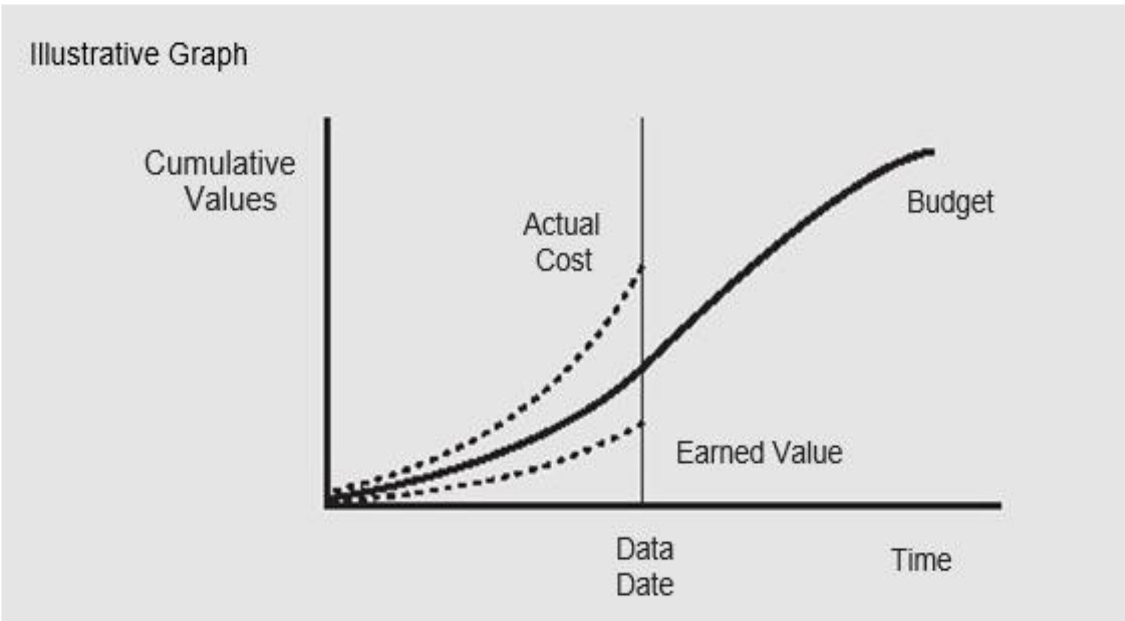

Figure 2: EVA Illustrative Graph

Source: PMBOK (1996)

Furthermore, the method helps managers to identify the possible needs of corrective actions. It integrates time and cost perspectives of a project monitoring system. For more detailed explanations on the basic principles of Earned Value Analysis can be seen in the following part (Sabry, 2014).

The key to a meaningful earned value analysis lies in the accuracy of estimates of earned value. To determine earned value, one must estimate.

- How much of a task have completed to date?

- How much of the task's total budget planned to spend for the amount of work have achieved?

If you assume a direct relationship between the portion of a task you've completed and the amount of funds you should have spent and if you've completed 60 percent of the task, then you should have spent 60 percent of the total task budget (Stanley, 2007).

According to Stanley (2007), there are three approaches to estimate earned value in different situations:

1. **Percent-complete method**: EV is the product of the fraction representing activity-completion and the total activity budget. This method is potentially the most accurate if you correctly determine the fraction of the activity you have completed. However, because that estimate depends on your subjective judgment, this approach is also most vulnerable to errors or purposeful manipulation.
2. **Milestone method**: EV is zero until you complete the activity, and it's 100 percent of the total activity budget after you complete it. The milestone method is the most conservative and the least accurate. You expect to spend some money while you're working on the task. However, this method doesn't allow you to declare EV greater than $0 until you've completed the entire activity. Therefore, you'll always appear over budget while you perform the activity.
3. **50/50 method**: EV is zero before you start the activity, 50 percent of the total activity budget after you start it, and 100 percent of the activity budget after you finish the activity. The 50/50 method is a closer approximation to reality than the milestone method because you can declare an EV greater than $0 while you perform the task. However, this approximation can inadvertently mask overspending (Stanley, 2007).

Choosing which of the three methods to use for the project requires to weigh the potential for accuracy against the possible misleading conclusions from subjective data. The milestone method and 50/50 methods allow to approximate earned value without estimating the portion of completed task (Stanley, 2007).

2.5.1 Terminology of EVA

Earned value involves calculating three key values for each activity (PMBOK, 1996):

- The budget, also called the budgeted cost of work scheduled (BCWS), is that portion of the approved cost estimate planned to be spent on the activity during a given period. In other words the sanctioned budget assigned to a scheduled work is the Planned value (PV). It may also be known as the Budgeted Cost for Work Scheduled (BCWS). This budget is allocated by phases over the life of the project, but at a given moment, planned value outlines the physical work that should have been accomplished. The total PV of the project is also known as budget at completion (BAC).

- The actual cost, also called the actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on the activity during a given period. In the same way Actual cost (AC) is the recognized cost incurred for the work performed during a specific time period. It is the total cost incurred in achieving the work that the EV measured. 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.

- The earned value, also called the budgeted cost of work performed (BCWP), is a percentage of the total budget equal to the percentage of the work actually completed. Many earned value implementations use only a few percentages (e.g., 30 percent, 70 percent, 90 percent, and 100 percent) to simplify data collection. Some earned value implementations use only 0 percent or 100 percent (done or not done) to help ensure objective measurement of performance. Similar meaning the measure of work performed at a specific point in time is Earned value (EV), which is expressed in terms of the authorized budget for that work. The EV being measured needs to be related to the Performance Measurement Baseline (PMB), and it cannot be greater than the authorized budget for an activity. The EV is often used to calculate the percentage completion of a project. Progress evaluation criteria should be established for each work breakdown structure (WBS) component to measure work in progress. The earned value methodology used to plan the baseline should be used consistently to determine the earned value. Current status of the project can be determined by incrementally calculating EV. Also overall performance tendencies can be known by cumulatively calculating EV (PMBOK, 1996).

2.5.2 Uses of EVA

Earned value analysis method has been recognized as a useful tool by many practitioners and government agencies and has become a standard in project management. It proved to be versatile enough to be applied to any type of a project, ranging from defense schemes worth millions and extending on many years to minor projects. The analysis can be conducted on any level of work breakdown structure and used by both clients and contractors (Czarnigowska, 2008).

According to Raveesh and Shenoy (2015), earned value analysis is one of the most effective performance analysis and feedback tools for controlling construction projects. Feedback is critical to the success of any project. Getting the relevant feedback in time enables project managers to identify problems early and make adjustments that keeps a project on time and on budget. Once a project has advanced to a stage of performance, the consistent and constant flow of information on the true status of the project is essential (Raveesh and Shenoy, 2015) and earned value analysis allows projects to be managed better on time and in budget. Furthermore, earned value analysis inspires the management team to pay more attention to cost, schedule and progress with more intensity and optimizes the project (Czarnigowska, 2008).

In the way of project status, Earned value analysis is used for determining 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. Moreover, it allows a project manager 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 (Czarnigowska, 2008). Those methods and tools used for determination of progress should be carefully considered and negotiated to achieve a fair and equitable environment that encourages successful accomplishment of contracted or outsourced project items (Raveesh and Shenoy, 2015). In addition to that, earned value analysis also used for progress payments to contractors based on the earned value (EV) of contracted or outsourced work. Since such contractual arrangements create legal and financial obligations, it is important to consider the method specified for evaluating progress.

Earned value analysis method, if to be used efficiently, requires a disciplined approach to collection of data on project cost and progress (on weekly basis) and the findings are to be processed immediately. The purpose is to detect any deviation as soon as possible, so that there is enough time to asses if the deviation is dangerous for the project and, if necessary, to take corrective actions (Czarnigowska, 2008).

2.5.3 Calculating Performance Using EVA

Three values, described under terminology, are used in combination to provide measures of whether the work is being accomplished as planned or not. The most commonly used measures are the cost variance, the schedule variance, schedule performance index and the cost performance index. The cumulative CPI (the sum of all individual BCWPs divided by the sum of all individual ACWPs) is widely used to forecast project cost at completion. In some application areas, the schedule performance index is used to forecast the project completion date (PMBOK, 1996).

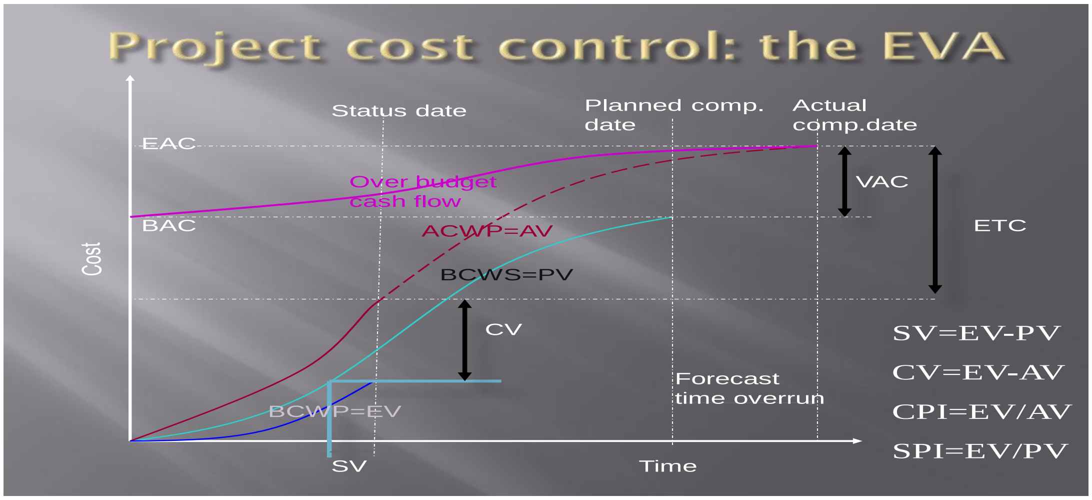

Figure 3: Illustrative for EVA Computation

Source: Raveesh and Shenoy, 2015

2.5.3.1 Schedule Variance (SV)

Schedule Variance (SV) is the comparison of amount of work performed during a given period of time to what was scheduled to be performed. It is calculated as follows (PMBOK, 1996).

SV = EV – PV ………………………………………………………….……………….. Equation 1

A negative schedule variance indicates that the project is behind schedule (bad) which means it took longer time than planned to perform the work. In the same way, a positive variance indicates that the project is ahead of schedule (good) which means it took lesser time than planned to perform. It is worth mentioning that the schedule variance (SV) is based on monetary values to quantify the deviation from the time schedule; it does not report the schedule variance in term of time units (Suresh and Ramasamy, 2015 and Verzuh, 2005).

A positive SV% is good; it means more work has been performed to date than originally planned. A negative SV% is bad, because it means less work has been completed than the plan (Verzuh, 2005). The schedule variance (SV) can be expressed as a percentage using Equation.

$$SV\% = \frac{SV}{PV} \quad \text{...} \textbf{Equation 2}$$

The schedule variance percentage (SV %) measures how much more or less work performed in reference to the initial project time plan (Dwaikat, 2016).

2.5.3.2 Cost Variance (CV)

Cost Variance (CV) is the comparison of the budgeted cost of work performed with the actual cost. It is calculated as follows (PMBOK, 1996):

$$CV = EV - AC \quad \text{...} \textbf{Equation 3}$$

A negative cost variance means the project is over budget (bad) that is performing the work cost more than planned. When this happens, the project managers will be able to know that cost is going beyond the budget. The reasons for this can be analyzed and suitable corrective measures can be taken to bring the project back on budget. In the same way, a positive cost variance (good) means that the project is progressing at a cost lesser than what was planned to be spent. This is a good sign as it shows that the project is progressing efficiently (Suresh and Ramasamy, 2015 and Verzuh, 2005).

The cost variance (CV) can be expressed as a percentage using Equation (Dwaikat, 2016).

$$CV\% = \frac{CV}{EV} \quad \text{...} \textbf{Equation 4}$$

The cost variance percentage (CV %) measures how much more or less work performed in reference to the initial project cost plan (Dwaikat, 2016).

2.5.3.3 Schedule Performance Index (SPI)

Schedule Performance Index (SPI) can be used to estimate the projected time to complete the project based on the performance to date. It is given by (PMBOK, 1996):

$$\mathbf{SPI} = \frac{\mathbf{EV}}{\mathbf{PV}} \cdots\cdots\cdots\cdots \textbf{Equation 5}$$

Where (Suresh and Ramasamy, 2015 and Verzuh, 2005):

SPI = 1 means that project is on schedule (good)

SPI < 1 means that project is behind schedule (bad)

SPI > 1 means that project is ahead of schedule (good)

2.5.3.4 Cost Performance Index (CPI)

Cost Performance Index (CPI) can be used to estimate the projected cost to complete the project based on performance to date. It is given by (PMBOK, 1996):

$$\mathbf{CPI} = \frac{\mathbf{EV}}{\mathbf{AV}} \cdots\cdots\cdots\cdots \textbf{Equation 6}$$

Where (Suresh and Ramasamy, 2015 and Verzuh, 2005):

CPI = 1 means that the planned and actual costs are same (good).

CPI < 1 means that project is poor cost performance (bad)

CPI > 1 means that project is good cost performance (good)

2.5.4 Forecasting Performance Using EVA

Earned value analysis is the most distinguished methodology for forecasting the project expected end dates and expecting budget at completion, the field for the research is construction field and specially the projects which content different phases without repetitive tasks. Forecasting for construction project is a complicated process need more than applying one equation only (Sabry, 2014). During the development stage of the project, the future cost and schedule performance can be forecasted. The earned value indexes created to serve the projects which have repeated tasks or can say which got one stage only, like information technology projects as those projects depending on manpower productivity and also based on few different qualifications. On such type of projects the earned value forecasting calculation is perfectly used (Sabry, 2014).

Common forecasting data includes:

2.5.4.1 Estimate to Complete (ETC)

The estimate to complete (ETC) is the expected cost needed to complete all of the remaining work for a control account, work package, or the project. The most accurate method is to develop a new, detailed, bottom-up estimate based on an analysis of the remaining work (Raveesh and Shenoy, 2015).

2.5.4.2 Estimate at Completion (EAC)

Estimate at completion (EAC), is the expected total cost of a control account, work package, or the project when the defined scope of work will be completed. The EAC is typically based on the actual cost incurred for work completed (AC), plus an estimate to complete (ETC) for the remaining work.

There are different techniques to calculate the EAC some of them are (Vandenbussche and Buyse, 2010):

1. EAC = Actual to date plus a new estimate for all remaining work. This approach is most often used when past performance shows that the original estimating assumptions were fundamentally flawed, or they are no longer relevant to a change in conditions.

2. EAC = Actual to date plus remaining budget. This approach is most often used when current variances are seen as atypical and the project management team expectations are that similar variances will not occur in the future.

3. EAC = Actual to date plus the remaining budget modified by a performance factor, often the cumulative cost performance index (CPI). This approach is most often used when current variances are seen as typical of future variances.

4. EAC = Budget at Completion (BAC) modified by a performance factor, cumulative cost performance index (CPI). This approach is most often used when no variances from BAC have occurred.

It is clear that, EAC is a simple linear extrapolation of current tendencies. It does not allow for any future risks or effects of corrective measures, so it is not a proper forecast. Nevertheless, EAC indicates the potential scale of cost problems. As the Earned Value method requires frequent progress checks from the very beginning of a project, an early EAC-based construction that current tendencies are likely to double the cost are likely to provide a valuable warning signal and trigger rectifying actions when it is still time(Czarnigowska, 2008).

EAC is not necessarily based on the assumption that future costs are going to follow the today's pattern. Other scenarios can be considered but, as the method rests upon a simplified model of a project, linear extrapolation is a rule and it proves to be adequate. The general EAC formula allows for a number of simple scenarios (Dhawale and Tuljapurkar, 2015):

$$\mathbf{EAC=ACWP+\frac{BAC-BCWP}{CPI}}\text{.............................}\textbf{Equation 7}$$

This is most commonly used formula for cost forecasting (Vandenbussche and Buyse, 2010). I.e. EAC is a sum of costs already committed and the reminder of the budget adjusted by a factor (CPI) that reflects the relationship between the project's future and its past. This can be project-specific. Scenario considered most often is the cost of remaining task is going to be as planned, i.e. future costs are not related to current costs, CPI=1 (Czarnigowska, 2008), so:

EAC=BAC+CV ……………………………………………………….…..Equation 8

In this research the forecasting performance of the building construction projects were calculated and the projects evaluated using EAC concept using equation 7.

2.5.4.3 Variance at Completion (VAC)

The cost variance at completion (VAC), derived by subtracting the EAC from the BAC, forecasts the amount of budget deficit or surplus at the end of the project. The VAC shows the team whether the project is forecasted to finish under or over budget. This can be expressed as a percentage by dividing VAC by BAC (Raveesh and Shenoy, 2015).

2.5.4.4 To Complete Performance Index (TCPI)

The TCPI is a comparative measure. It compares work completed to date with budget required to complete the remaining work. The TCPI data can be used as the basis for a discussion which explores whether the performance required is realistically achievable. It is the ratio of remaining work to the remaining budget (Raveesh and Shenoy, 2015).

2.6 Reasons and causes for Major Variances

The earned-value system identifies the magnitude of cost and schedule deviations from the original project plan. However, it does not identify the cause of the problem. The project manager and his or her team must assess each status report to identify the reason the project is not progressing as planned. The problems can be the result of numerous situations (Garold, 2000).

The original cost estimate is the BAC in the earned-value analysis. Therefore, if the original cost estimate for the project is incorrect, then all progress measurements during execution of the project would be measured against an incorrect budget. The system of recording costs charged against the job must be consistent to provide realistic comparisons from one reporting period to another (Garold, 2000). Also, the method of measuring work completed must also be consistently applied from one reporting period to another; otherwise the predicted status of the job will vary widely. Each project must be assessed based on the unique circumstances and conditions that apply to the project in order to use the earned-value system to manage the project. Garold (2000) partially list items that can cause the cost or schedule to vary from the original project plan.

- Estimating errors
- Technical problems
- Design errors
- Test data problems
- Constructability
- Equipment problems
- Management problems
- Scope control (change orders)
- Personnel skill level
- Resource availability
- Organization structure
- Economic/inflation
- Delayed material deliveries
- Delayed equipment deliveries
- Poor production rates
- Subcontractor interference and delays
- Acts of God (weather, fire, flood, etc.)
- Accidents during construction.

As said by Stanley (2007), positive or negative values of the cost or schedule variances indicate your project performance isn't going exactly as you planned. After you determine that a variance exists, you want to figure out the reason(s) so you can take corrective actions (if the variance is negative) or be sure you continue what you've been doing (if the variance is positive).

Possible reasons for positive or negative cost variances are as follows:

- Your project requires more or less work to complete a task than you originally planned.
- The people performing the work are more or less productive than planned.
- The actual unit costs of labor or materials are more or less than planned.
- Actual organization indirect rates are higher or lower than you originally planned.

Possible reasons for positive or negative schedule variances are as follows:

- Work is running ahead of or behind schedule.
- The project requires more or less work than you originally planned.
- People performing the work are more or less productive than planned (Stanley, 2007).

2.7 Cases where EVA used for building construction

India

A study was made in India to assess the building performances. In this paper, construction of hospital building is referred as a case study. The name of the building is Esic multi-specialty hospital which is one of the reputed hospitals in Karnataka. To reach more optimum welfare development supported by good performance building, a good practice of fair evaluation is needed. The study evaluates the performance of the hospital construction in Karnataka India. The study used earned value analysis.

According to referred case study that the project is over budget and within the schedule. Two parameters of EV i.e. CPI and SPI clearly indicate the lacunas of project in terms of cost and schedule which can help to track the project and hence help in successful completion of project.

The calculation of EV parameters can also be done with the help of MS Project, calculation can be done in an efficient manner within short time, and this can be helpful in mega projects.

Brazil

A study was made in Fortaleza, Brazil to assess the building performances. In this paper, construction of 26 floor business tower is referred as a case study. The project started in December of 2010 and conclusion was scheduled to July of 2013, 3 months later than programmed. To reach a good construction performance building, a good practice of fair evaluation is needed. The study on a construction project that applied Earned Value Analysis.

According to referred case study that it can be observed that actual cost was under earned value during 27 periods. This represents a good performance of CPI (in average 1.10). It means that the building company was able to operate under budget. The PV is most of the time above EV it means that progress was slow. As a consequence, SPI achieved a low performance (on average 0.89). This represents an eminent delay for total project duration.

EGYPT

This research was qualitative research based on “clinical study” using one of the major running construction projects in Egypt. The start is to analyze and describe the forecasting process using EV & CPM techniques, then applying the analysis process for running project “Hurghadah International Airport—New Terminal Building and landside facilities” which is a four-year contract duration with 266 Million USD estimated budget, EVM implemented normally for four months—March, June, September, and December 2012, and also implemented the suggested protocol for calculating the project end dates and the project expected end budget for the similar months.

INDIA

The selected site for the case study is located in Nayandahalli, Bengaluru. The building consists of residential apartments of 2B+G+24 with a helipad on the terrace equipped with modern amenities, Spacious Residential Dwellings, Private Garden Sit-outs, Club House, Gymnasium, Helipad on the Terrace. Each floor consists 10 no.s of combination of 2BHK and 3BHK Luxury apartments comprising of total 246 apartments. In this study, an attempt is made to analyses the real construction project and come up with forecasts about the cost and schedule variances at the end of the project using earned value analysis (EVA).

