

FLYOVER CONSTRUCTION-PERFORMANCE MEASUREMENT BASELINE (PMB) & EVM-EAC TECHNIQUE TO EVALUATE CONTRACT PERFORMANCE REPORT (CPR)

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Abstract: *This research aims to evaluate and improve the construction project management. A conceptual research framework was generally developed to perform a study of the project management performance from the contractor viewpoint wrt Performance Measurement Baseline (PMB) & EVM-EAC Technique to Evaluate Contractor Performance Report (CPR). In the literature that deals with construction project success and causes of quality, resource, time and cost overrun in the construction industry. Quality, time and cost are the four factors that play important roles in planning and controlling of construction projects. The project success is reflected by quality outputs standards, meeting time and budget objectives. The contractors are involved in this study to validate the research approach. It provides in key performance indicator (KPI) which can be evaluate and measure potential contractors as well as their capacity by requesting these indices. The finding can help construction firms to learn from the best practices of other and carry out continuous improvement. The research methodology has general use thus it may be applied to other contractors with minor modifications. The purpose of the CPR is to provide early identification of problems that may have significant cost, schedule and/or technical impacts, and report the effects of management actions and project status information for use in making and validating management decisions.*

Keywords: *Performance Measurement Baseline, Contract Performance Report, Earned Value Management, Project Management-P6*

1. INTRODUCTION

1.1 CONTRACT PERFORMANCE & PMB

The Contract Performance Report (CPR) is a contractually required report to the customer as defined in NHAI regulation. The importance and demand of CPR is to provide early identification of problems that may have significant cost, schedule and/or technical impacts, and report the effects of management actions and project status information for use in making and validating management decisions.

The CPR is normally prepared each month to formally provide technical, schedule and cost status information for company project management and for the government customer on major projects (typically Rs10 Cr or more or as defined in the contract). The purpose of the CPR is to provide early identification of problems that may have significant cost, schedule and/or technical impacts, and report the effects of management actions and project status information for use in making and validating management decisions.

Contract performance can be defined by the level and quality of projects delivered to clients. It has been a common practice however to select the least cost bidder among competing contractors to perform the job as per PMB. Predicting the performance of construction firms in such a situation is indispensable in order to ensure quality and guarantee international standards. Inefficient management of construction project can result in low performance and productivity. Therefore, it is important for contractors and construction firms to be familiar with the method leading to evaluate the performance of the construction project using contract performance report (CPR).

Performance measurement baseline is an approved integrated scope-schedule-cost plan for the project work against which project execution is compared to measure and manage performance. The PMB is formed by the budgets assigned to control accounts plus budget with identified scope that have not been distributed budget plus the undistributed budget. It does not include management reserve (MR).

Earned value management (EVM) is truly a state of the art methodology for project performance management.

Client's satisfaction is therefore a fundamental issue for construction participants who must constantly seek to improve their performance if they are to survive in the global marketplace. In the construction industry, the measurement of client's satisfaction is often associated with performance and quality assessment in the context of products or services received by the client (Soetanto & Proverbs 2004). Usually the client's requirements are to get construction needs translated into a design that specifies characteristics, performance criteria and conformance to specifications, besides to get the facilities built within cost and time.

Poor performance such as low quality, time delays and cost overrun are not uncommon in construction project (Lo et al., 2006). Frimpong et al., (2003) suggested that time delays and cost overruns arise primarily as a result of payment difficulties, poor contractor management, material procurement problems, poor technical ability, and escalation of material prices. On the other hand, some researchers have analyzed the major causes of quality defects, one of which Atkinson (1999) identified as human effort and another of which Love & Li (2000)

described as poor workmanship. These studies also contributed to the identification of quality, time and cost as the three most important indicators to measure construction project performance. Conversely this may not ensure quality which is an indispensable measure in project delivery. Predicting the performance of the contractor is highly important for both the contractor and the owner.

Quality performance is defined as the totality of features required by a product or services to satisfy a given need, or fitness for purpose (Parfitt & Sanvido 1993). In other words, the emphasis of quality in construction industry is on the ability to conform to established requirements. Requirements are the established characteristics of a product, process or service as specified in the contractual agreement and a characteristic is any specification or property that defines the nature of those products, processes or services, which are determined initially by the client. In order to achieve a completed project that meets the owner's quality expectations, all parties to a project must acquire an understanding of those expectations, incorporate them into the contract price and other contract documents to the extended possible, and commit in good faith to carry them out (Ganaway, 2006).