Based on the results the project manager can take decisions to accelerate the project for achieving the planned activities. From the collected data and calculated results it can be concluded that currently the project is lagging behind the schedule and is running over budget. At the beginning stage of the project the critical activities were not closely monitored, which seems to be the reason for the delay of the project. Due to the delay in completing the activities, cost escalations and overheads are being experienced which is leading to increase in actual cost of the project. The project needs immediate attention to get it back on track. Now, the future predictions have been detailed in this analysis, based on the final completion of this project, we can find out the reasons for the variance in schedule and cost of the project.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter discusses the research methodology as well as the research design adopted in carrying out the research study. There is also description of the sources and types of data, sampling and sampling procedure and the procedures of data collection. The research relied on both primary and secondary data sources. The research methodology employed in this thesis outlines the steps used to answer research questions as described using desk study, discussion and questionnaire.

3.1 Study area

Jimma is the largest city in south-western Ethiopia. Jimma town is special zone of Oromia Region and is surrounded by Jimma Zone. Jimma is located 346 Kms from Addis Ababa and has total surface area of 4,623 hectares. Jimma town is found at 1676m altitude, latitude and longitude of 7^{o}40'N and 36^{o}50'E / 7.667^{o}N 36.833^{o}E. Prior to the 2007 census, Jimma was reorganized administratively as a special zone. Based on 2007 census, Jimma has a total population of 120,960 with an area of 50.52 square kilometers. Three largest ethnic groups were reported in Jimma. The Oromo (46.71%), the Amhara (17.14%) and the Dawro (10.05%); all other ethnic groups made up 26.1% of the population.

Jimma University (JU) is the public research university located in Jimma. It is recognized as the leading national university by the Federal Ministry of Education (MoE) for four successive years (2009-2012). The establishment of Jimma University dates back to 1952 when Jimma college of Agriculture was founded. The University got current name in December 1999. The university campus is located in the city of Jimma around 352 kilometers southwest of Addis Ababa. Its grounds cover some 167 hectares. Now the numbers of campuses under JU is five, including the new agaro campus, so that this study selected case study buildings from four of them namely, Main campus, Agriculture campus, Agaro campus, Kito Furdisa campus.

3.2 Study design

- The First approach is to collect the existing research and analysis that have been done on Earned Value Analysis.

- The Second approach is to study the implementation of EV in various projects, how they have concluded based on the results.
- The third approach is to collect schedule data, cost data and major cost and schedule variation causes of projects by review project progress reports on different status dates. The report may include activities in progress, budgeted costs, cost incurred etc .so that EV analysis can be done and conclusions can be made regarding the future of the project. From projects data and unstructured interview, the researcher also identified 29 causes that had an impact on performance of building construction projects in Jimma University.
- The fourth approach is developing and distributing questionnaires to rank the major responsible causes of schedule and cost variation of the projects. A questionnaire was developed to assess the perceptions of client, consultants, and contractors due to the importance index (RII) of causes of delay in Jimma town building construction projects. The format used for questionnaire was priority ranking (5-extremely significant; 4-very significant; 3-moderately significant; 2-slightly significant; 1-not significant.). The target groups in this research are owners, consultants and contractors. 36 questionnaires were distributed as follows: 3 to owners, 8 to consultants and 25 to contractors. 32 questionnaires (89%) were received as follows: 3 (100%) from owners, 8 (100%) from consultants and 21 (84%) from contractors as respondents.
- The fifth approach is to perform the analysis for EVA and for questionnaire after inputting the actual cost and inputting questionnaires ratings. The analysis was done using Microsoft Office Excel and RII formula.
- The final approach is to make suitable conclusions based on the Schedule and Cost indices obtained after Earned Value Analysis.

3.3 Study Population and Sample Size

The population is considered all large construction projects executed in Jimma zone. This is a huge population. As the focus of this study lays on large construction projects, the selected projects are all heavy construction projects. The study targeted building construction projects in Jimma zone designed and implemented under the Supervision of Jimma University. The Target Population was made up of Six (6) Building Projects. From all, construction of G+4 classroom and dormitory constructions were finished and the rest four are ongoing. A brief overview of the projects is given in table 1. A more detailed description of every project is provided in the next section.

Table 1: Projects

PROJECT NAME	
CLASSROOM	Construction of G+4 Classroom
DORMITORY I	Construction of G+4 Dormitory
DORMITORY II	Construction of G+3 Dormitory
LIBRARY	Construction of G+2 Library
HOSPITAL	Construction of G+2 Teaching Hospital Main Block (for veterinary medicine)
CANTEEN	Construction of G+3 Student Canteen

Questionnaire was distributed for six of selected projects. The total number distributed to contractors were 24 questionnaires. The total number returned were 21 questionnaires. The total number of questionnaire distributed for consultants were 8 questionnaires. The total number returned was 8 questionnaires. Since the client of Jimma University is one no need of calculation for sample size. I simply distributed for three engineers in clients side. And all questionnaires were returned.

3.4 Sampling

There is a consensus among case study research methodology scholars that non-probability sampling is recommended for case study research; they suggest that samples are selected purposively because they are information-rich case studies that allow deep investigation and analysis to answer the research questions.

3.5 Study Variables

3.5.1 Independent variables

The independent variables which are to be measured and manipulated to determine its relationship to observed phenomena are selected and listed below.

- PV= Planned Value

- EV= Earned Value
- AC= Actual Cost
- CPI= Cost Performance Index
- SPI= Schedule Performance Index
- CV= Cost Variance
- SV= Schedule Variance
- EAC= Estimate At Completion

3.5.2 Dependent variables

The dependent variable which is to be observed and measured to determine the effect of the independent variables is listed below.

- Performance evaluation of building construction project

3.6 Data Collection

3.6.1 Data Collection Techniques

Multiple data sources were used for the purpose of investigating the different dimensions of the research objective. Therefore data used can be categorized as primary and secondary data. These different data were collected using different techniques at various stages as presented in the coming subsections. For desk study of earned value analysis, first collect monthly planned cost of six projects from client then after collect percentage completion of activities from consultant finally the actual cost of the activities was collected from contractor and again the discussion was held with client, consultant and contractors engineers about the major causes of time and cost variations. During discussion, first discussed about the existence of variations next to that discussed about which causes were the major contributor for those selected projects.

3.6.2 Collected Data

For this research data collected from the concerned bodies the Jimma university capital project planning and monitoring office:

- Monthly progress report
- Contract document
- Final payment

- Problems encountered during project execution

From consultant office:

- Financial progress of the project as per activities
- The master schedule
- Problem encountered during project execution

From Contractor about

- Project cost expenses
- Monthly progress report
- Problem encountered during project execution

3.6.3 Data Analysis Tools

The data collected from the three construction parties like Jimma University capital project planning and monitoring office, contractors and consultants.

A combination of the following techniques was employed in the study.

1. **Desk/Record/ study** –By looking through the existing relevant documents or literatures tried to analyze the issues related with the building construction performance evaluation.
2. **Discussion** –This is conducted by applying the method of dramaturgy. This has helped to create conversation with persons found in concerned bodies without creating the feeling that they are being interviewed. This method has helped to understand how relevance is this issue i.e. building evaluation and what major causes was affected cost and time variations.
3. **Questionnaire** – by distributing questionnaire for major parties to rate and rank the major causes for cost and time variation.

The results obtained from desk study were inserted in Microsoft Excel and transformed the data into useful data for the study. Calculations were made and graphs were designed to do the qualitative analysis. For the questionnaire analysis, the study used relative importance index (RII) to rank the major responsible cause for schedule and cost variations. RII can be calculated by using the formula (Abushaban et.al, 2009):

$$\textbf{RII} = \frac{\Sigma \boldsymbol{W}}{\boldsymbol{A} * \boldsymbol{N}} \quad \textbf{Equation 9}$$

Where:

- W is the weight given to each cause by the respondents and ranges from 1 to 5
- A = the highest weight = 5
- N = the total number of respondents

3.7 Plans for Dissemination

The results and plan for such dissemination should be adapted to the level of understanding and interests of the different audiences in the industry. Moreover, the result of this study will be disseminated to Jimma University, contractor and consultants, Jimma Institute of Technology, especially to the Civil Engineering Department, while a copy of it will be set aside in the library of Jimma University for future reference.

3.8 Case study projects description

In this thesis six projects were analyzed to obtain information concerning the evaluation of EVA on building construction projects. To allow comparison of this evaluation against the objectives of each project, both finished and ongoing projects were considered. The six projects are all situated in Jimma University in different campus and were executed under the supervision of Jimma University. As described in table 2 the sample of construction projects budgets ranges from forty-nine to three-hundred-three million birr and the duration of those projects ranges from eleven to fourteen months. This range variability allows to the researcher to consider different size of building construction projects.

Table 2: Projects Description

	CLASSROOM	DORMITORY I	DORMITORY II	LIBRARY	HOSPITAL	CANTEEN
Budget	263,476,641.00	303,933,598.00	101,049,380.00	49,287,262.00	53,535,339.54	120,278,709.76
Duration	11 months	13 months	12 months	13 months	13 months	14 months
Construction type	Building	Building	Building	Building	Building	Building

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Project Performance Evaluation

In this study the research relied on information that was readily available considering the time availability and resources availability. The indicators used are understandable and will make meaning to major building construction parties. The main objective is to evaluate the building construction project performance considering some of project indicators using earned value analysis.

4.2 Project Progress Evaluation

Under project progress evaluation planned value, actual value and earned value or percentage completion of the activities should be carefully identified from documents listed under collected data and then the data analyzed. Then compare actual and performed activities with respect to the schedule on the way of comparison the projects performance were evaluated. Classroom project and dormitory I project are finished projects and the rest of four projects were ongoing.

Classroom

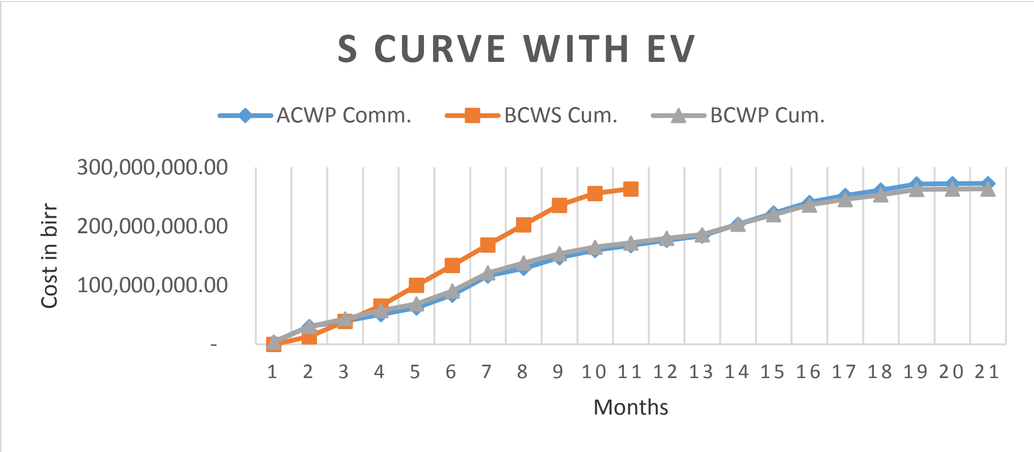

Figure 4: Classroom S-curve with EV

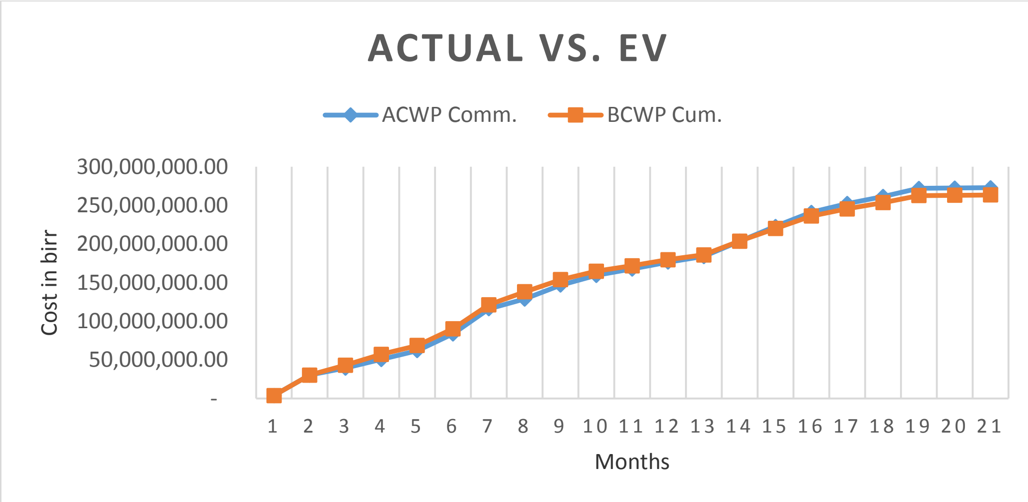

Figure 5: Classroom EV and Actual

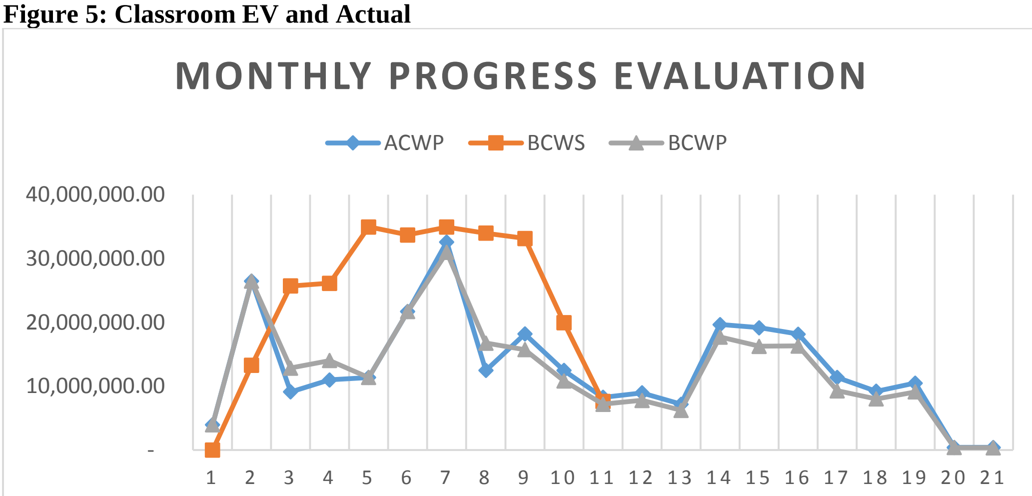

Figure 6: Classroom monthly progress evaluation

Two curves were drawn in terms of S-curve and monthly progresses using cumulative cost and monthly cost respectively. To begin with cumulative cost or S-curve and EV curve, First three months the planned cost of the project was less than from both the actual and earned value it means that the work performed on the first three months were higher than the planned one. After third month the planned amount of the project was increased and laid on top of both actual and earned costs of the project. Graphically speaking chart shows beginning from end of 3rd month up to final scheduled completion month the planned amount of the project were on top of actual and earned value costs. To compare earned value and actual cost, first three months earned value and the actual amount of the project went on almost the same spot however between third and thirteen months the earned value laid on top of the actual amount but after thirteenth month the actual amount of the project overtake and laid on top earned value and under planned.

Monthly progress evaluation curves showed that each month preview of planned, actual and earned value. Like S-curve for the first two months the planned cost of the project was laid under both actual and earned value costs. On this chart earned value was higher on 3rd, 4th and 8th months and other available months of the project were dominated by actual cost. Furthermore the graph lines of both earned value and actual cost were extended beyond the scheduled months of the construction it means extended beyond eleventh months this indicate that this construction project went beyond the scheduled time simply put the project was on time overrun.

Dormitory I

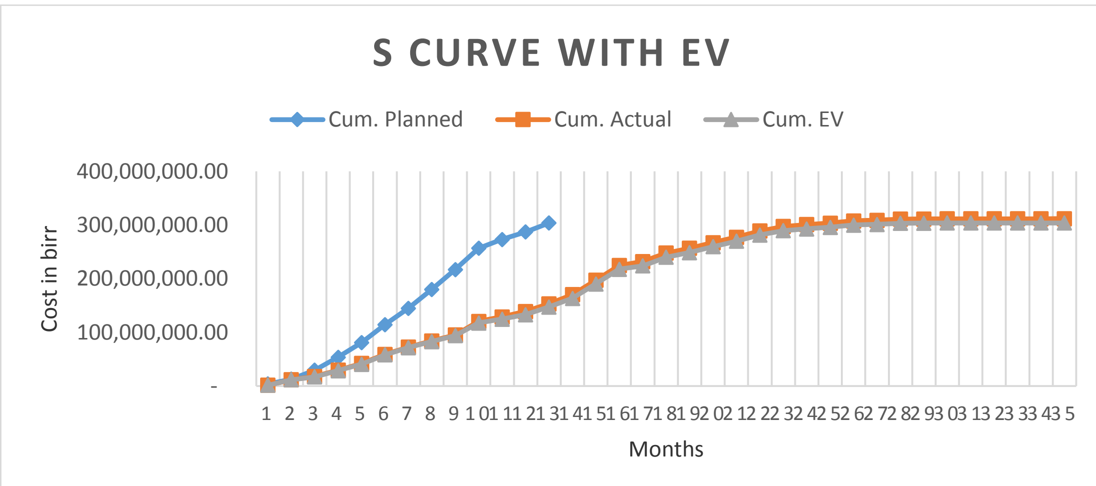

Figure 7: Dormitory I S-curve with EV

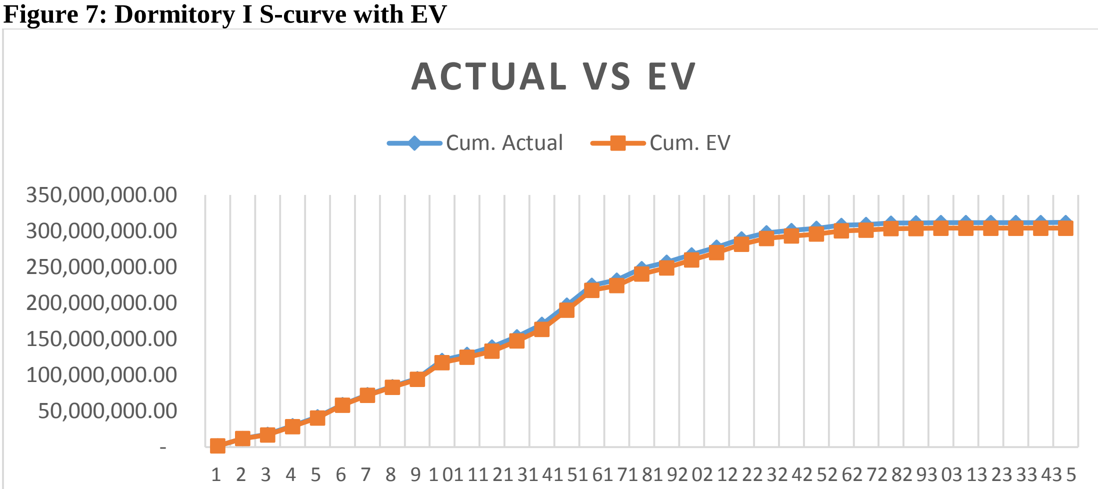

Figure 8: Dormitory I EV and Actual

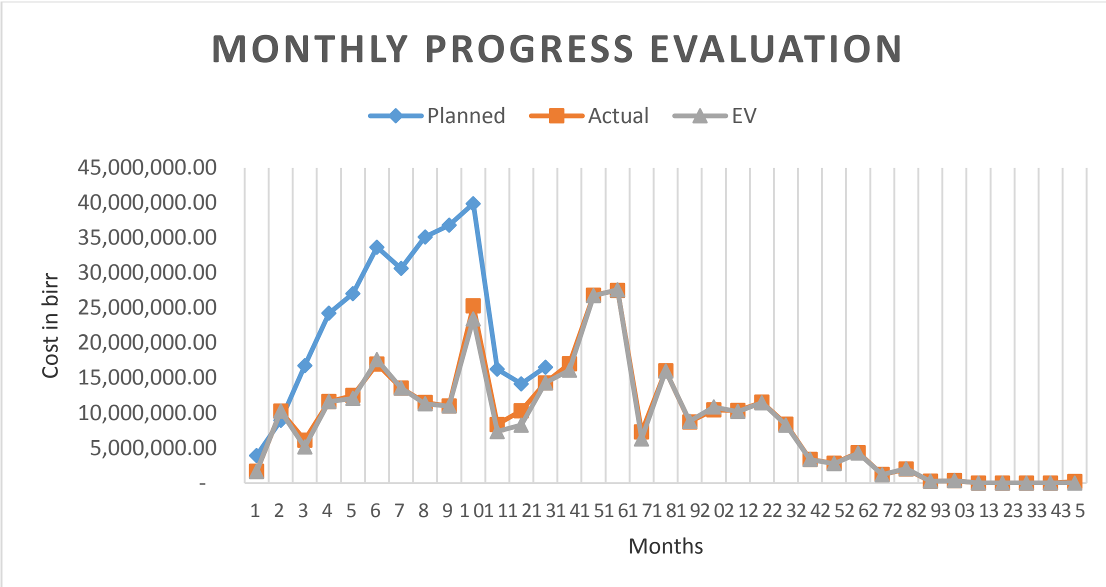

Figure 9: Dormitory I monthly progress evaluation

Budgeted cost of this project was 303,933,598.00 and time of the project was scheduled to finish was in thirteen months but due to reasons (discussed in section 4.8) project's cost and time was increased to 311,970,831.89 birr. Similar with the first project the data was analyzed according to S-curve and monthly progress charts and table. On S-curve and earned value curve, first two months three of the curves laid on almost the same spot in particularly at the end of 2nd month the difference of three of them were insignificant mainly the actual cost and earned value cost were similar. After the end of 3rd month up to scheduled finishing month the planned cost was above and far from both actual and earned value cost of the project. Graphically explained earned value and actual cost of the project lay almost on the same spot up to the end of 13th month after that the actual cost of the project was laid on top. Monthly progress evaluation chart showed that the actual and the earned costs of the project were close enough the difference of both significantly identified at the ends of 11th, 12th and 17th months first two months the actual cost of the project were advanced by maximum of 2M.

Above charts also clarified the schedule status of this project. Both earned and actual costs graph lines were stretched beyond planned graph line it means the project executed away from scheduled month i.e. the construction project extended 169.23 percent higher from scheduled time. Generally it specified that this project was over budget and behind the schedule in all months.

Dormitory II

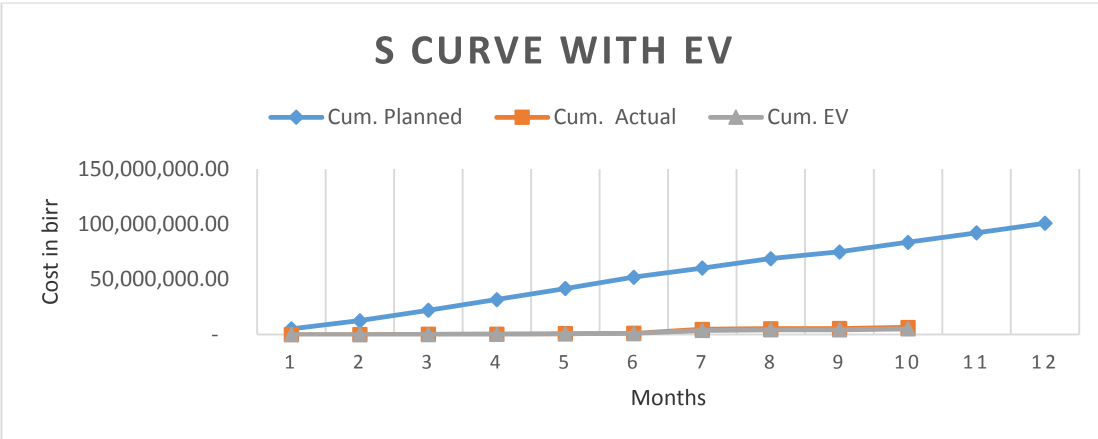

Figure 10: Dormitory II S-curve with EV

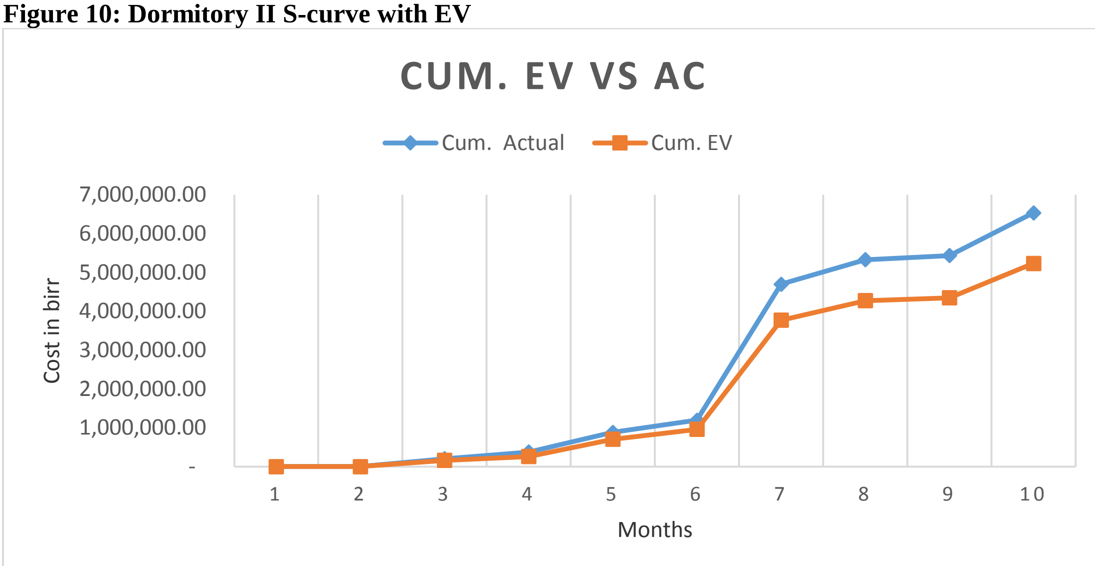

Figure 11: Dormitory II EV and Actual

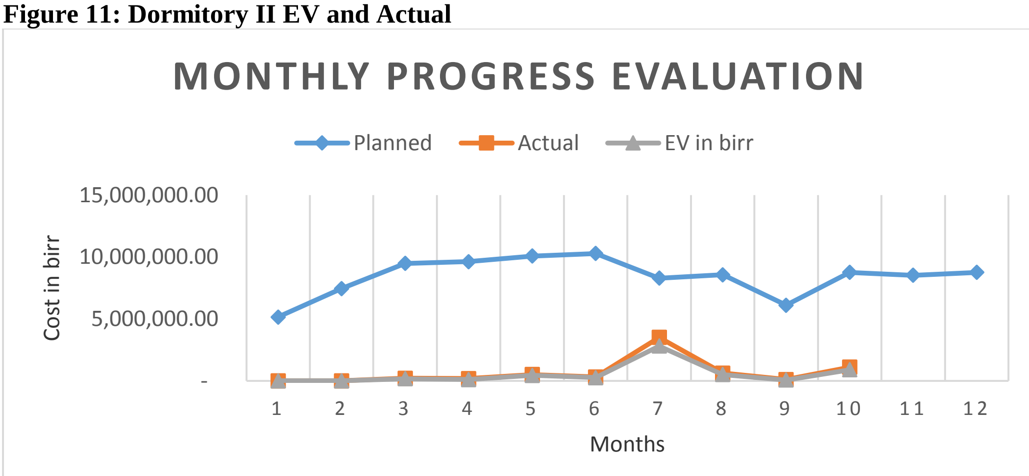

Figure 12: Dormitory II monthly progress evaluation

This project is ongoing but the results of cumulative and monthly charts showed that from the beginning of the project cumulative planned cost of this project was far from both earned and actual cost of the project. The planned completion months were twelve months even though at the end of 12th month this project is performed only 5.18% graphically showed on above charts, the planned cost couldn't compare with the actual and earned value because the planned cost is significantly far from the actual and earned value costs. First 6 months the difference of earned value and actual costs was maximum of 500,000 birr but next 4 months the difference was greater than 500,000 birr so that the difference easily visible on the chart. This clearly indicated that the project was behind the schedule. On the contrary, earned value and the actual cost of the project did not have a big difference but all 10 months the actual cost of the project was higher than the earned value cost of the project and this led over budget on the project.

Monthly point of view like cumulative charts the planned cost of the project was suspended far above from actual and earned values costs though actual and earned value costs are notably close at the end of 7th month the actual cost laid on top of earned cost. In conclusion this project did not execute according to scheduled time and budgeted cost.

Library

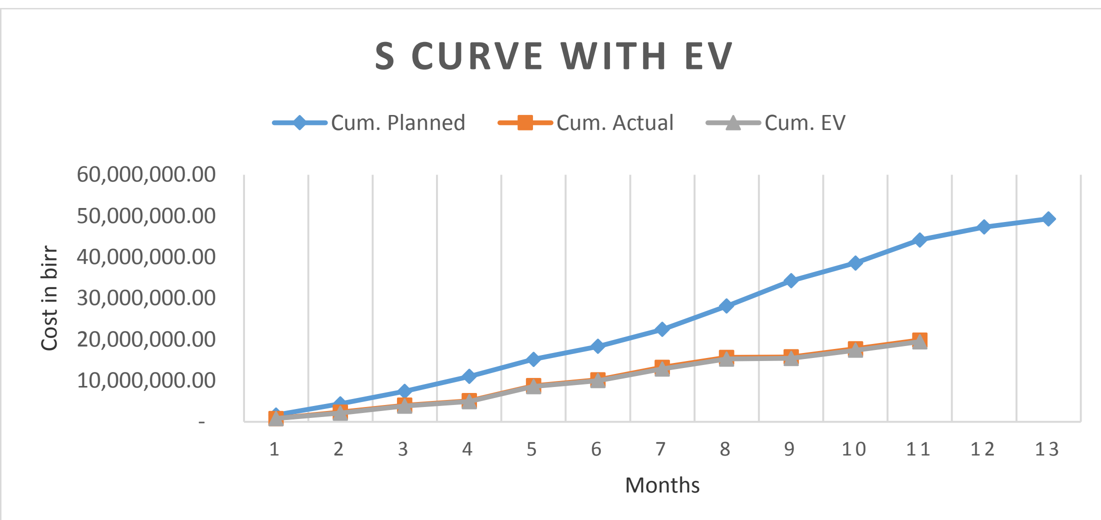

Figure 13: Library S-curve with EV

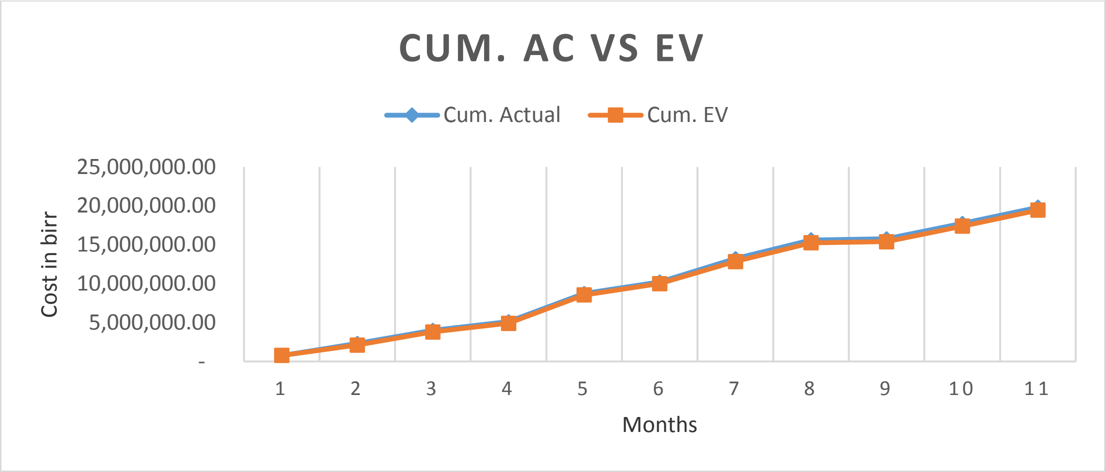

Figure 14: Library EV and Actual

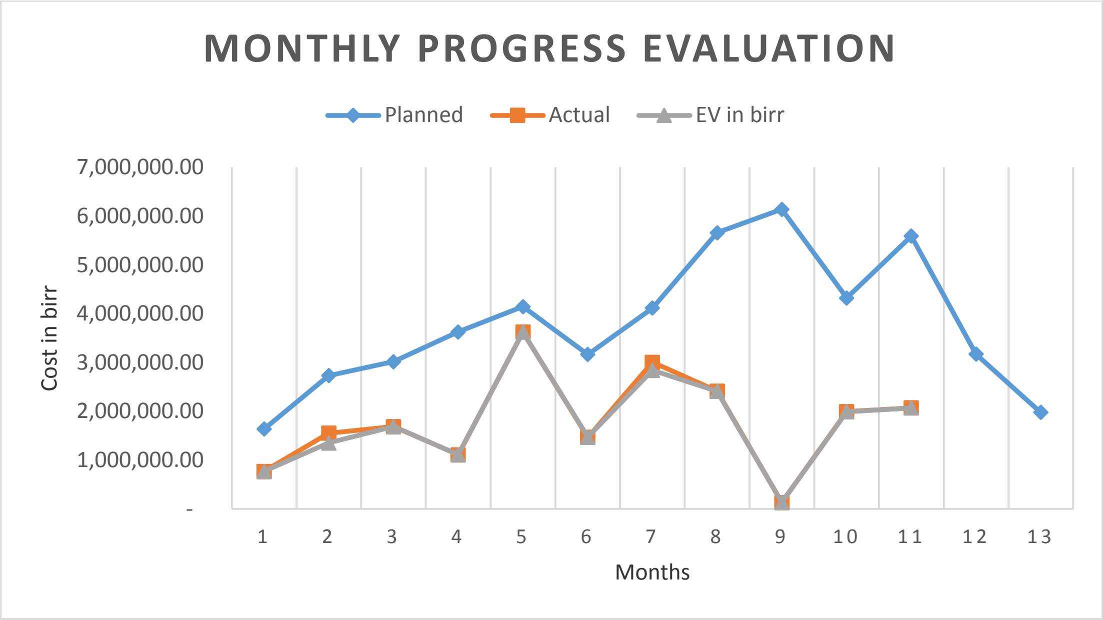

Figure 15: Library monthly progress evaluation

As compared to the above three projects, project four showed the closest gap between planned and the two parameters means on this project cumulative planned, earned and actual costs showed minimum difference as compared with above three construction project however the planned cost of the project was above cumulative earned and actual costs. Above chart showed that cumulative earned value cost and actual cost was close especially in this project they are almost on the same point the maximum cost difference was recorded at the end of 8th month 364,845.86 birr comparatively minimum.

Monthly preview chart showed up to end of 7th month the closest cost difference was reported. At the previous months of the data collection the planned cost of the project budgeted 5,589,175.51 birr however actual and earned value costs of the project was 2,069,953.00 and 2,069,572.13 more than 3M difference. At the ends of 2nd and 7th months the actual cost of the project laid on top of earned value cost. On these specific months the actual cost of the project was higher than the earned value cost it means on the 2nd and 7th months the project was over budget. At the end of 11th month the project planned to finish 89.56 percent of project work however the result showed that the project work was completed only 39.459 percent of the work it means 50.1 percent work was still not completed. So that the project was not only over budget also the project works were not completed as per schedule.

Hospital

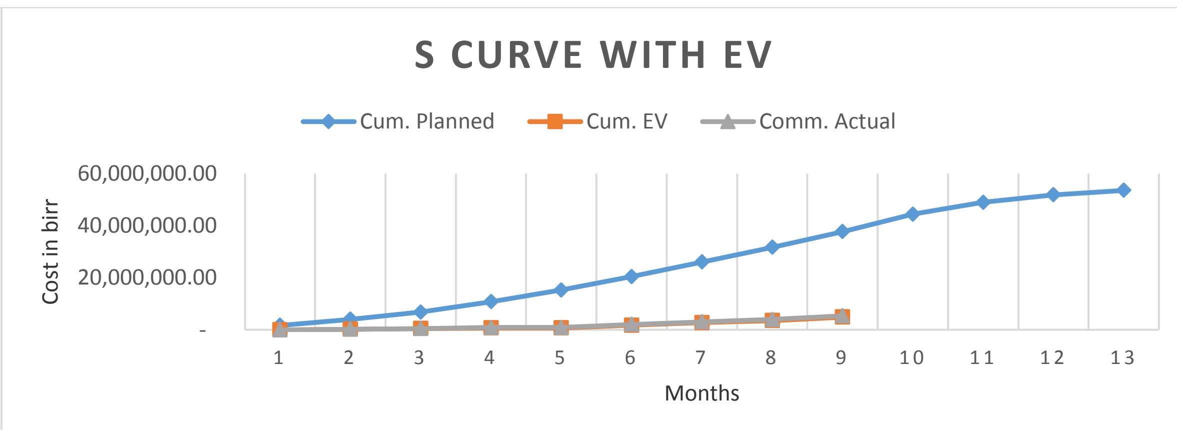

Figure 16: Hospital S-curve with EV

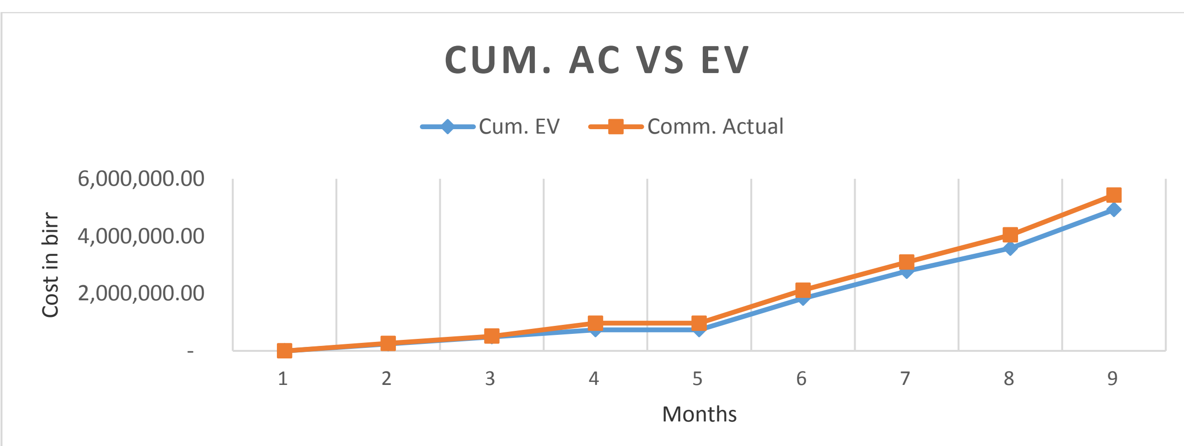

Figure 17: Hospital EV and Actual

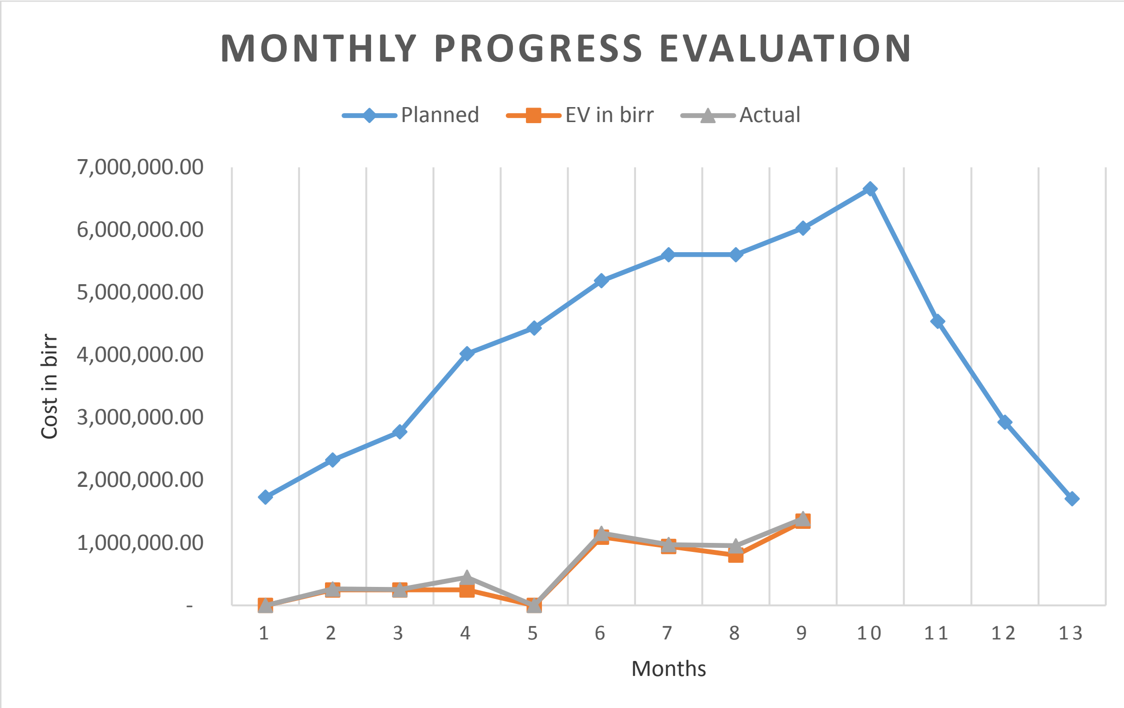

Figure 18: Hospital monthly progress evaluation

This construction is ongoing construction project. At the end previous month of data collection, project scheduled percentage should be reach 70.43% from the total work but on that time the project only accomplished 6.99% from 100%. So that Above chart showed, the planned cost of the project far top of the two parameters (actual and earned value costs). Cumulative actual and earned value costs of the project chart drawn in detail and it also describe the project actual cost was almost parallel with earned value cost. The maximum cost difference was scored at the end of 1st month. At the end of the 1st month the cost difference was 251,341.15 but at the end of the end 9th month the difference of the costs were 1,011,730.06 birr. The cost difference of the cumulative costs of both actual and earned cost of the project increased with month. Monthly talking, the major difference was scored at the ends of 1st, 4th, 5th and 8th months figuratively 251,341.15, 475,689.18, 727,030.33, 969,057.43, 1,011,730.06 birr respectively. All months the actual cost of the project had difference but as compared with other construction projects the cost difference was minimum yet there was deviation so that the consultant, contractor and client should be sit and solve the problems encountered on this project as soon as possible.