Time performance is very important for construction projects to be completed on time, as the clients, users, stakeholders and the general public usually looks at project success from the macro view where their first criterion for project success appeared to be the completion time (Lim & Mohamed 2000). Salter & Torbett (2003) mentioned that time variance is one of the techniques for assessing project performance in construction projects. The element of time could indicate to project managers that the project was not running as smoothly as scheduled.

Furthermore, the ensuring timely delivery of projects is one of the important needs of clients of the construction industry. Construction time can be regarded as the elapsed period from the commencement of site works to the completion and handover of a building to the client. The construction time of a building is usually specified before the commencement of construction. Construction time can also be deduced from the client's brief or derived by the construction planner from available project information.

Cost performance is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubshait & Almohawis, 1994). Salter & Torbett (2003) indicated that cost variance was the most common technique used to measure design performance. It is not only confined to the tender sum, but the overall cost that a project incurs from inception to completion, which includes any costs arise from variations, modification during construction period and the cost arising from the legal claims, such as litigation and arbitration. It can be measured in terms of unit cost, percentage of net variation over final cost (Chan & Tam, 2000). Cost variance is a very important factor in measuring project performance because it indicates how much the project is over or under budget. Georgy et al., (2005) suggested the element of cost to measure the performance of engineering projects. Hence, in this article, cost variance is calculated by the variance between the actual cost and the budgeted cost of a project.

Clients' satisfaction is regarded as a function of comparison between an individual's perception of an outcome and its expectation for that outcome. In the construction industry, client's satisfaction has remained an elusive and challenging issue for some considerable

time. Dissatisfaction is widely experienced by clients of the construction sector and may be caused by many aspects but is largely attributable to overrunning project costs, delayed completion, inferior quality and incompetent service providers including contractors and consultants. Client's satisfaction is therefore a fundamental issue for construction participants who must constantly seek to improve their performance if they are to survive in the global marketplace. In the construction industry, the measurement of client's satisfaction is often associated with performance and quality assessment in the context of products or services received by the client (Soetanto & Proverbs 2004). Usually the client's requirements are to get construction needs translated into a design that specifies characteristics, performance criteria and conformance to specifications, besides to get the facilities built within cost and time. Contract Decisions-Transferring or sharing risk via a contract, as a form of risk response, will lead to the involvement of third parties. This will have an impact on how the project work will be accomplished and how the budget consumption will occur and be monitored. The use of EVM to monitor the performance of subcontracted work requires proper consideration in the PMB. For example, the visibility of work accomplishments and budget consumption will depend on the type of contract and the terms agreed upon with the suppliers.

2. IMPORTANT EARNED VALUE MANAGEMENT, CPR, PMB TERMS

The basic terms associated with Earned Value Management

Planned Value (PV): It is the amount of money budgeted to be spent at a particular point of time.

Earned Value (EV): It is the amount of work in terms of cost that is actually accomplished at a particular point of time with respect to the planned value.

Actual Cost (AC): It is the actual amount of money spent for the corresponding planned and earned value.

Cost Variance (CV): It is the difference between Earned Value and Actual Cost. (EV-AC)

Schedule Variance (SV): It is the difference between Earned Value and Planned Value. (EV-PV)

Cost Performance Index (CPI): It is the ratio between Earned Value and Actual cost. If CPI greater than 1 then the project is under budget and CPI less than 1, then the project is under budget.

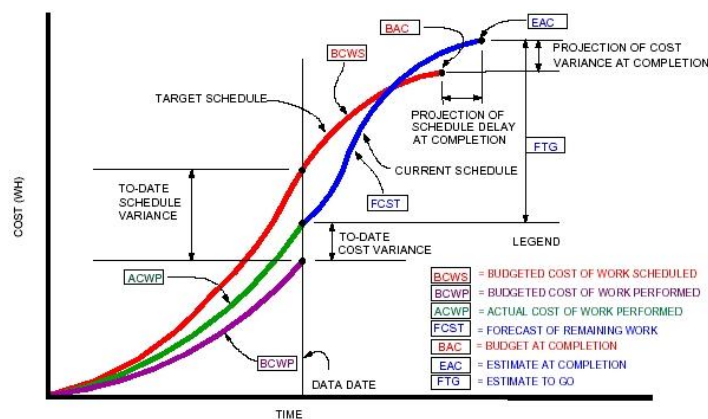


Fig.1 EVM-EAC Relationship

Schedule Performance Index (SPI): It is the ratio between Earned Value and Planned Value. It indicated how much ahead or behind schedule the project is at a particular point of time.