Canteen

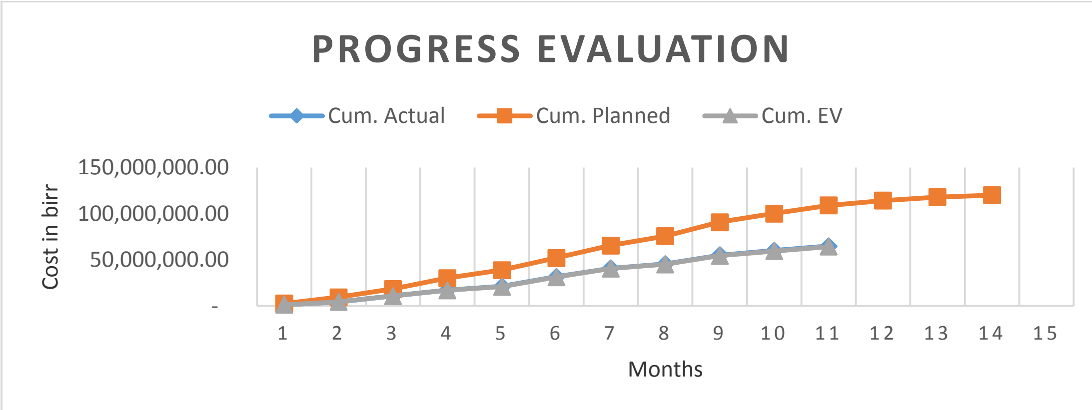

Figure 19: Canteen S curve with EV

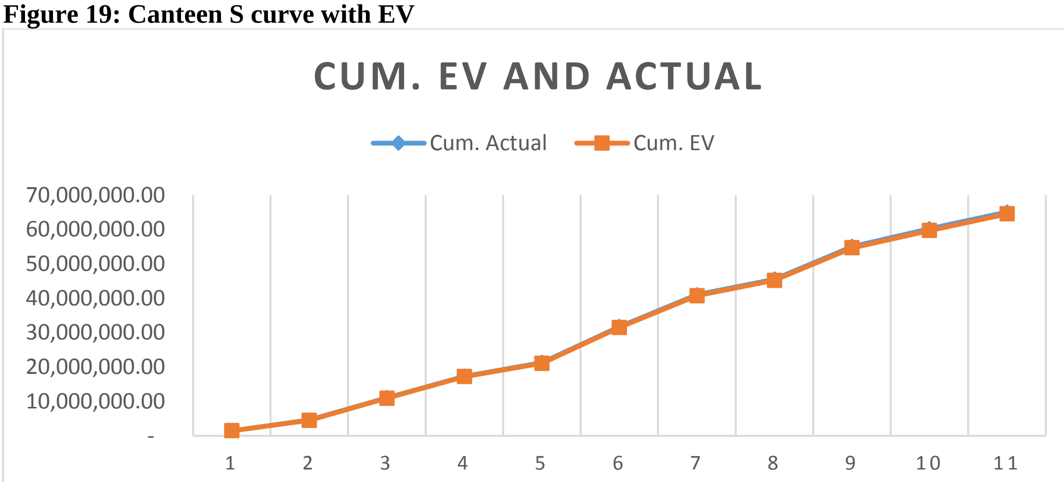

Figure 20: Canteen EV and Actual

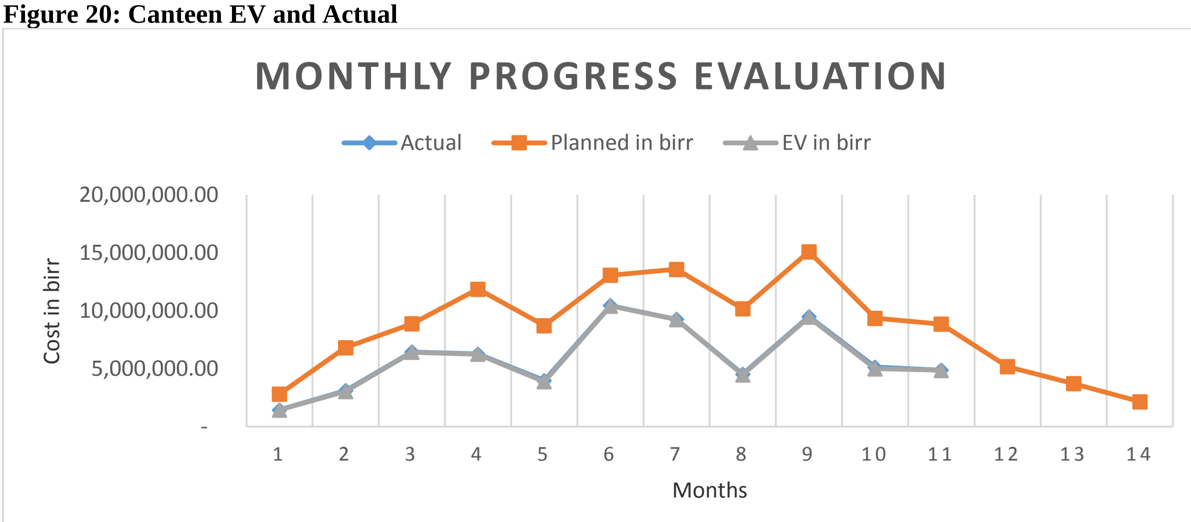

Figure 21: Canteen monthly progress evaluation

The cumulative planned cost of this project increased almost linearly and reached the maximum cost that was 120,278,709.76 birr up to previous month of data collection. At the end of that month the project was scheduled to finish 90.79% of work but the project was completed 53.67% i.e. it was late about 37.12% from planned completion. Compared with other months the first two months the planned cost graph lines went on adjacent with actual and earned value costs. The earned value cost was less than the planned cost. This means that the project was behind schedule. The actual cost was greater than the earned value cost. This means that work is being accomplished with high cost than planned.

Similarly Above chart showed that the planned cost line of the project were on top of both earned value cost and actual cost. Within earned value cost and actual cost, the actual cost line of the project was laid above earned value cost. The two parameters actual and costs are still has difference but it is insignificant as compared with total project cost. In conclusion, the project major parties should solve the problem as soon as possible to back the project on schedule.

4.3 Schedule Variance (SV) and SV Percentage (SV %)

The brackets inscribe the numbers indicate the number has negative value if not the number is positive.

Classroom

It is already finished project so that schedule variance was calculated up to scheduled completion month.

Table 3: Classroom SV

Months	SV
1	3,978,497.28
2	13,173,832.05
3	(12,857,660.08)
4	(12,093,577.82)
5	(23,581,159.37)
6	(11,988,187.17)
7	(3,952,149.62)
8	(17,215,563.72)
9	(17,415,805.97)
10	(9,116,291.78)
11	(447,910.29)

SUM	(91,515,976.48)
IN %	(35)

See from the above table and chart, the schedule variance of end first and second months were positive it means for the first two months this project were ahead of schedule then extended to scheduled completion month the schedule variance was negative means behind schedule. First two months cost of works performed were higher than the planned cost especially at the end of 2nd month the difference of earned value cost and planned cost of the project had higher positive value than other months figuratively 13,173,832.05 birr 10M alteration with 1st month. However for the next 9 months the schedule variances were under zero line. The minimum negative value or the minimum schedule variance was scored at the end of scheduled month and it was numerical negative 447,910.29 birr and the maximum schedule variance also score at the end of 5th month numerically 23,581,159.37 birr. This 5th month variance took 8.59% from the original cost of the project. The minimum negative schedule variance of this project was scored at the end of 11th month which was negative 447,910.29. Again the summation of schedule variance was negative. The summation of the variance was done by adding all schedule variance from the first month of the project up to the end of the scheduled month. After the summation calculation was done the project was negative 91,515,976.48 birr variance simultaneously calculating the summation percentage of schedule variance was done and scored 35% behind planned time. Therefore the project was behind planned time for the last 9 months.

Dormitory I

Similar with first project, this project is finished project meanwhile the schedule variance was calculated up to scheduled completion month.

Table 4: Dormitory I SV

Months	SV
1	(2,279,501.99)
2	1,306,914.47
3	(11,610,263.44)
4	(12,613,244.32)
5	(14,983,926.38)
6	(16,078,087.33)

7	(17,081,068.21)
8	(23,828,394.08)
9	(25,834,355.83)
10	(16,473,201.01)
11	(8,874,861.06)
12	(5,896,311.80)
13	(2,249,108.63)
SUM	(156,495,409.61)
IN %	(51)

See from the table and chart above, on this project the schedule variance showed positive value only at the end of 2nd month means the project was ahead of schedule but the rest of all twelve months the project was behind the schedule. The chart of schedule variance showed, beginning from 1st month, except 2nd month, the value of schedule variance was significantly decreased up to 9th month then the schedule variance was getting higher and back but could not pass zero line. The maximum schedule variance of the project was recorded at the end of 9th month. Figuratively negative 25,834,355.83 birr, 16.5% from the total cumulative schedule variance costs. Generally from the beginning up to scheduled finished month the project was behind the schedule with exceptional of 2nd month. The summation of all schedule variance within thirteen months was negative 156,495,409.61 birr in percent 51 percent behind the schedule.

Dormitory II

Table 5: Dormitory II SV

Months	SV
1	(5,153,518.38)
2	(7,447,339.31)
3	(9,316,752.84)
4	(9,518,851.60)
5	(9,630,005.91)
6	(10,034,203.43)
7	(5,476,876.40)
8	(8,063,740.52)
9	(6,032,647.99)
10	(7,871,746.70)
SUM	(78,545,683.07)
IN %	(78)

From the above table and chart results, all schedule variance costs were negative which means that the project was all over behind the schedule. Above chart clearly showed that the schedule variance value decreased almost linearly up to end of 3rd month again without disturbance decreased till end of 6th month then at the end of 7th month got back and record the second least schedule variance value however this increment did not went up to 10th months but the schedule variance again drop to negative 8,063,740.52 birr from 5,153,518.38 birr. All schedule variance values were varying from 5M up to 11M but the 6th month schedule variance value is the major contributor for the schedule delay by scoring 10,034,203.43 birr and the least schedule variance was scored at the end of 1th month figuratively 5,153,518.38 birr which was 6.6 percent from cumulative variance value. The schedule delay of the project was evaluated in terms of money it delays 78,545,683.07 birr in percent it covered 78 percent of project's scheduled time.

Library

Table 6: Library SV

Months	SV
1	(867,455.81)
2	(1,380,043.34)
3	(1,330,756.07)
4	(2,518,579.09)
5	(522,444.98)
6	(1,695,481.81)
7	(1,276,540.09)
8	(3,248,030.57)
9	(6,003,188.51)
10	(2,331,287.49)
11	(3,519,603.38)
SUM	(24,693,411.13)
IN %	(50)

The results showed this project had many ups and downs at the end of 1st month schedule variance was 867,455.81 birr which was the second least schedule variance value i.e. the project was good enough but still correction needed. After that for the next three months the schedule variance value was getting drop then at the end of 5th month the project was getting back on the track and recorded the first lowest schedule variance value which was negative 522,444.98 birr. Distinguished that all schedule variance value were negative the maximum schedule variance was scored on 9th month in numbers -6,003,188.51birr means the project faced major behind schedule value at the end of 9th month. The percentage of schedule variance of the project indicated that the work performed cost of the project was 50% less than the scheduled time.

Hospital

Table 7: Hospital SV

Months	SV
1	(1,729,191.47)
2	(2,076,998.45)
3	(2,526,695.30)
4	(3,774,068.71)
5	(4,432,726.11)
6	(4,096,218.12)
7	(4,661,654.94)
8	(4,802,475.11)
9	(4,683,246.65)
SUM	(32,783,274.86)
IN %	(61)

Schedule variance is the difference between earned value and planned value. Schedule variance is an indicator that provides project managers with a value that represents whether the project is on schedule or not. A negative (positive) value means that the project is behind (ahead of) schedule (Suresh and Ramasamy, 2015). The schedule variance value of this project placed in terms of chart and table and so those two results indicated that the project is under time overrun all past nine months i.e. all months had negative value. From the beginning of the project to the end of 5th month the project schedule variance was continuously decreased but at the end of 6th month the schedule variance increased to 4,096,218.12 had difference of more than 300,000 birr from 5th month. After that, for the next three months the project scored almost equal negative value 4,661,654.94 birr, 4,802,475.11 birr and 4,683,246.65 birr respectively. The major contributor for this time delay was recorded at the end of 8th month by -4,802,475.11 birr. The sum values was -32,783,274.86 birr in percent the project lags 61% of its time from the planned time.

Canteen

Table 8: Canteen SV

Months	SV
1	(1,359,149.42)
2	(3,764,723.62)
3	(2,453,685.68)
4	(5,592,960.00)
5	(4,847,232.00)
6	(2,658,159.49)
7	(4,318,005.68)
8	(5,689,182.97)
9	(5,629,043.62)
10	(4,354,089.29)
11	(3,981,225.29)
SUM	(44,647,457.06)
IN %	(37)

The time performance is measured through calculating the schedule variance which is the difference between the earned value and the planned value (Suresh and Ramasamy, 2015). The schedule variance is a metric used to quantify how much the project is running ahead or behind the time schedule. The schedule variance value of this project negatively varied from 1M to 5M which indicate the project lags every months from the beginning to the previous month of data collection i.e. the project was all over behind the schedule. At the end of 1st month the project scored the least schedule variance value which was negative 1,359,149.42 birr but on the next month the project schedule variance getting worse and went to negative 3,764,723.62 birr i.e. more than 2M schedule variance difference. On the next nine months the project schedule variance value had many ups downs at the ends of 3rd and 6th months comparatively the project scored minimum cost of schedule variance. The top two minimum schedule variance of this project was scored at the ends of 8th and 4th months numerically negative 5,689,182.97 and negative 5,592,960.00 respectively. For the last three months, at the ends of 9th, 10th and 11th months, the project scored negative 5,629,043.62, 4,354,089.29 and 3,981,225.29 respectively. Clearly the schedule variance showed decreasing but the value was still negative. Cumulatively the schedule variance value in birr -44,647,457.06 birr the percentage of schedule variance again shows the schedule variance value took 37% of project time.

4.4 Schedule Performance Index (SPI)

Values of SPI greater than 1.0 indicate the project is ahead of schedule. The project may be progressing faster than expected if the original production rates were predicted too low or the actual working conditions are better than originally anticipated. There may be more staffing on the project than anticipated, which would also show the work as progressing ahead of schedule. Values of SPI less than 1.0 indicate the project is behind schedule. The project schedule may slip due to weather delays, understaffing, or disorganized work.

Classroom

Table 9: Classroom SPI

Months	SPI
1	0
2	1.99
3	0.50
4	0.54
5	0.33
6	0.64
7	0.89
8	0.49
9	0.47
10	0.54
11	0.94
AVERAGE	0.67

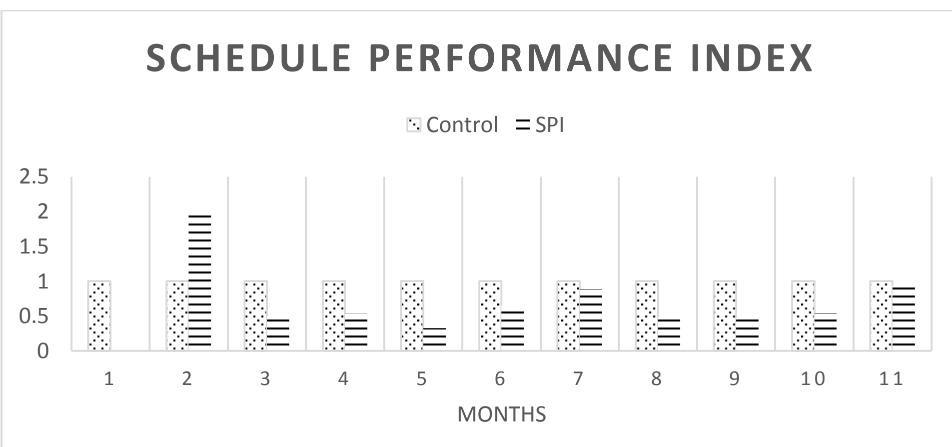

Figure 22: Classroom SPI

The above chart and table illustrated, at the end of 1st month the schedule performance index of this project was zero because at end of first the month there was no budgeted cost but the construction was began. At the end of 2nd month the schedule performance index value was above the control line of 1 means project's earned value cost were above planned cost and scored 1.99 to put simply at the end of 2nd month the project was ahead of schedule however this result of schedule performance could not extended to other months. After that all 9 months the schedule performance index calculated less than 1 or all 9 months the project was behind the schedule. The closest value of schedule performance index was recorded at the end of 11th months and it scored 0.94 the second closest result was scored at the end of 7th month counted 0.89. The average schedule performance index within planned months were 67%. This means that for every birr worth of work the project planned to accomplish, 0.67 birr worth of work was accomplished.

Dormitory I

Table 10: Dormitory I SPI

Months	SPI
1	0.42
2	1.15
3	0.31
4	0.48
5	0.45
6	0.52
7	0.44
8	0.32
9	0.30
10	0.59
11	0.45
12	0.58
13	0.86
AVERAGE	0.53

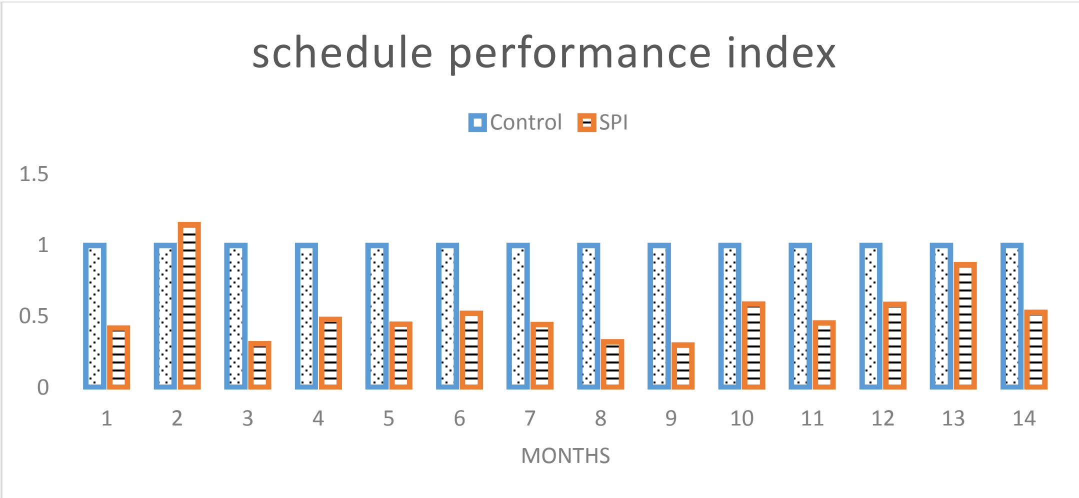

Figure 23: Dormitory I SPI

Above chart and table showed that the schedule performance of this construction project was, except at the end of 2nd month, under the control line which has the value of 1. For the next 13 months project's progress went under 1 with maximum scoring of 0.86. At the beginning month the schedule performance index of the project was 0.42. However at the end of 2nd month this project performed work was 15% greater than the planned numerically 115% from 100%. But this schedule performance was not continued it got drop until the spot hit the second least schedule performance index score by 0.31. After that the value was slightly higher up to end of 6th month although the scheduled performance index of the again dropped. On the data collection month it seems the project was showed better schedule performance index. The average schedule performance index within scheduled months was 53%. This means that for every birr worth of work the project planned to accomplish, 0.53 birr worth of work was accomplished.

Dormitory II

Table 11: Dormitory II SPI

MONTHS	SPI
1.00	0
2.00	0
3.00	0.02
4.00	0.01
5.00	0.04
6.00	0.02
7.00	0.34

8.00	0.06
9.00	0.01
10.00	0.10
AVERAGE	0.06

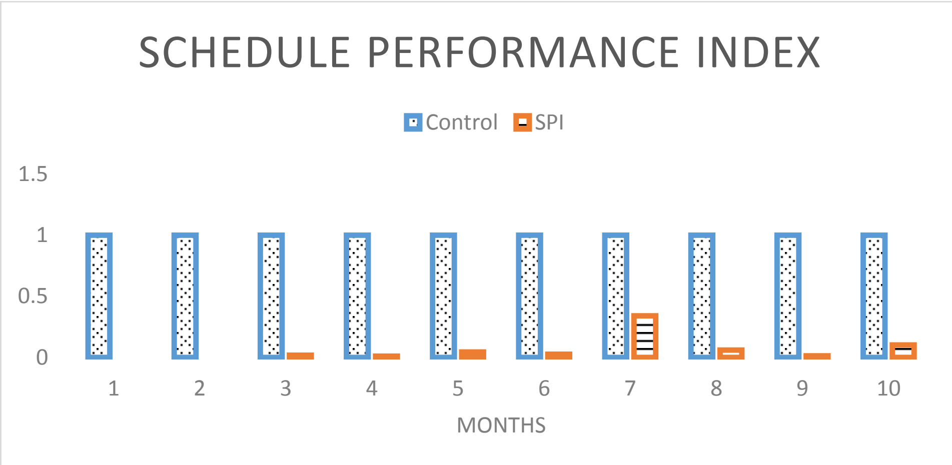

Figure 24: Dormitory II SPI

For any project the schedule performance index may also be greater than, less than, or equal to 1.0. Values greater than 1.0 indicate good performance and values less than 1.0 indicate poor performance. Thus, the project manager's analysis of project performance is complicated due to various schedule performance indices. For the first ends of two months the project was stopped so that the schedule performance index of the project showed zero. This the lowest of the schedule performance index values was extended up to the 4 months up to 6th month. Within the next four months the maximum schedule performance index of this construction project was only 4 percent from 100. However at the end of 7th month the schedule performance of the project increased to 34% but this value did not enough for the project. At the last ends of three months the schedule performance indices down to 6, 1 and 10 % from 100%. In other words the earned value cost of the project was 94, 99 and 90 percent respectively less from the planned cost of the project.

To generalize, from the above result table and chart, the schedule performance index of this project is below 10% literally average of 6% this means the work planned to be performed only 6% worth of work is accomplished. From months preview only the 7th months could attain 34% the other 9 months were less than 10%. So we can precisely say that this project is under performance.

Library

Table 12: Library SPI

Months	SPI
1	0.47
2	0.49
3	0.56
4	0.31
5	0.87
6	0.46
7	0.69
8	0.43
9	0.02
10	0.46
11	0.37
Average	0.47

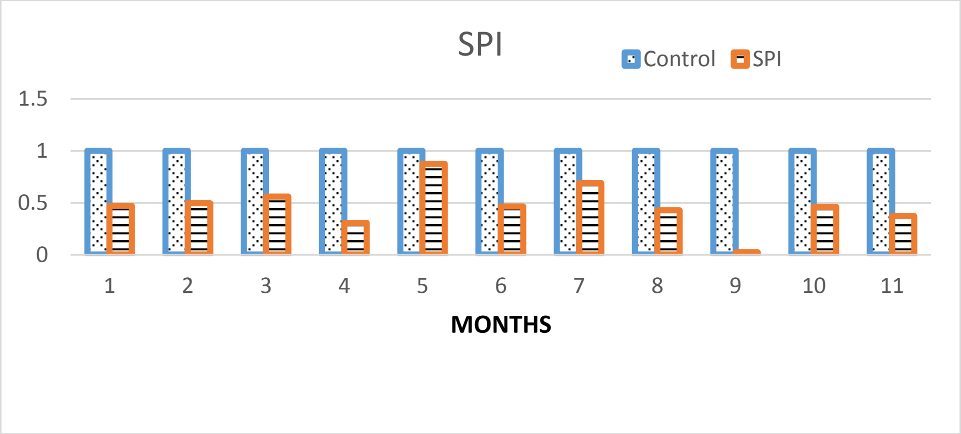

Figure 25: Library SPI

Schedule performance index is the ratio of work accomplished versus work planned, for a specific time period. Schedule performance index indicates the rate at which the project is progressing. The schedule performance index shows whether the project is performing on schedule or not. A schedule performance index of more (less) than one means that the project is ahead of (behind) plan (Suresh and Ramasamy, 2015).

Monthly preview the schedule performance of the project at the ends of first, second and third months was showed stability but with comparison to the performance index limitation the project was behind the schedule not only for the first two months also for 11 months the project was behind the schedule. At the end of 4th month the project scored the second lowest schedule performance index value by the value 0.31. Conversely at the next month the project recorded the highest schedule performance index throughout 11 months. At the ends of 7th, 8th and 9th months the project schedule performance decreased almost linearly and spotted the lowest schedule performance value of 0.02. And the next two months the project schedule performance increased to 0.47. The previous month of the data collection the schedule performance was 0.64 far from 1. Basically the earned value cost of the project was 64% less than from the planned cost of the project.

In conclusion, above chart and table explains all schedule performance index values are less than one or below the control bar the least value scored at the end of the 9th month. This project the average work planned to be done is only 47% but on monthly preview the 87% was the greatest recordable schedule performance.

Hospital

Table 13: Hospital SPI

Months	SPI
1	0
2	0.11
3	0.09
4	0.06
5	0
6	0.21
7	0.17
8	0.14
9	0.22
AVERAGE	0.11

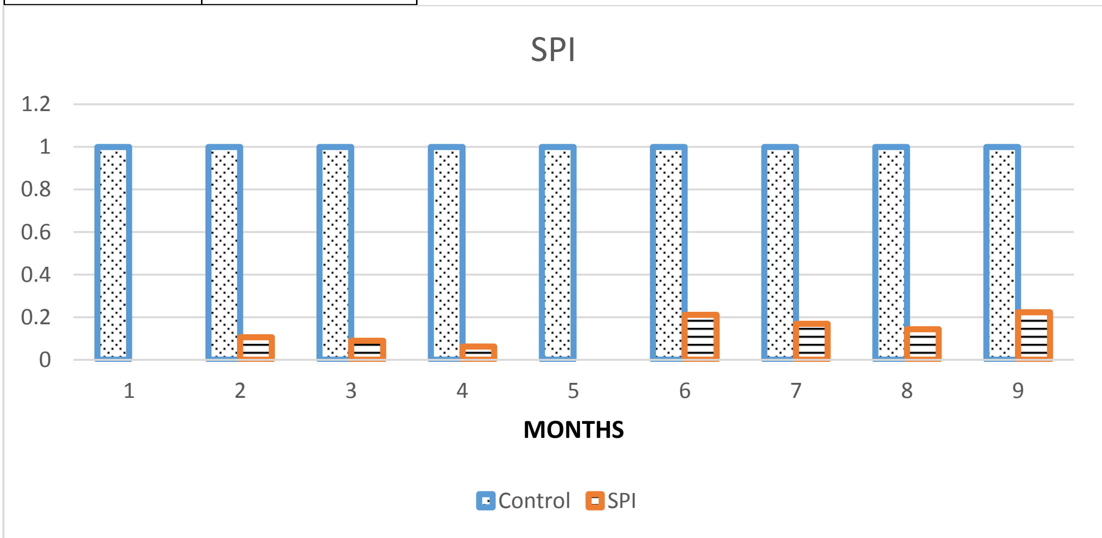

Figure 26: Hospital SPI

At the beginning of the project the schedule performance of the project was zero because of the earned value of the project was zero no work was performed on that month. At the next month the project schedule performance had value but still the schedule performance was 11% from 100% it means earned value cost was 89% less from the planned cost. Beginning from 2nd month up to 5th month the schedule performance of the project was decrease and reached to zero. At the end of 5th month the project was again practically stopped. But on the next month the project scored the second highest schedule performance index then again the schedule performance was dropped till 0.14. At the end of 9th month, the previous month of the data collection, the schedule performance of the project recorded the highest value but this value was not even close to control bar.

While the project was implemented, the project schedule performance index value should be one or above as much as possible. On this project the first 5 months the project's schedule performance was under 10% even the project stopped for 2 months but after that the schedule performance of the construction project increased to up to 22% but it is not enough it needs at least 88% schedule performance.

Canteen

Table 14: Canteen SPI

Months	SPI
1	0.52
2	0.45
3	0.72
4	0.53
5	0.44
6	0.80
7	0.68
8	0.44
9	0.63
10	0.53
11	0.55
AVERAGE	0.57

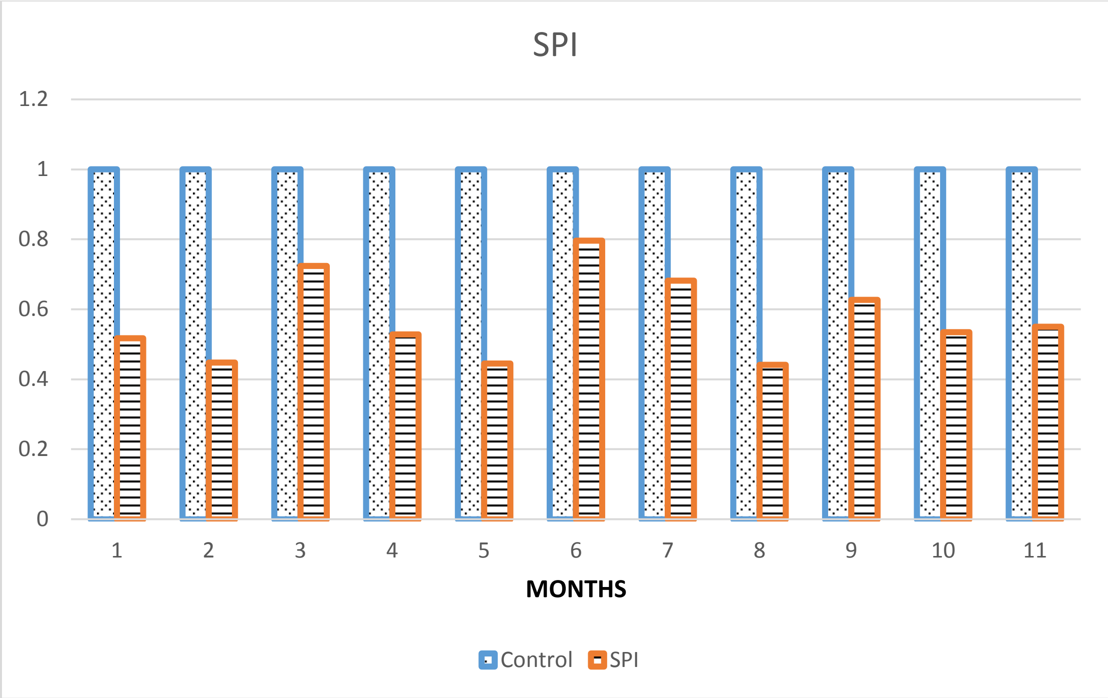

Figure 27: Canteen SPI

Schedule performance index (SPI) is also calculated to report the magnitude of work deviation from the initial project time plan. The SPI is a metric used to measure time efficiency in projects. On this project, schedule performance index chart showed that there was many ups and downs at the end of first month the project scored 0.52 and the end of the next month the schedule variance decreased in to 0.45. End of 3rd month showed the second highest schedule performance index 0.72 but for the next two months the schedule performance index was getting down to 0.53 and 0.44 respectively. Then again on the next month the schedule performance spotted to the highest point of the chart. At the ends of 7th and 8th months the project schedule performance dropped to 0.68 and 0.44. Similar manner was repeated at the ends of 9th and 10th months down to 0.63 and 0.53. At the end of 11th month the project was 45% behind from the schedule.

Schedule performance index of this project monthly maximally scored 0.80 at the end of 6th month along with average of 57% from 100% or above. The whole months as well as the average was less than 1 means the project is on delay. For the last 11 months this project score maximum of 80% still the project is under schedule performance.

4.5 Cost Variance and CV Percentage

Classroom

Table 15: Classroom CV

Months	CV
1	10,437.14
2	(37,486.62)
3	3,748,375.68
4	3,038,923.67
5	9,055.09
6	0.01
7	(1,630,120.57)
8	4,284,661.72
9	(2,457,232.76)
10	(1,633,023.64)
11	(1,082,076.30)
12	(1,173,240.29)
13	(939,384.96)
14	(1,966,410.61)
15	(2,889,702.45)
16	(1,866,008.32)
17	(2,075,530.90)
18	(1,204,949.51)
19	(1,371,422.77)
20	(29,143.34)
21	(55,491.00)
SUM	(9,319,770.76)
IN %	(4)

In this project cost variance were happened every month of the project. At the end of first month the cost variation of the project was positive 10,437.14 birr it seems imminent for 263M budgeted construction project but it showed the project was on track although at the end of 2nd month the cost variance of the project turned in to negative but like first month the value imminent it was negative 37,486.62 birr but the negative sign was an alert because of that on the next month project scored the second highest positive cost variance it means at the 3rd month the project went under budget even for the next three months the cost variation was positive and zero. All of the sudden on the 6th month the project was on budget but this cost variation performance could not went on the following months. At the end of 7th month the cost variation dropped in to negative 1,630,120.57 birr. But then again end of 8th month cost variation increased and took the leading positive cost variation score of 4,284,661.72 birr. After the end of 9th month up to the end of the construction scored different negative values. During those months the minimum cost variance was scored at the end of 20th month while the project was 1 month left for completion.

Generally, for six months the cost variance for this project was positive, meaning that for six months the actual costs are less than the earned value cost; same way this positive variance indicated that for the first six months the project is under budget unfortunately after 6th months the cost variance is negative meaning the project is over budget. Cumulative point of view of cost variances it went to 9,319,770.76 birr in percent 4%.

Dormitory I

Table 16: Dormitory I CV

MONTHS	CV
1	(8,163.07)
2	(13,534.49)
3	(988,164.19)
4	(12,092.74)
5	(419,225.72)
6	604,553.34
7	(14,708.88)
8	(187,527.32)
9	(5,001.59)
10	(961,036.12)
11	(997,518.14)
12	(2,044,109.06)
13	(14,912.49)
14	(913,087.54)
15	(77,937.30)
16	103,199.56
17	(989,779.08)
18	(46,580.32)
19	86,167.04
20	415,637.97
21	(139,490.31)
22	(67,217.61)

23	(125,525.65)
24	(34,109.73)
25	(46,596.42)
26	(68,914.55)
27	(14,219.02)
28	68,462.85
29	(218.27)
30	4,326.96
31	(330,000.00)
32	(199,978.00)
33	(199,978.00)
34	(199,978.00)
35	(199,978.00)
SUM	(8,037,233.89)
IN %	(3)

First two months the cost variance of the project had negative value but the result was in thousands that is why the above chart look like the bar is on the line of zero. On the next month the cost variance of the project was going down to negative 988,164.19 birr then again at the end of 4th month the project tried to get back on the budget and it scored negative value but the variation cost was negative 12,092.74 birr it was better. After the 5th months negative 419,225.72 birr variation the project came back and scored the highest positive cost variation in execution stage of this project numerically the cost variation was positive 604,553.34 birr. Then after most of the time the project cost variation laid under neutral line of zero with the exceptional at the ends of 6th, 16th,19th, 20th, 28th and 30th the project was positive. The minimum cost variation of this project was recorded at the end of 29th month and it was scored only negative 218.27 birr it was very minimum it can be said that it was on the budget. Cumulative value of this project cost variance was negative 8,037,233.89 birr the major contributor for this cost variation was at the end of 12th month figuratively negative 2,044,109.06 birr it took 25.43% from overall cumulative cost variation. In percent the cumulative cost variation of this project was 3% of the projects cost. Generally speaking, for six months the project was under budget but for the rest 29 months the project was over budget.

Dormitory II

Table 17: Dormitory II CV

MONTHS	CV
1	(133,576.00)
2	(133,576.00)
3	(39,884.55)
4	(75,318.55)
5	(59,291.12)
6	(62,319.29)
7	(692,990.56)
8	(120,947.88)
9	(37,886.43)
10	(210,888.76)
SUM	(1,566,679.14)
IN %	(29.93)

First two months the chart showed that the cost variance was steady and scored negative 133,576.00 on that month the project needed correction to go back to budget. After that at the end of 3rd month the second minimum negative cost variance was scored by negative 39,884.55 birr. At the ends of 4th, 5th and 6th months the negative cost variation of the project increased and it seems it was steady then on the next month suddenly the project cost variance increased significantly to negative 692,990.56 birr. Then after the project tried to get back on the budget and recorded the lowest cost variation amount negative 37,886.43 birr. On the previous month of data collection the cost variance of the project was negative 210,888.76 birr. 173,002.32 increment from the previous month.

On this project from top to bottom all cost variances are negative indicate all months up to date construction works are over budget but as we compared to total cost of the project the variance is minimum. When we see cumulative the cost variance was negative 1,299,527.14 birr in percent 25% from the work performed. Generally this project cost variation was good enough but still it needs consideration and correction.

Library

Table 18: Library CV

Months	CV
1	(0.00)
2	(200,000.00)
3	0.00
4	463.41
5	(1,011.34)
6	2,120.41
7	(163,307.39)
8	(3,110.94)
9	825.61
10	(2,301.44)
11	(380.87)
SUM	(366,702.56)
IN %	(2)

As compared with above evaluated building construction projects this project performed very good cost variation performance. Above chart and table showed that at the end of the first month the budget was on budget but this stability was not extended to next month. At the end of 2nd month the project recorded the highest cost variance cost by negative 200,000.00 birr. At the end of 3rd month the project was back on budget. During the constructions months the project was under budget for three months at the ends 4th, 6th and 9th. This project also performed negative cost variations for six months but as we saw from the graph the major cost variations was conducted at the ends of 2nd and 7th months furthermore at the ends of 5th, 8th, 10th and 11th months there was negative cost variations figuratively 1,011.34 birr, 3,110.94 birr, 2,301.44 birr and 380.87 birr respectively. From four of them at the end of previous month of data collection the project scored the least negative cost variation.

This project has cost variance the same with others but in percent this project is the second lowest cost variance project in 2% in cost 366,702.56 birr. From monthly variances the 2nd months takes the led by 200,000 birr. In conclusion this project performed better cost variation through 11 months most of the time the project was on budget and under budget even the negative cost variations were was not too much just like above projects.

Hospital

Table 19: Hospital CV

Months	CV
1	(251,341.15)
2	(16,295.86)
3	(5,875.30)
4	(202,176.87)
5	(251,341.15)
6	(62,506.68)
7	(28,562.51)
8	(150,957.91)
9	(42,672.62)
SUM	(1,011,730.06)
IN %	(20.56)

On the beginning month of the project, the cost variation performance of the construction touched the negative number of 251,341.15 birr which was the highest variation cost for entire nine months but at the ends of 2nd and 3rd month the cost variation performance of the project continuously scored the least negative cost variation performance figuratively 16,295.86 and 5,875.30. Though this good cost variation performance was not went through this pace at the ends of 4th and 5th months the project cost variation was continuously negatively increased and again at the ends of 6th and 7th months the project tried to regain its cost variation performance. On the previous month of data collection the project cost variation scored negative 42,672.62 birr. The minimum cost variation of the project was recorded at the end of 3rd month by numerical value of negative 5,875.30 birr. The maximum cost variation was scored both at the ends of 1st and 5rd by 251,341.15.

In conclusion, all nine months cost variation was negative it means from the beginning of the project up to the end of 9th month the project was over budget. The cumulative cost of the variance was taking 10% of the work performed which was in birr 509,047.76 birr. The major contributor of this cumulative cost variation was contributed by 1st and 5th months each of them contribute 24.84 percent from the total cumulative cost of the project.

Canteen

Table 20: Canteen CV

Months	CV
1	(3,000.00)
2	(70,000.00)
3	(32,000.00)
4	(9,000.00)
5	(100,780.00)
6	(50,000.00)
7	(7,000.00)
8	(52,000.00)
9	(50,000.00)
10	(137,000.00)
11	(6,000.00)
SUM	(516,780.01)
IN %	(1)

On the first month the project cost variation was negative but with respect to other months this month cost variation was scored the closest cost variation by 3,000.00 birr. However, at the end of 2nd month the project earned value cost and actual cost was showed difference and at the ends of 3rd and 4th months the project regained its cost variation cost but at the end of 5th month the cost variation difference made gap. The project gone like this up and downs for the next 6 month and scored maximum of negative 137,000.00 birr at the end of 10th month. At the end of the previous month of data collection the cost variation was numerically -6,000.00 birr it was minimum but still there was over budget.

Generally, the variation amount of the project was insignificant as compared to others but still up to date months had variation. From all eleven months end of 10th month got higher variance value than other months by scored -137,000.00 birr. When we saw the cost variance percentage results the variance took only 1% of the work should be performed cost in money 516,780.01 birr. All in all months the cost variation of the project was negative in other words all 11 months the project was over budget.

4.6 Cost Performance Index (CPI)

All the values enumerated in the tables are rounded.

Classroom

Table 21: Classroom CPI

Months	CPI
1	1.00
2	1.00
3	1.41
4	1.28
5	1.00
6	1.00
7	0.95
8	1.34
9	0.86
10	0.87
11	0.87
12	0.87
13	0.87
14	0.90
15	0.85
16	0.90
17	0.82
18	0.87
19	0.87
20	0.93
21	0.87
AVERAGE	0.97

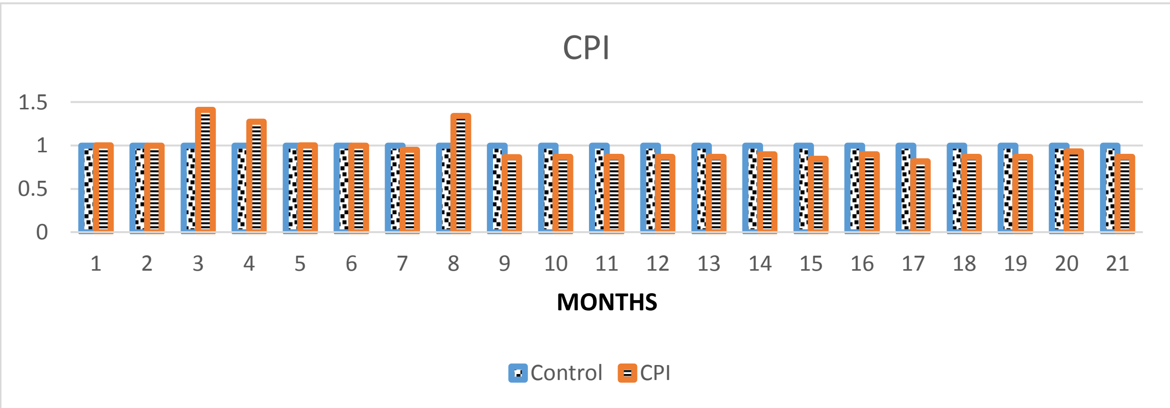

Figure 28: Classroom CPI

At the end of first and second months of the project the cost performance of the project was 100% nevertheless for the next two months the cost performance of the project placed on top of the control line which is one by which scored by 1.41 and 1.28 respectively. In other words at the end of 3rd and 4th month the work performed cost was 41 and 28 percent higher than from the actual cost of the project. And for the next two consecutive months the cost performance index of the project was labeled with control line. But at the end of 7th month the cost performance of the project showed 3% less from the control line though at the end of 8th month the project regained its good cost performance index capability rose up to 1.34, 34% higher than from the actual cost of the project. Next to all the rest 13 months the project could not recovered its cost performance and all thirteen months the project scored under control line with the maximum of 0.93 and with the minimum of 0.82.

Values of cost performance index greater than 1.0 indicate good project cost performance. Good cost performance may be reported if actual productivity is better than planned or if the measured percent of completed work is too high. Values of cost performance index less than 1.0 indicate poor cost performance, which may be a result of poorer than planned productivity or due to an underestimate of the measured percent of completed work.

Generally, the cost performance of this project was averagely tremendous up to at the end of 8th month which means the cost performance value was greater or equal to 1 but after that the cost performance getting drop to the minimum of 82%. Averagely the cost performance was 97% of the actual cost. It was good enough but there was poor cost performance.