Critical Ratio (CR): It is the product of Cost Performance Index and Schedule Performance Index. It indicates the overall performance of the Project with respect to both cost and time.

Estimate at Completion (EAC): It's a prediction of the total project cost based upon the current trends in project performance.

Variance at Completion (VAC): It is the difference between the planned budgets at the beginning of the project to the Estimate at Completion. This value denotes how much more profit or loss the contractor will make on that Project.

Time Estimate at Completion (EACt): It predicts the completion time of a Project based on its current performance. $EACt = (BAC / SPI) / (BAC / \text{months})$

Performance measurement baseline (PMB) is an approved integrated scope-schedule-cost plan for the project work against which project execution is compared to measure and manage performance. The PMB is formed by the budgets assigned to control accounts plus budget with identified scope that have not been distributed budget plus the undistributed budget. It does not include management reserve (MR).

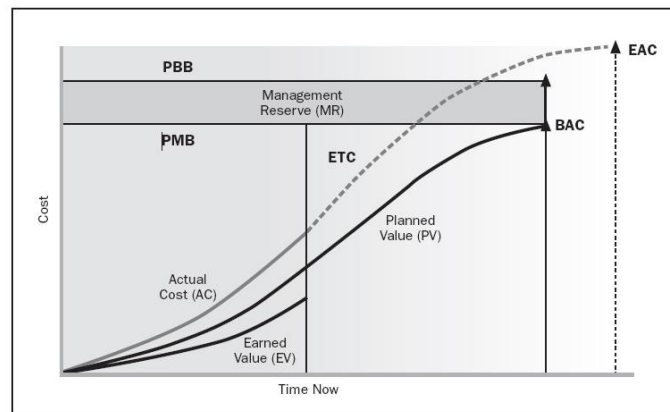


Fig.2 PMB, EAC & ETC Relationship

The performance measurement baseline (PMB) is the budget and schedule against which project performance is measured. It is formed by budgets and is assigned to control accounts, summary level planning budgets, and undistributed budgets. It equals the PBB minus the management reserve. The PMB is maintained by project management, and all changes within the PMB are approved by the project manager.

1 Undistributed Budget- refers to project work that has not yet been incorporated into the WBS during planning (and therefore not yet time-phased). It is a temporary holding account for newly authorized work and budget. In practice, this means that the UB is budget that has not yet been assigned to a control account or to an SLPB. At all times, it must be possible to identify the work that is associated with the UB.

2 Summary Level Planning Budgets desirably, all planned resources, including the resources issued from the undistributed budget to the PMB, should be distributed to control

accounts if at all practicable. However, because of the size, criticality, or multiple phases of the project, budgets may be authorized to a higher WBS element level (i.e., above the control account), with corresponding work scope and schedule identified on a project work authorization document—these are the summary level planning budgets (SLPB). These summary level planning budgets and their corresponding high-level tasks in the WBS (i.e., the summary level planning packages), are assigned to control accounts as soon as sufficient definition of the work is available.

3 Control Account Budgets-Control account budgets and their corresponding work are assigned and time-phased in accordance with an approved schedule and within control accounts, and may include both direct and indirect costs. Control accounts are time-phased according to the rolling wave concept, which requires detailed planning of work packages for as specified number of EV reporting time periods before the scheduled start of the work.

The sum of the budgets in a control account is the budget at completion (BAC) for that control account. The time-phased budget spread of all the resources required to accomplish the control account scope of work is called the planned value (PV). Therefore, the sum of all work package budgets plus the sum of all planning package budgets must equal the control account total budget, in each EV reporting period (typically one month) both incrementally and at completion.