Dormitory I

Table 22: Dormitory I CPI

Months	CPI
1	1.00
2	1.00
3	0.84
4	1.00
5	0.97
6	1.04
7	1.00
8	0.98

9	1.00
10	0.93
11	0.88
12	0.80
13	1.00
14	0.95
15	1.00
16	1.00
17	0.86
18	1.00
19	1.01
20	1.04
21	0.99
22	0.99
23	0.99
24	0.99
25	0.98
26	0.98
27	0.99
28	1.03
29	1.00
30	1.01
Average	0.97

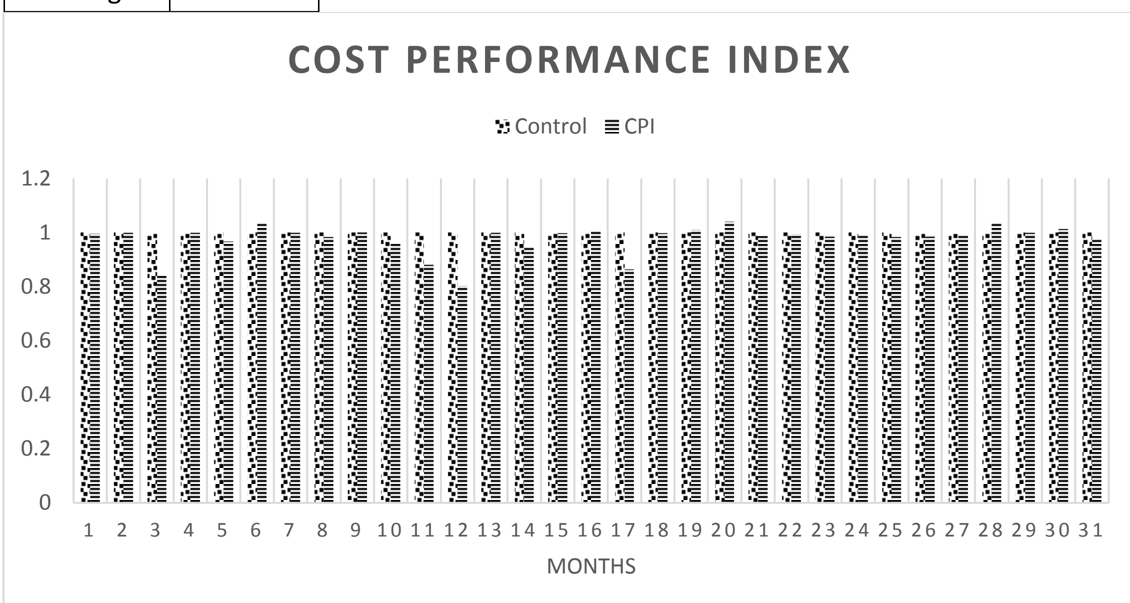

Figure 29: Dormitory I CPI

The cost performance of this project more of suspended below and on the control bar 1 which means the project was good and poor cost performance this result indicated the project cost estimation was good but when we look at the average of cost performance for all months still there was poor cost performance in minimum level numerically 97% from 100% which was 3% less. In other words the work performed cost of this project were equal or greater than the actual cost. The maximum and the minimum value of cost performance index of this project were 1.04 and 0.8 respectively.

Dormitory II

Table 23: Dormitory II CPI

Months	CPI
1	0
2	0
3	0.80
4	0.57
5	0.88
6	0.80
7	0.80
8	0.81
9	0.65
10	0.81
Average	0.77

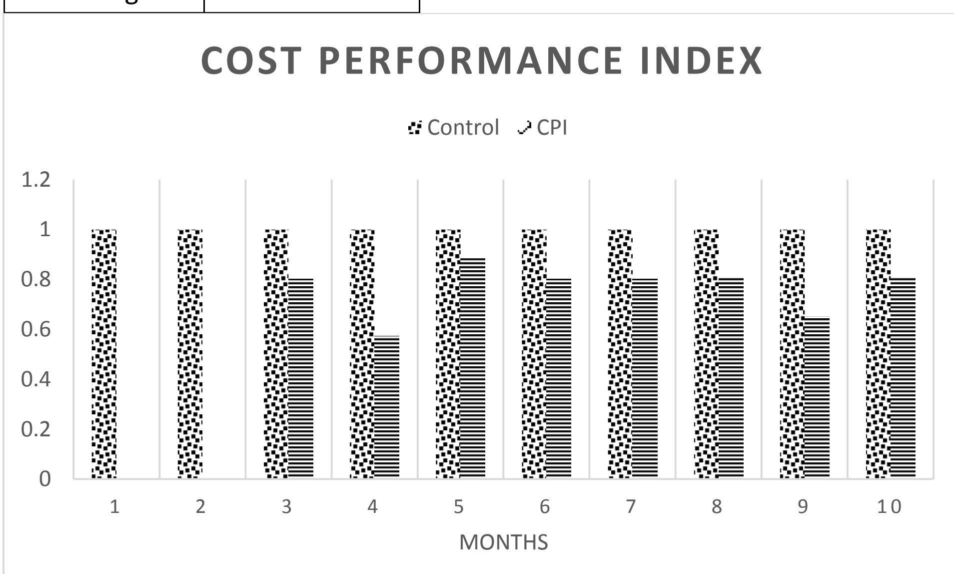

Figure 30: Project Three CPI

For the first two months the earned value cost of this project was zero in other words the construction did not began on this months. Next to that at the end of 3rd month scored the first numerical cost performance index of the project by 0.8 but on the previous month this less than 1 score dropped in to 0.57 almost 50% far from the control line. After that the project tried to recovered and verified 0.88 the maximum cost performance of this project. It was not good still the project needed 12% cost performance. But the project could not recovered and lined up with control line. At the ends of 6th, 7th and 8th months the above chart and table showed the cost performance was steady under control line. At the ends of 9th and 10th months the project scored 0.65 and 0.81 respectively. The month previous to the data collection was good as compared to end 9th month cost performance but the project still need close cost monitoring and controlling.

Generally, the cost performance of the construction project over budget. The maximum over budget was scored at the end of 4th month and the minimum was at the end of 5th month by scoring 0.57 and 0.88 respectively but both of them are less than 1 means over budget. When we look at the average, the average cost performance or the work performed cost of the project was 77% less of the actual cost incurred. Therefore the construction parties engaged in this building construction should be sit and identify and solve the problems to run back the project on 100% cost performance.

Library

Table 24: Library CPI

Months	CPI
1	1.00
2	0.87
3	1.00
4	1.00
5	1.00
6	1.00
7	0.95
8	1.00
9	1.01
10	1.00
11	1.00
Average	0.98

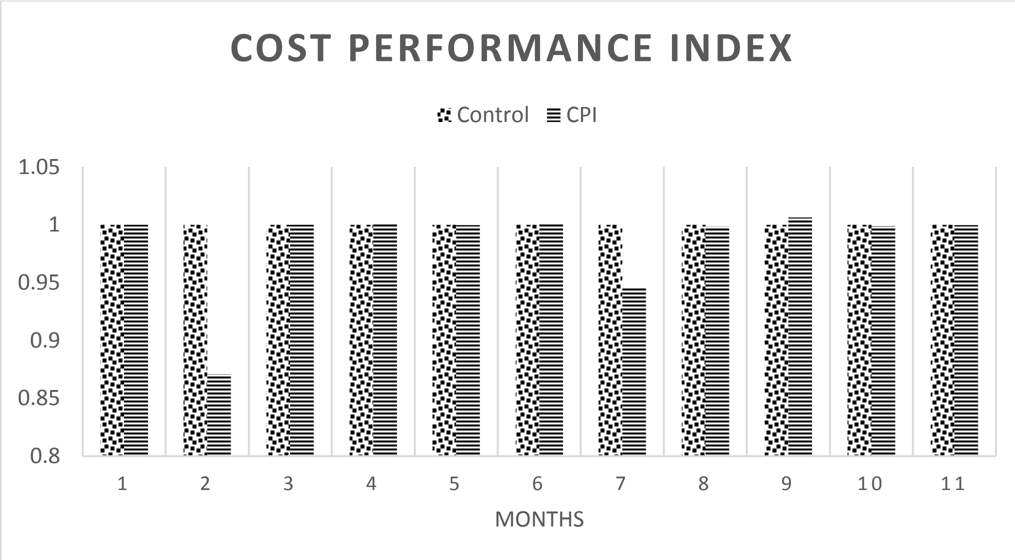

Figure 31: Library CPI

At the beginning of the project the cost performance of the project scored one labeled on the control line then unexpectedly the project scored the lowest cost performance index within 11 months by 0.13 less from the control line. But for the following four consecutive months the project steady and labeled with control line by the score of 1. By the sudden at the end of 7th month the cost performance of the project dropped and scored the second least score by 0.95 but this sudden down it was not stayed lifted up and labeled with control line even at the end of 9th month the project scored 1% higher from the control line. At the previous month of data collection the cost performance of the project was one.

Generally, all months with the exceptional of 2 months end of 2nd and 7th the project was most of the time on and under budget but still the average cost performance shows that the project is over budget. Figuratively the average cost performance of the project was 2% less of the cost incurred to date means 2% less than 100%. The project is now on good shape of cost performance but this cost performance does not guarantee for the future cost performance so that the project major constructing parties should be work more closely.

Hospital

Table 25: Hospital CPI

Months	CPI
1	0
2	0.94

3	0.98
4	0.55
5	0
6	0.95
7	0.97
8	0.84
9	0.97
Average	0.88

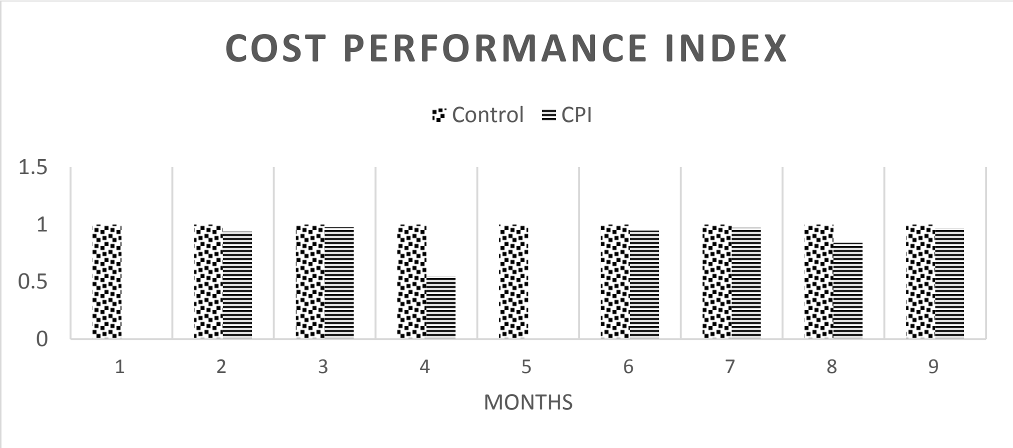

Figure 32: Hospital CPI

At the ends of 1st and 5th months the project was not performed any work thus the earned value cost of the project was zero it gives the project cost performance of these two months were zero. On the other hand at the ends of 2nd and 3rd month project cost performance increased to 0.94 and 0.98 respectively. Suddenly the cost performance of the project dropped and scored 0.55 the second lowest cost performance from the entire 9 months. After hit zero the project cost performance again rose up and got 0.95 and next to 6th month the project continued the better cost performance and spotted 0.97 the second highest cost performance. In between 7th and 9th months the project was scored 0.84. At the previous month of data collection the project recorded 0.97 which was 3% percent less from the actual incurred cost of the project.

Total speaking, excluding of 1st, 4th and 5th months, the other 6 months cost performance index were above 80% but when we say that it did not mean that the project was good or poor still the project was poor cost performance averagely with 12% less. For the 1st and 5th months the project was stopped so that the cost performance index of those two months were zero. Other than those months the maximum and the minimum cost performance index value were recorded on the end of 3rd and 4th months.

Canteen

Table 26: Canteen CPI

Months	CPI
1	1.00
2	0.98
3	1.00
4	1.00
5	0.97
6	1.00
7	1.00
8	0.99
9	0.99
10	0.97
11	1.00
Average	0.99

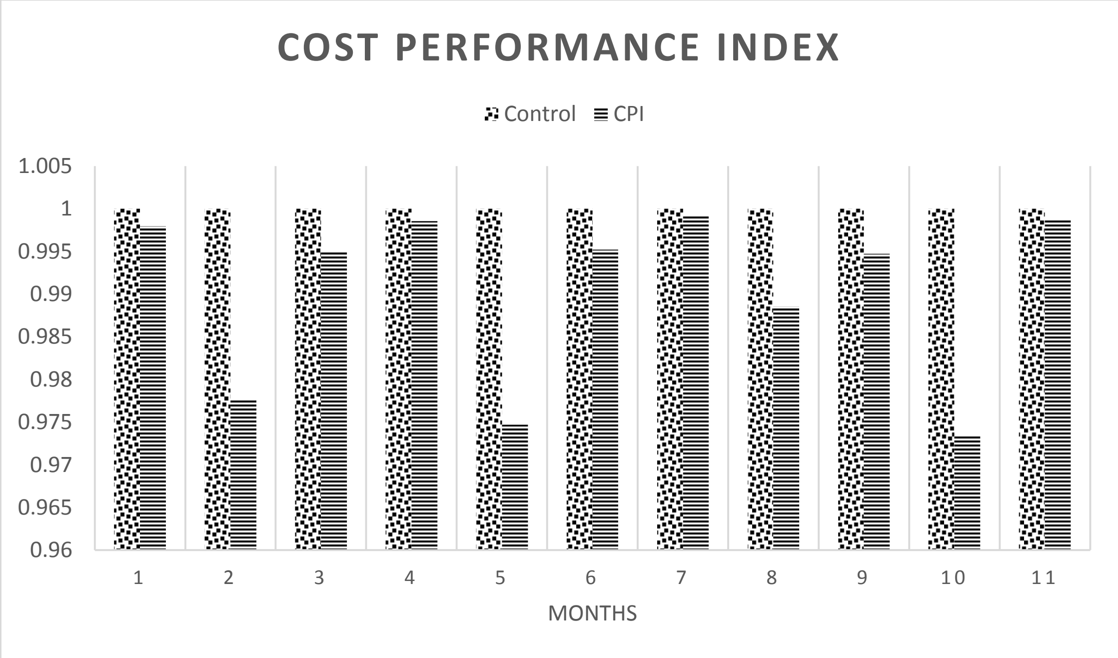

Figure 33: Canteen CPI

On the above chart and table showed that this construction project all cost performance index were greater than 0.97. At the beginning of the project cost performance was on the same spot with control chart line. On the following month cost performance of the project downed to 0.98 which was 0.02 less from the first month however for the next two consecutive months the project regained its cost performance labeled with control line. Unfortunately this cost performance did not showed on the 5th month. Next to 5th month the project rose up its cost performance just like 3rd and 4th month. At the ends of 8th and 9th months the cost performance of the project were in between of 0.985 and 0.99. After that at the end of 10th month the project scored the highest cost performance by 0.97. At the previous month of the data collection the project cost performance was recovered and back in to the track.

Generally, this project showed good cost performance for 6 months however 5 months were over budget but the maximum over budget was only deviate 3% from the control means from 1 or the actual cost incurred. From the table average cost performance index of this project was 99% from 100% up to end of 11th month the project was poor cost performance but the deviation was only 1%. So that this construction was better for cost performance but the project currently need close monitoring and controlling to clear 1% deviation.

4.7 Cost Forecasting

Dormitory II

Table 27: Dormitory II Forecasted Cost

Months	BAC	EAC
1	101,049,380.00	101,049,380.00
2	101,049,380.00	101,049,380.00
3	101,049,380.00	125,977,225.00
4	101,049,380.00	176,367,930.00
5	101,049,380.00	114,524,634.09
6	101,049,380.00	125,977,096.00
7	101,049,380.00	125,977,097.84
8	101,049,380.00	125,238,956.00
9	101,049,380.00	155,172,857.14
10	101,049,380.00	125,014,011.36

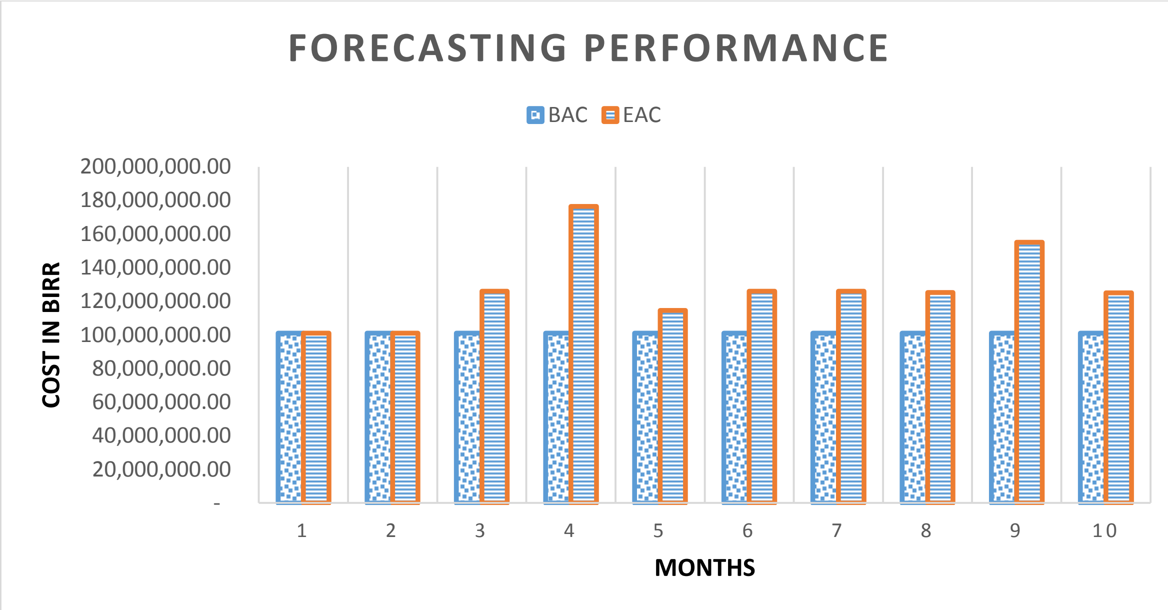

Figure 34: Monthly Dormitory II Forecasted Cost

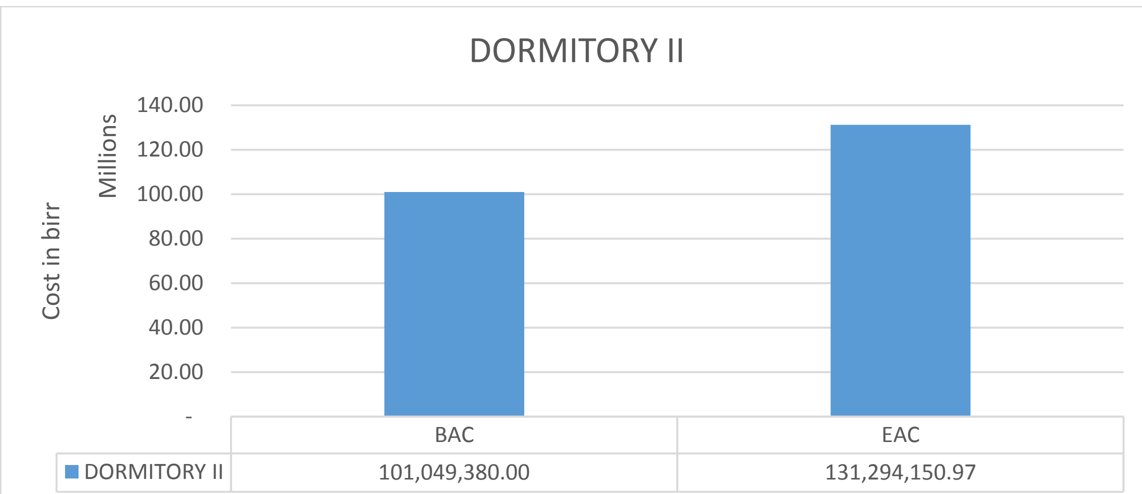

Figure 35: Dormitory II Forecasted Cost

Above chart and table illustrated the first two months the estimate cost at completion of this project was equal with the budgeted cost of the project though next 8 months EAC cost of the project was greater than planned cost because of the project indicated less work performed. The maximum estimation was conducted at the end of 4^{th} month i.e. 176,367,930 birr deviation of 75% from original cost. At the end of 10^{th} month the completion cost of the project was estimated to 125,014,930 birr 24% greater from the planned cost. Exceptional of the first two months, all 8 months estimation at completion cost were different with budgeted cost at completion. In all months except the two months the estimation at completion cost were larger than the budgeted cost at completion. Cumulatively, the budgeted cost of this project was 101,049,380.00 birr but the forecasted cost of this project showed 131,294,150.97 birr it means this project will not be finished as per the budgeted cost it will be increased 30M beyond the total planned cost.

Library

Table 28: Library Forecasted Cost

Months	BAC	EAC
1	49,287,262.00	49,287,262.18
2	49,287,262.00	56,586,532.12
3	49,287,262.00	49,287,261.99
4	49,287,262.00	49,266,666.22
5	49,287,262.00	49,301,021.77
6	49,287,262.00	49,216,107.38
7	49,287,262.00	52,122,459.72
8	49,287,262.00	49,350,880.37
9	49,287,262.00	48,981,481.48
10	49,287,262.00	49,344,228.22
11	49,287,262.00	49,296,332.46

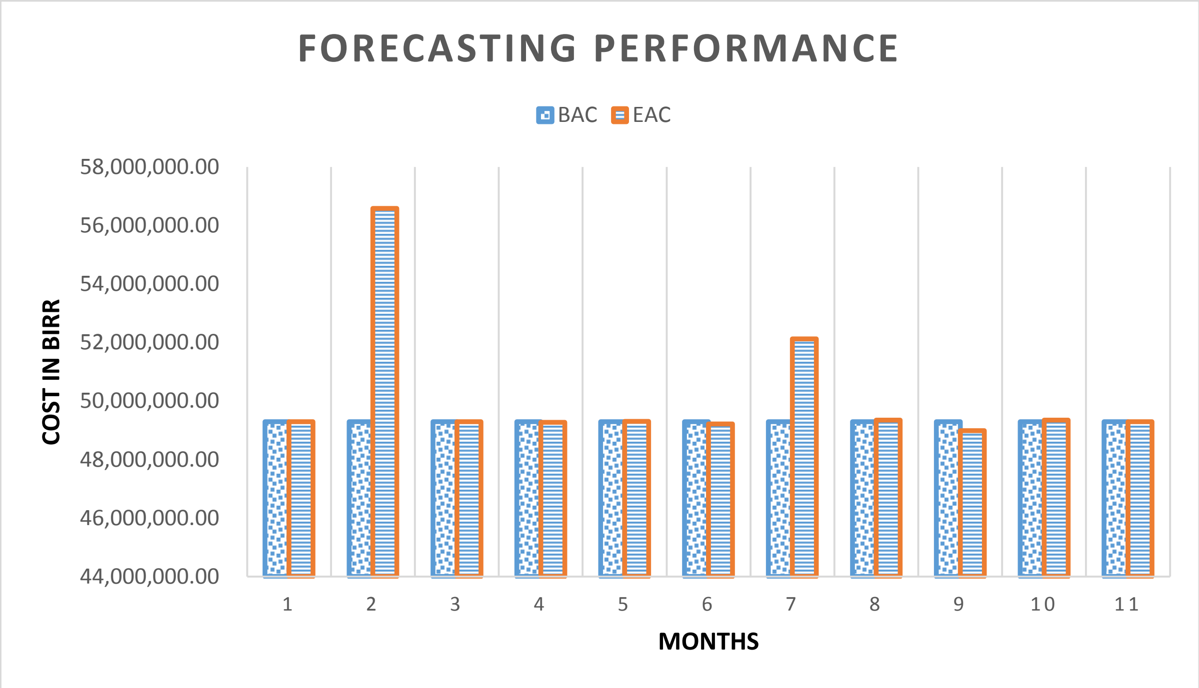

Figure 36: Monthly Library Forecasted Cost

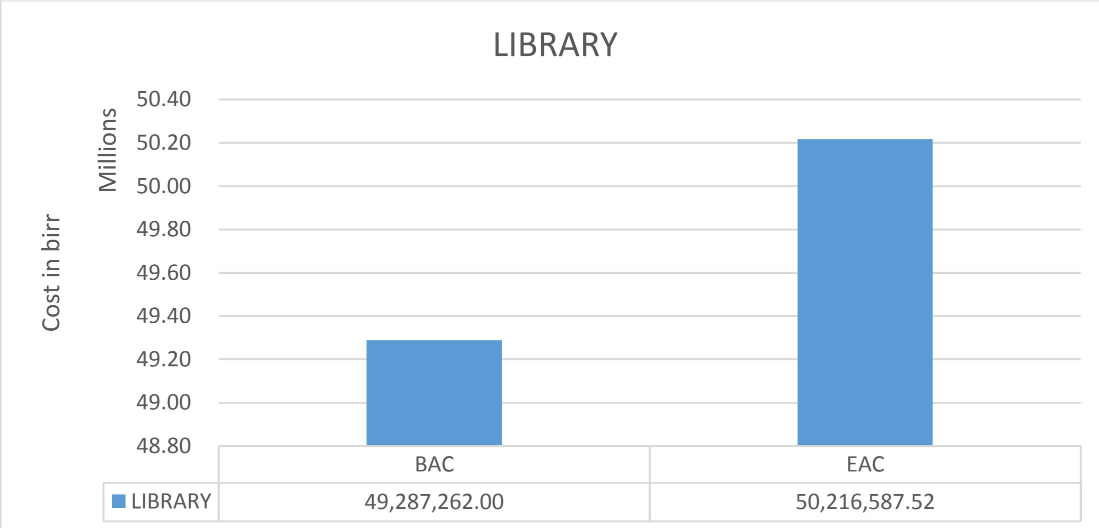

Figure 37: Library Forecasted Cost

Above table and chart presented most of months this project estimation cost were similar with budgeted cost but at the end of 2nd and 7th months the project forecasting estimation were significantly higher than the budgeted cost at completion. Specifically at the end of 2nd month the estimation cost of the project was 56,586,532.12 birr for 49,287,262.00 budgeted cost. However end of 9th month the estimation cost of the project was less than planned cost. At the end of 11th month the project is going back to the track and the estimated cost and the planned cost of the project was getting closer. Cumulatively, the forecasted cost of this project within 11 months was 50,216,587.52 birr and the budgeted cost of the project was 49,287,262.00 birr which was 1M difference.

Hospital

Table 29: Hospital Forecasted Cost

Months	BAC	EAC
1	53,535,339.54	53,535,339.54
2	53,535,339.54	57,075,434.98
3	53,535,339.54	54,811,683.64
4	53,535,339.54	97,456,027.47
5	53,535,339.54	53,535,339.54
6	53,535,339.54	56,601,539.25
7	53,535,339.54	55,156,019.73
8	53,535,339.54	63,603,652.94
9	53,535,339.54	55,234,059.03

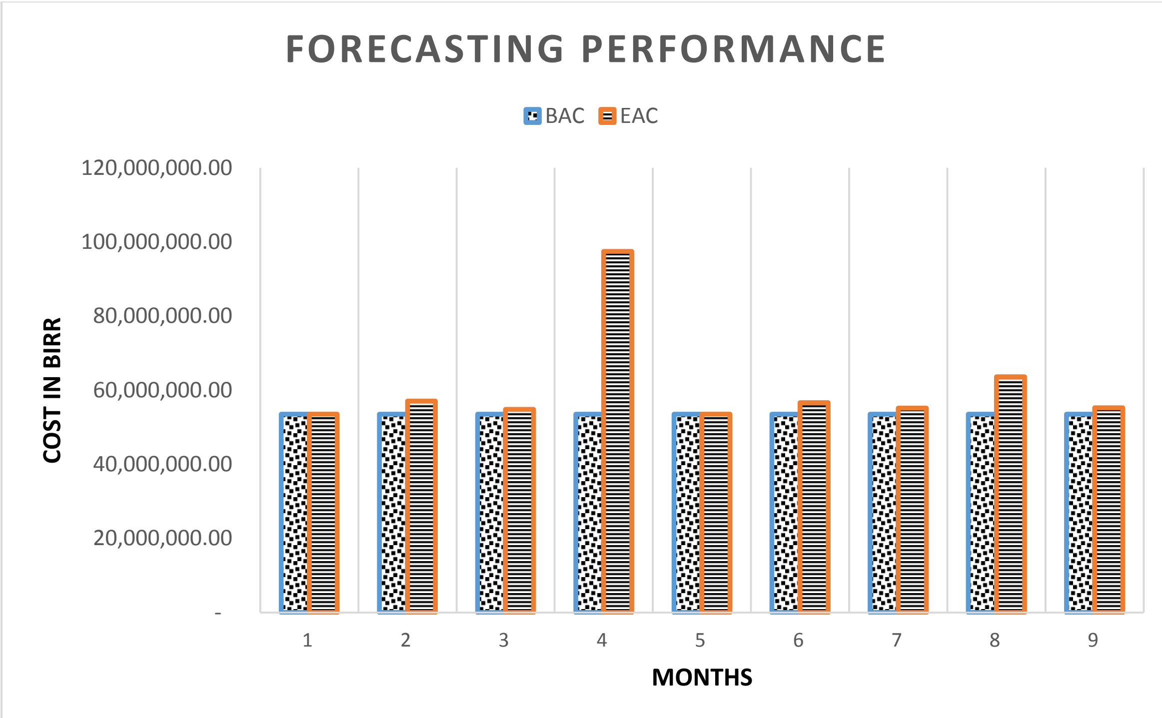

Figure 38: Monthly Hospital Forecasted Cost

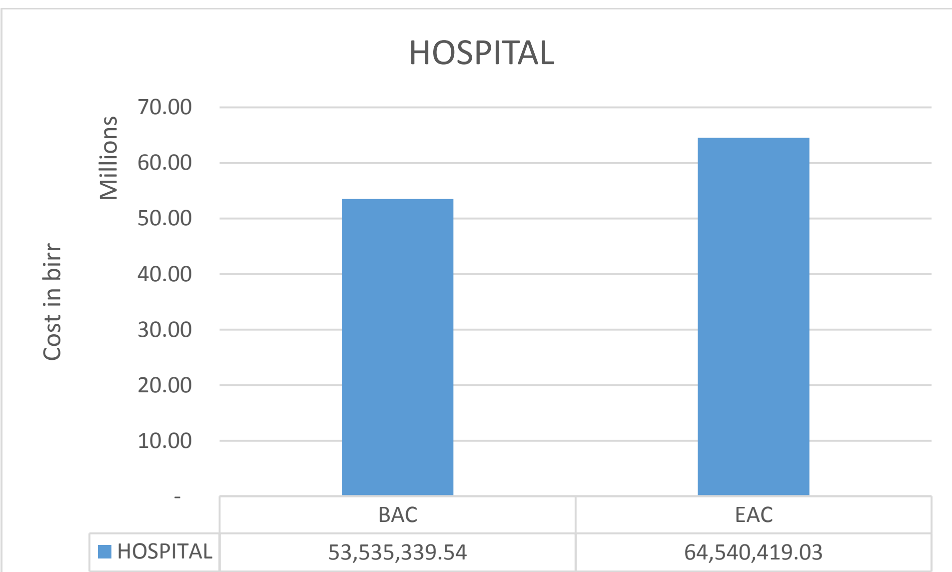

Figure 39: Hospital Forecasted Cost

On this project end of 1st and 5th months estimation showed that the estimation and the planned cost of the project were on the spot means the project will be completed with the same cost with planned. The rest 7 months the estimation cost performance of the project were greater than the planned cost of the project. The maximum estimation cost was recorded at the end of the 4th month figuratively 97,456,027.47 birr 82 percent from the original cost. At the end of 9th month the project completion cost was forecasted to 55,234,059.03 birr yet it had difference with budgeted cost but as compared to 4th month the project cost performance were decent. General conclude that with exceptional 4th all other months were similar with the budgeted cost at completion. Cumulatively, at the end of 9th month, project forecasted cost pointed 64,540,419.03 birr but the budgeted at completion cost of the project was 53,535,339.54 birr therefore end of 9th month forecasted cost showed the project will not be finished on budget or this project will be finished 11M birr increased cost from budgeted cost.

Canteen

Table 30: Monthly Canteen Forecasted Cost

Months	BAC	EAC
1	120,278,709.76	120,526,643.80
2	120,278,709.76	123,034,615.35
3	120,278,709.76	120,877,960.67
4	120,278,709.76	120,451,454.51
5	120,278,709.76	123,398,833.75
6	120,278,709.76	120,856,744.39
7	120,278,709.76	120,369,737.06
8	120,278,709.76	121,672,811.53
9	120,278,709.76	120,914,842.11
10	120,278,709.76	123,571,979.09
11	120,278,709.76	120,426,858.02

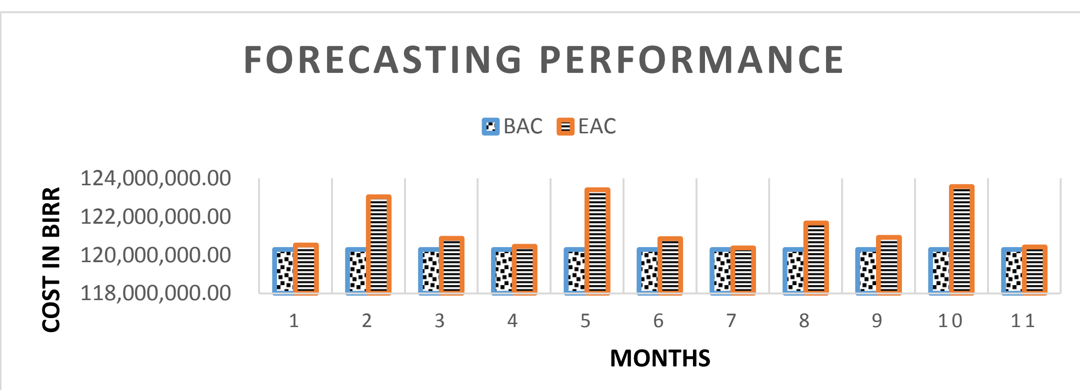

Figure 40: Monthly Canteen Forecasted Cost

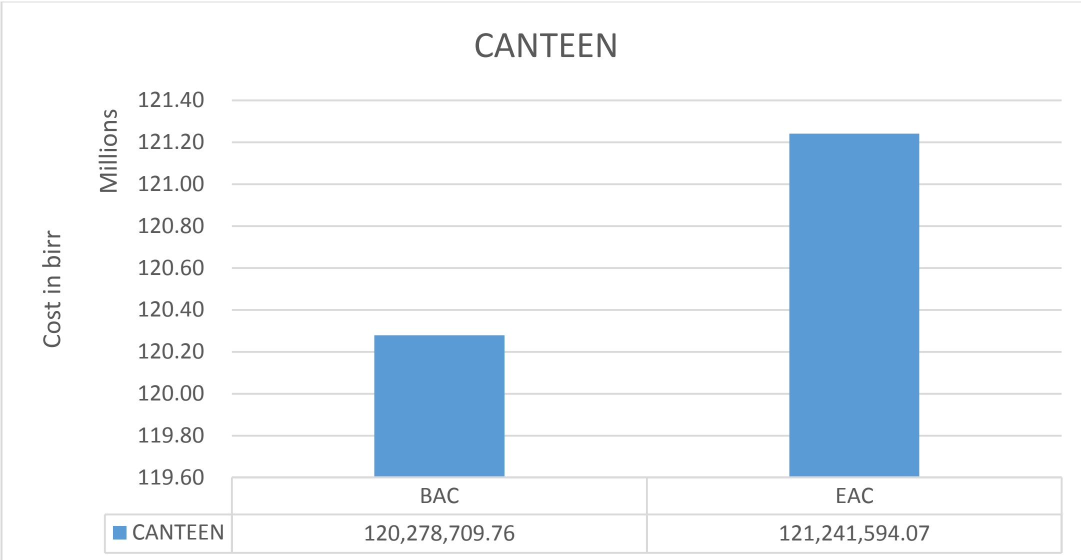

Figure 41: Canteen Forecasted Cost

Above graph and chart showed the maximum cost deviation generated between estimation and original cost were less than 3M yet there was difference but compared with above projects this project counted better cost performance than other construction projects. At the ends of 1st, 4th, 7th and 11th the closest difference were recorded and at the ends of 2nd, 5th, and 10th months the estimation cost showed highest gap. But the 11th month estimation showed the project come up with better cost performance and the cost estimation was close with planned cost. Cumulatively point of view, according to forecasted cost of this project it would be finished 121, 241, 594.07 birr which is 1M difference with budgeted cost at completion

4.8 Root Causes Responsible for Major Cost and Time Variations of the projects

A structured questionnaire survey approach was considered to study the causes of time and cost variations and rank those causes due to the influence on building construction projects performance. The questionnaire assist to study the attitude of owners, consultants and contractors towards responsible causes. These questionnaires were distributed to expert engineers such as projects managers, site engineers/office engineers and project engineer. They have a strong practical experience in construction industries field. Their sufficient experiences are a suitable indication for pilot study.

Twenty nine causes were considered in this study. The target groups in this research are owners, consultants and contractors. Totally thirty-six questionnaires were distributed as follows: 3 to owners, 8 to consultants and 25 to contractors. 32 questionnaires (89%) were received as follows: 3 (100%) from owners, 8 (100%) from consultants and 21 (84%) from contractors as respondents. The respondents are classified as projects managers, site engineers/office engineers and organizations managers, as they have a practical experience in construction industries field. Their sufficient experiences were a suitable indication to find out the perceptive of the relative importance of project performance indicators of the owner, consultant and contractor parties. The results were analyzed, discussed to obtain the most performance indicators. The relative importance index method (RII) was used here to rank the major responsible causes for schedule and cost variations in Jimma University building construction projects.

Table 31: Root Cause and Ranking

ROOT CAUSES OF MAJOR VARIATIONS	RII	RANK
Design change	0.912	1
Actual quantity of activity greater than planned	0.907	2
Shortage of skilled and unskilled labor	0.864	3
Time needed to implement variation orders	0.864	4
Cost of variation order	0.861	5
Climate condition in the site	0.835	6
Unable to have approved drawing on time	0.797	7
Material change	0.794	8
Material shortage on the market	0.781	9
Time needed to rectify defects	0.778	10
Poor material and equipment delivery	0.777	11
Poor financial capacity of the contractor	0.769	12
Employer interference	0.764	13
Delay due to site possession	0.749	14
Late transfer of service lines	0.746	15
Delay due to work suspension	0.744	16
Delay in claim approval	0.718	17
Poor sequencing of work according to schedule	0.718	18

Poor project time estimation	0.713	19
Local construction materials did not stocked	0.703	20
Poor site monitoring system	0.691	21
Poor communication with head office	0.549	22
Poor project cost estimation	0.547	23
Property rights problems	0.527	24
Poor manpower mobilization	0.518	25
resource utilization problem	0.518	26
Delay in payment for contractor	0.437	27
Delay due to provisional acceptance	0.375	28
Shortage of foreign currency	0.339	29

According to the above table; it was obtained that design change was main responsible root cause for major variations as it has the first rank among all other causes with relative index (RII) = 0.912. Design changes alters both time and cost of the project. For instance, on the 3rd month of classroom project, during the construction of - stone masonry, basement floor, grade beam and basement floor elevation column, the design of the basement floor and stone masonry height was changed. Dormitory I project also delayed due to change of cupboard size due to that 30 days was granted for supply, production and fixing. In addition to that main water supply lines were changed due to that the project was delayed for that reason the client was granted 46 days for the contractor. Again on the hospital project previous retaining wall design was changed to the project.

Studied building construction projects encountered cost and time variation secondly by actual quantity of activity greater than planned with relative index of 0.907. During discussion and desk study identified most of time actual and planned quantity of the activity deviation was majorly occurred on the excavation and earth work and also during discussion all respondents agreed that all projects were affected by this cause. In addition to earth work excavation on hospital project estimated numbers and size of trees were less than actually appeared.

Shortage of skilled and unskilled labor and time needed to implement variation orders has been ranked by the respondents in the third position and fourth position respectively with RII equal 0.864. Especially daily labor was the major challenging cause for all projects due to that the schedule of the project was affected. Mainly, on the classroom project it was very difficult to obtain aluminum and ceramic installation workers, in addition to that daily labor was another major challenge. Shortage of mason, plasterer and daily labor was also major challenge for library.

Cost of variation orders of the project were the fifth major cause for cost variation with RII equal to 0.861. Especially on the classroom project when LTZ changed to aluminum the cost of the project affected and when the PVC finish changed to ceramic tile. Again all of six projects were earth work excavation quantity was increased due to that the cost of the project changed.

Most of the project began on the summer seasons for that reason climate condition of site i.e. rain was the major challenge to perform the work according to the schedule. For instance, on dormitory I the client approved 50 additional days because of delay due to rainy season. On the fifth project the contractor claimed for rainy weather. On the library project at the month of commencement i.e. August the project time was majorly influenced by rain. During questionnaire collection the analysis showed that climate condition of the site was sixth major cause for time variation relative important index was equal to 0.835.

The questionnaire result showed that unable to have approved drawing on time was the seventh major responsible cause for time variation of the projects with relative importance index of 0.797. For instance on dormitory I the client granted 35 days for the delay of the bridge structural drawing for purchasing and supplying the materials. On the hospital project retaining wall structural drawing was not arrived on time due to that the project was delayed. On the dormitory II project due to delay of structural detail drawing and the contractor claimed 4,907,106.56 birr.

The above table listed material change of the project on the eighth place by scoring RII of 0.794. for instance, On the classroom project, at the 7th month starting from commencement month the contractor claimed material change initiated from client the changed materials were during planning the windows and some doors of the building were LTZ but at execution stage the client request to the contractor to change the LTZ to aluminum, the floor of computer rooms changed to wooden floor due to that the contractor requested additional 209 days but after evaluation the client approved 86 additional days, PVC tile finish also changed to ceramic tile due to that the contractor requested additional 195 days but after evaluation the client approved 151 additional days and all the doors are changed to MDF panel door. On dormitory I project also white marble is changed to granite marble on the meeting conducted according to the request the contractor and also water proofing and sanitary appliance materials was changed.

From the above the ninth ranked cause for the major time and cost variations was material shortage on the market questionnaire showed RII of the project was 0.781. For classroom project there were three major causes for cost and time variation the first cause was aluminum shortage for doors and windows installation next to that was ceramic shortage and the last but not the least cause was formwork shortage. Dormitory II project also tackled cost and time variation due to shortage formwork and scaffolding made of eucalyptus for concrete casting. During construction of fourth building around two materials were majorly shorted the first was HCB used for external wall and partition walls and the second electrical and sanitary material shortage. On dormitory I similar with the above this project was faced formwork shortage, secondly industrial materials used for finishing, for production of doors, windows and truss was shorted so that this shortage tackled the project to progress according to the work program, next the project was delayed due to marble finishing supply shortage therefore the contractor conducted meeting and change white marble with granite marble and eucalyptus tree scaffolding and form work. Like project three, materials used for HCB production and materials used for concrete production especially aggregates for concrete were shorted.

Time needed to rectify defects was tenth major cause for time variation from the questionnaire the relative importance index is equal to 0.778. During classroom project construction the waste water line needed rectification work. The cause was problem on elevation and slopes per actual site and existing man hole surveying data. On dormitory I, the project was delayed due to over flow of waste water out of septic tank and drainage system because of drainage system which is near the project site was blocked due to unknown reason and overflow on nearby areas and access to the site was not possible for some areas. Due to that the projects faced time and cost variation.

Poor material and equipment delivery was major cause for time and cost variations. From desk study, discussion and questionnaire result showed, compared with other projects dormitory I project and dormitory II project more influenced. On dormitory I project, late delivery of excavator and adequacy of mechanical mixers was decreased the daily output of concrete work and this project also had poor delivery of coarse aggregate, sand. On dormitory II project similar with above project late delivery of roller and grader affects the project time on earth work and again the contractor delayed delivery of selected borrow fill material and concrete aggregates especially coarse aggregate, sand for that reason the concrete work of the project behind the schedule and the next were fuel shortage for site vehicles and construction equipment. Library project also faced coarse aggregate shortage because of poor delivery of the material. According to questionnaire poor material and equipment delivery was listed eleventh and the RII equal to 0.777.

From all of six projects, dormitory II project time performance was majorly attacked by the financial capacity of the contractor. dormitory II project contractor could not perform the project according to the schedule for instance while the contractor tackled by finance the contractor could not delivered construction materials on time and could not assigned enough manpower to execute the construction as per schedule. Therefore the financial capacity of the contractor is not questionable. Questionnaire and discussion showed that hospital and canteen projects time performance also attacked by poor financial capacity of the contractor but not much as third project. The questionnaire result indicated that the financial capacity of the contractor is ranked at twelfth place by scoring RII value 0.769.

Employer was majorly interfere two building construction projects namely library project and canteen project. During library project execution, project site was occupied by private land owners due to that the employer did interfered to move out the land owners from construction site. On canteen project also, the site was engaged by court restricted construction equipments due to dispute between Jimma University and other construction company because of that the employer interfered to the construction project to move out the stagnant equipments from the construction site. Questionnaire relative importance index showed that RII of employer interference was 0.764 therefore it placed thirteenth.

The fourteenth major cause of cost and time variations of the projects were delay due to site possession with relative importance index of 0.749. Before the hospital project began the construction the project site was engaged by bee houses due to that the project was delayed more than twenty days to be removed. Similar with hospital project, canteen project site was possessed by other construction company's construction equipment because of unresolved dispute with the client. Court ordered not to move the equipment unless legal permission. Similar manner dormitory

I project recorded data showed project two was delayed due to site possession. On dormitory II project the septic tank site was possessed to move out the land owners due to that the contractor awarded 22 day additional time.

Late transfer of service lines was the fifteenth highest responsible cause for the project's cost and time variation with RII of 0.746. During execution of earth work and excavation on hospital project the contractor found telecom fiber optics cables passed through the project site and the telecom did not transfer the cable from the construction site on time because of the project delayed.

Sixteenth responsible cause for time and cost variation was delay due to work suspension. The relative importance index of this cause of variations was 0.744. On dormitory I project, due to the existence of road crosses to animal husbandry. The road was passes through the construction site. To resolve such problem and to construct alterative road the project was suspended. Due to that the contractor claimed additional time and the client and the consultant approved 32days.

According to questionnaire delay in claim approval and poor sequencing of work was listed seventeenth and eighteenth place they had the same RII value of 0.718. After the commencement of dormitory I project, in seventh month the consultant recommend to the contractor to execute activities according to original schedule. Similar manner on dormitory II project the contractor showed poor sequencing of work according to schedule.

According to questionnaire result the respondents argued that poor project time estimation was nineteenth major cause for deviation construction actual time with planned. From questionnaire analysis, poor project time estimation relative importance index equal to 0.713.

During commencement of dormitory I project and dormitory II project, local construction materials did not stocked before the project is fully active especially coarse aggregate, sand because of that sub and super structure concrete work was lagged as per schedule. Questionnaire result indicated local materials did not stocked was twentieth with RII of 0.703.

Poor site monitoring system was one of the major cause for time and cost variations in the projects from the questionnaire. Poor site monitoring also has a direct relationship with sequence of the activities. Poor site monitory system was placed twenty first with 0.691 relative importance index. Dormitory II project major cause for time and cost variation was poor site monitoring system due to that the sequencing of activities were did not proceeded according to the schedule because of that the project was not effective on time and cost.

Poor communication with head office in project has been ranked by the respondents in the position of twenty second with RII equal 0.549. It was obtained from record data and discussion that this cause majorly showed on dormitory II project. Project site information was not effectively, efficiently and on time transferred to head office.

All of six projects had cost variations due to design or material change or variation orders etc. some of respondents think that those variations were because of poor cost estimation and the respondents placed poor project cost estimation on twenty third with rank of 0.547.

Property right problem was the twenty fourth rank for the cause of time variation with RII value of 0.527. Library project construction site occupied by land owners due to that to move the land owners from the construction site with compensation the project was delayed. On the questionnaire analysis and ranking poor manpower mobilization was the twenty fifth cause by scoring relative importance index of 0.518. Especially first months of the dormitory I project, project mobilization was the major cause for the time and cost variation. On dormitory II project manpower mobilization was majorly affect project's time performance. Due to that the project faced manpower shortage.

Resource utilization problem was twenty sixth responsible cause for time variation with RII of 0.518. For instance, on dormitory II project resource utilization problem was the major time variation and because of this problem the project had the problems of manpower, equipment and material utilization.

The respondents from the questionnaire placed delay in payment for contractor on twenty seventh with RII of 0.437. During discussion the respondents said in sometimes the payment of the contractor delayed more than month during that time the payment was paid to the contractor for each day delay at specified rate stated in special condition of contract but it had influence on the construction time.

The respondents ranked delay due to provisional acceptance on twenty eighth root cause for time variation and it had RII equal to 0.375. From two finished projects dormitory I project was major victim. After finishing of dormitory I project the client could not provisionally accept the building on time and due to that the project was delayed as a result the contractor claimed and got approved 35 additional days from contract time.

After questionnaire data analysis, shortage of foreign currency had the twenty ninth rank with RII of 0.339. Dormitory I project used imported materials for the construction. During construction the project was delay due to shortage of foreign currency.

4.9 Summary of Findings

This study focused on evaluation of building construction project performance using earned value analysis and forecasted the cost of ongoing projects. After evaluating the parameters of earned value analysis, it use criterion such are: for cost and schedule variances to say the project is good performance the values should be zero or positive and for cost and schedule performance indices to say the project is good performance the value should be one or more than one.

Progress evaluation of all projects showed that planned cost was always on top of both EV and actual cost of the project and again mostly the actual cost was higher than EV cost both cumulatively and monthly it indicated that all projects were over budget and behind schedule. The major responsible causes for variations were design change, actual activity greater than planned and cost of variation works etc…

From all of six projects the maximum and the minimum schedule variation was scored on dormitory II and classroom projects respectively. Similarly maximum and minimum cost variation was recorded on dormitory II and canteen projects respectively. And CPI and SPI results showed the same thing with schedule and cost variance results. Future completion cost of dormitory II and hospital project showed the highest difference with their own budgeted completion cost.

Table 32: Summary of Findings

PROJECT	SV		SPI			CV		CPI			EAC	
	Highest	Lowest	Highest	Lowest	Average	Highest	Lowest	Highest	Lowest	Average	Highest	Lowest
Classroom	13,173,832.05	(23,581,159.37)	1.99	0	0.67	4,284,661.72	(2,889,702.45)	1.41	0.82	0.97	-	-
Dormitory I	1,306,914.47	(25,834,355.83)	1.15	0.30	0.53	604,553.34	(2,044,109.06)	1.01	0.80	0.97	-	-
Dormitory II	(5,153,518.38)	(10,034,203.43)	0.34	0	0.06	(37,886.43)	(692,990.56)	0.88	0	0.77	176,367,930.00	114,524,634.09
Library	(522,444.98)	(6,003,188.51)	0.87	0.02	0.47	2,120.41	(163,307.39)	1.00	0.87	0.98	56,586,532.12	48,981,481.48
Hospital	(1,729,191.47)	(4,802,475.11)	0.22	0	0.11	(5,875.30)	(251,341.15)	1.00	0	0.88	97,456,027.47	53,535,339.54

Canteen	(1,359,149.42)	(5,689,182.97)	0.80	0.44	0.57	(3,000.00)	(137,000.00)	1.00	0.97	0.99	123,571,979.09	120,369,737.06
Criteria	POSITIVE		GREATER THAN ONE			POSITIVE		GREATER THAN ONE			-	

NOTE: numbers inscribed in bracket indicate the negative value of the number

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

By using EVA, the progress of six building construction projects were evaluated and the results concluded that all of six projects cumulative planned cost was greater than cumulative earned value it means the projects were poor time performance again projects cumulative actual costs were greater than cumulative earned value it means that the projects showed poor in cost performance as well. From all of six projects, Dormitory II and Hospital projects showed highest poor time and cost performance.

To answer the second objective, the EVA includes;

- The first is schedule variance. According to the criteria, the schedule variance of the projects were less than zero. The negative sign determines that projects are lagging behind the original schedule. After the calculation of summation, the minimum schedule variation was scored classroom project was negative 91,515,976.48 birr variance simultaneously the maximum schedule variance scored on Dormitory II project. It delayed 78,545,683.07. All six projects schedule variance showed negative so that all projects were delayed with respect to the original plan.

- Secondly, the monthly as well as average amount efficiency of projects are demonstrated by schedule performance index for all selected projects were less than 1 hence project performed less efficiently and running less of the planned schedule. The maximum schedule performance index showed on the classroom project the average schedule performance index within scheduled months was 67% and the minimum schedule variance showed on the dormitory II project which was 6% from 100%. Generally, monthly and average schedule performance index showed that all six project were less than one i.e. behind the schedule.

- Cost Variance of the all projects had negative value i.e. the projects were over budget for overall cost. The negative value which depicts an unfavorable scenario. The maximum cost variation showed on Dormitory II project cumulative cost variance was

1,299,527.14 birr in percent 25% from the work performed and the minimum cost variance showed on canteen project results the variance took only 1% of the work should be performed cost in money 516,780.01 birr. All in all months all projects cost variations were negative in other words all projects were over budget so that all projects needs consideration and correction.

- Cost performance index indicates the project efficiency of project utilization. For best case scenario, it must be equal to 1 or higher. However all evaluated projects were less than 1, this showed that projects had low cost efficiency as compared to its spending. The maximum cost performance scored on canteen which was 99% from 100% only 1% and the minimum cost performance index showed on Dormitory II project which was 77% less of the actual cost incurred. All in all projects cost estimation was good but all projects need close evaluation and control i.e. the average cost performance all projects showed that all the projects, no matter the values were close to 1, showed poor cost performance.
- The future predictions have been detailed in this analysis, based on the final completion of this project, the estimation at completion forecast was calculated for ongoing projects from the beginning of project three. Dormitory II project forecasted completion cost showed 30M difference from budgeted cost and the minimum forecasted cost showed on canteen and library projects numerically 1M difference with their budgeted costs. the forecasted cost of library project within 11 months was 50,216,587.52 birr and the budgeted cost of the project was 49,287,262.00 birr and the forecasted cost of canteen project was 121, 241, 594.07 birr which was 1M difference with budgeted cost at completion.

Finally, according to Design change, actual quantity of activity greater than planned, Shortage of skilled and unskilled labor and cost needed to implement variation orders has been top four major responsible causes for time and cost variations by scoring RII of 0.912, 0.907, 0.864, and 0.861 respectively Suresh and Ramasamy (2015) argued that difference of estimated quantity of the activity with planned quantity is the responsible cause for cost and schedule variation and resource utilization problem, delay in payment for contractor, delay due to provisional acceptance and Delay due to shortage of foreign currency was bottom four rankings with RII of 0.518, 0.437, 0.375 and 0.339 respectively.

Above all result and discussion the researcher concluded that, throughout all variables the schedule variation and schedule performance of the projects were the dominant cause for performance of building construction projects.

5.2 Recommendation

It is necessary for owners and consultants in Jimma University to consider both design and material change and quantity of the activity before implementation of building construction project. Those causes are major responsible causes for time and cost variations. That will assist contractor to perform projects successfully and strongly. In addition, construction contractors are recommended to evaluate project overtime through project construction in order to enhance and improve time and cost performance of projects. Time needed to implement variation orders and to rectify defects should be estimated and scheduled without affecting project time completion. Having regular meeting among project participants can also enhance performance. Construction contractors should have different incentive systems in order to improve overall performance. In addition, they should have continuous safety training and meeting in order to apply safety factors and achieve better performance and it is re\commended for the contractors stock the construction materials and deliver the construction equipment as per schedule to facilitate and increase the performance of the project. Consultants should be delivered the construction drawings as per schedule in order to improve the performance and to fulfill owner’s satisfaction.

The future research in general will include probably new metrics in the EVA methodology to take into account issues like Risk Analysis or Quality and technical performance for an efficient project control. Implementation of EVA creates lot of extra work where it is difficult to integration of company’s planning, scheduling, budgeting, work authorization and cost accumulation processes with each other. All these project management constrains likely to exist on most projects. So future research should be aimed to reduce the extra work.

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APPENDICES

APPENDIX A: Tables for Earned Value Analysis

A1: CLASSROOM

Months	Planned	Cum % Completion	Actual
1	0	1.51	3,968,060.14
2	13,279,222.71	11.55	26,490,541.38
3	25,715,320.16	16.43	9,109,284.40
4	26,136,882.79	21.76	11,004,381.30
5	34,963,350.26	26.08	11,373,135.80
6	33,698,662.38	34.32	21,710,475.21
7	34,937,002.60	46.08	32,614,973.55
8	33,988,486.69	52.446	12,488,261.25
9	33,145,361.44	58.416	18,186,788.23
10	19,971,529.39	62.536	12,488,261.25
11	7,640,822.59	65.266	8,274,988.60
12		68.226	8,972,148.86
13		70.596	7,183,781.35
14		77.316	19,672,040.89
15		83.49	19,156,750.27
16		89.68	18,175,212.40
17		93.21	11,376,256.33
18		96.25	9,214,639.40
19		99.71	10,487,714.55
20		99.86	424,358.30
21		100	424,358.30

A2: DORMITORY I

Months	Planned	Cum. % Completion	Actual
1	3,920,743.41	0.54	1,649,404.50
2	8,935,647.78	3.91	10,256,096.74
3	16,746,741.25	5.60	6,124,642.00
4	24,223,507.76	9.42	11,622,356.18
5	27,050,090.22	13.39	12,485,389.56
6	33,675,842.66	19.18	16,993,201.98
7	30,636,506.68	23.64	13,570,147.35
8	35,134,723.93	27.36	11,493,857.17
9	36,806,358.72	30.97	10,977,004.48
10	39,876,088.06	38.67	24,363,923.17
11	16,230,054.13	41.09	8,352,711.21
12	14,163,305.67	43.81	10,311,102.93
13	16,533,987.73	48.51	14,299,791.60
14		53.81	17,021,568.23
15		62.61	26,824,093.92
16		71.69	27,493,971.14
17		73.76	7,281,204.56
18		79.02	16,033,487.57
19		81.92	8,727,907.30
20		85.49	10,434,791.48
21		88.85	10,351,659.20
22		92.62	11,525,514.25

23		95.34	8,392,519.52
24		96.44	3,377,379.31
25		97.35	2,812,392.16
26		98.75	4,323,984.92
27		99.14	1,199,560.05
28		99.81	1,967,892.26
29		99.89	243,365.15
30		100.00	330,000.00
31			330,000.00
32			199,978.00
33			199,978.00
34			199,978.00
35			199,978.00

A3: DORMITORY II

Months	Planned	Cum. % Completion	Actual
1	5,153,518.38	0	133,576.00
2	7,447,339.31	0	133,576.00
3	9,478,431.84	0.16	201,563.56
4	9,619,900.98	0.26	176,367.93
5	10,074,623.19	0.70	503,908.39
6	10,286,826.88	0.95	314,942.74
7	8,286,049.16	3.73	3,502,163.32
8	8,568,987.42	4.23	626,194.78
9	6,103,382.55	4.30	108,621.00
10	8,760,981.25	5.18	1,100,123.30
11	8,518,462.73		
12	8,750,876.31		

A4: LIBRARY

Months	Planned	Cum. % Completion	Actual
1	1,636,337.10	1.56	768,881.29
2	2,730,514.31	4.30	1,550,470.98
3	3,016,380.43	7.72	1,685,624.36
4	3,627,542.48	9.97	1,108,499.99
5	4,145,058.73	17.32	3,623,625.10
6	3,164,242.22	20.30	1,466,640.00
7	4,115,486.38	26.06	3,002,253.68
8	5,658,177.68	30.95	2,413,258.05
9	6,136,264.12	31.22	132,250.00
10	4,322,492.88	35.26	1,993,506.82
11	5,589,175.51	39.459	2,069,953.00
12	3,169,170.95		
13	1,976,419.21		

A5: HOSPITAL

Months	Planned	Cum. % Completion	Actual
1	1,729,191.47	0	251,341.15
2	2,323,433.74	0.35	262,731.15
3	2,773,130.59	0.70	252,310.59
4	4,020,504.00	1.05	448,612.16
5	4,432,726.11	1.05	251,341.15
6	5,187,574.40	2.60	1,153,862.96
7	5,605,150.05	3.94	972,057.62
8	5,605,150.05	5.08	953,632.85
9	6,028,079.23	6.99	1,387,505.20
10	6,659,796.24		
11	4,539,796.79		
12	2,928,383.07		
13	1,702,423.80		

A6: CANTEEN

Months	Planned	Cum. % Completion	Actual
1	2,814,521.81	1.21	1,458,372.39
2	6,819,802.84	3.75	3,125,079.23
3	8,876,568.78	9.09	6,454,883.10
4	11,859,480.78	14.30	6,275,520.78
5	8,732,234.33	17.53	3,985,782.33
6	13,062,267.88	26.18	10,454,108.39
7	13,567,438.46	33.87	9,256,432.78
8	10,175,578.85	37.60	4,538,395.87
9	15,082,950.20	45.46	9,503,906.59
10	9,357,683.62	49.62	5,140,594.33
11	8,852,513.04	53.67	4,877,287.75
12	5,184,012.39		
13	3,728,640.00		
14	2,165,016.78		

APPENDIX B: Questionnaire Data

No.	VARIATIONS CAUSES	ΣW	A	N	RII	RANK
1	Climate condition in the site	134	5	32	0.835	6
2	Design change	146	5	32	0.912	1
3	Unable to have approved drawing on time	128	5	32	0.797	7
4	Actual quantity of activity greater than planned	145	5	32	0.907	2
5	Poor material and equipment delivery	124	5	32	0.777	11
6	Shortage of skilled and unskilled labor	139	5	32	0.864	3
7	Time needed to rectify defects	125	5	32	0.778	10
8	Poor project time estimation	114	5	32	0.713	19
9	Time needed to implement variation orders	139	5	32	0.864	4
10	Poor manpower mobilization	82	5	32	0.518	25
11	Cost of variation order	138	5	32	0.861	5
12	Delay due to work suspension	119	5	32	0.744	16
13	Material change	127	5	32	0.794	8
14	Poor site monitoring system	110	5	32	0.691	21
15	Material shortage on the market	126	5	32	0.781	9
16	Shortage of foreign currency	54	5	32	0.339	29
17	Poor project cost estimation	87	5	32	0.547	23
18	Poor financial capacity of the contractor	123	5	32	0.769	12
19	resource utilization problem	82	5	32	0.518	26
20	Employer interference	122	5	32	0.764	13
21	Property rights problems	84	5	32	0.527	24
22	Poor sequencing of work according to schedule	115	5	32	0.718	18
23	Delay due to site possession	121	5	32	0.749	14
24	Delay in claim approval	115	5	32	0.718	17
25	Delay due to provisional acceptance	60	5	32	0.375	28
26	Late transfer of service lines	120	5	32	0.746	15
27	Poor communication with head office	88	5	32	0.549	22
28	Delay in payment for contractor	70	5	32	0.437	27
29	Local construction materials did not stocked	112	5	32	0.703	20

APPENDIX C: Questionnaire Data Collection

QUESTIONNAIRE FOR RESEARCH THESIS

Introduction

This questionnaire is prepared to obtain information from key informants with semi-structured questions. The information is required for the academic research entitled "evaluation on the performance of building construction projects using EVA: the case of Jimma zone", which is being conducted as partial fulfillment of MSc in construction engineering and management. The main objective of this questionnaire is to identify the main causes that leads to time and cost variations, and make recommendations based on the findings.

The questionnaire consists of three sections. Section A general organization information. Section B contains Root Causes for Major Variations in Building Construction Projects Located in Jimma University.

Your response, in this regard, is highly valuable and contributory to the outcome of the research. All feedback will be kept strictly confidential, and utilized for this academic research only.

Thank you,

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QUESTIONNAIRE FOR STAKEHOLDERS IN UNIVERSITY CONSTRUCTION PROJECTS

SECTION A: GENERAL ORGANIZATION INFORMATION

This questionnaire is to be completed by stakeholders i.e. clients, consultants and contractors involved in University construction projects. It seeks to investigate the major causes for time and cost variations in Jimma University.

1. State respondent organization/company type.

Client____________ Contractor_____________ Consultant__________

2. Respondents designation:

Owner of organization____________

Project manager___________

Site Engineer__________

Office Engineer___________

Resident Engineer___________

Site Supervisor______________

Other ________________

SECTION B: Root Causes for Major Variations in Building Construction Projects Located In Jimma University.

Please indicate the significance of each cause by ticking the appropriate boxes. Add any remarks relating to each factor on the last column e.g. as to the reasons, the critical causes or the solutions.

E.S. = extremely significant (5);
V.S. = very significant (4);
M.S. = moderately significant (3);
S.S. = slightly significant (2);
N.S. = not significant (1).

No.	Root causes for major variations	ES	VS	MS	SS	NS	Additional comment (If any)
1	Climate condition in the site						
2	Design change						
3	Unable to have approved drawing on time						
4	Actual quantity of activity greater than planned						
5	Poor material and equipment delivery						
6	Shortage of skilled and unskilled labor						
7	Time needed to rectify defects						
8	Poor project time estimation						
9	Time needed to implement variation orders						
10	Poor manpower mobilization						
11	Cost of variation order						
12	Delay due to work suspension						
13	Material change						
14	Poor site monitoring system						
15	Material shortage on the market						
16	Shortage of foreign currency						
17	Poor project cost estimation						
18	Poor financial capacity of the contractor						
19	resource utilization problem						
20	Employer interference						
21	Property rights problems						
22	Poor sequencing of work according to schedule						
23	Delay due to site possession						
24	Delay in claim approval						
25	Delay due to provisional acceptance						
26	Late transfer of service lines						
27	Poor communication with head office						
28	Delay in payment for contractor						
29	Local construction materials did not stocked						