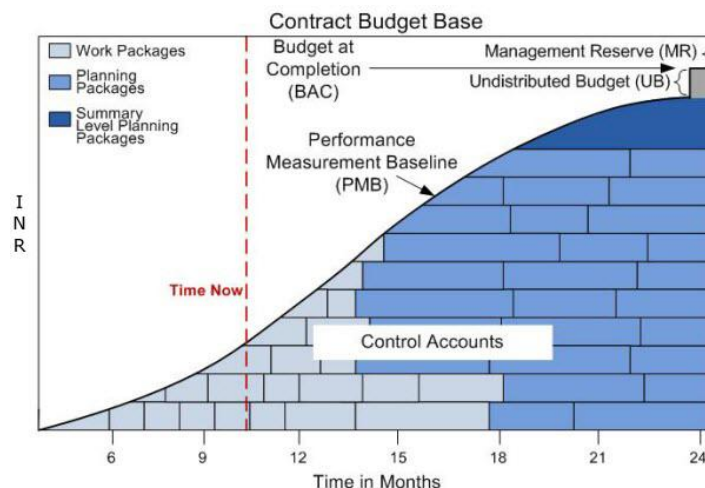


Fig.3 Contract Budget Base

The performance measurement baseline (PMB) must include, but is not limited to the following elements:

- Schedule start and completion dates for each work package and planning package in the WBS
- Budget for each work package and planning package, and its time-phased distribution, decomposed by the resources allocated.
- Time-phased distribution of the quantities of the resources allocated to each work package and planning package
- Description of the risks covered, including: their value, the time period to which they refer and possibly the types considered (for example, a cost reserve may include separate limited amounts for external services and for internal resources)

- List of constraints and assumptions regarding work progress, corresponding budget, and resource Consumption.

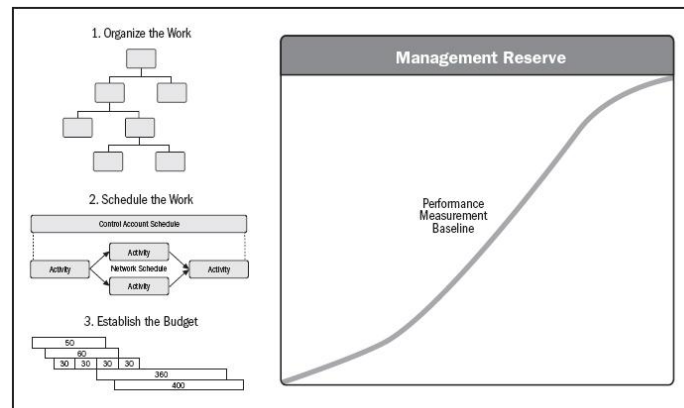


Fig.4 PMB formation Process

Project Control- Time and cost over-runs in Indian projects often discouraged owners from undertaking such projects. Control of road & flyover infraprojects must be catered-for in the planning stage itself. The parameters to be measured or assessed, the method and frequency of reporting, and the levels at which corrective decisions are to be taken, should all be planned in advance. Client owners of projects in India will benefit immensely by drawing their attention to some important aspects of project control and contract performance report evaluation such as:

1. Resource Scheduling
2. Financial Control
3. Budget Formulations and Periodic Review
4. Expenditure Reporting and

2.1 The Estimate at Completion - EAC

Project managers are continually asked by company management and the customer to verify that the project's cost and schedule goals can be met within the authorized budget, the Budget at Completion (BAC), and the Planned Completion Date (PCD). The Estimated at Completion (EAC) and the Estimated Completion Date (ECD) are the measures used to provide the answers to this question.

The Earned Value Guidelines define the EAC as the sum of the contract's cumulative to date Actual Cost of Work Performed (ACWP) plus the company project manager's best estimate of the time-phased resources (funds) required to complete the remaining authorized work, the Estimate to Complete (ETC). This relationship is often expressed by the formula $EAC = ACWP + ETC$. Thus, the EAC is a forecast of the project's final

cost. The project manager may revise work priorities, replan remaining tasks on the project schedule and/or adjust the technical approach to complete the project's goals within the estimated remaining resources. The goal is to complete all of the contract work scope within the Contract Target Cost (budget) and Contract Completion Date (schedule).

As with all estimates, the level of uncertainty of an EAC will vary with the type of remaining work, the available information, and the perceived remaining risks. Prudent management needs to know how valid an EAC is, especially when the EAC varies significantly from the project's authorized budget (BAC). Thus, the objectives of project management include the identification of the level of uncertainty associated with the remaining schedule, establishing the cost estimate for the remaining work, and managing the impact of the uncertainty upon the project cost goals.

For these reasons, the Contract Performance Report (CPR) and the Integrated Program Management Report (IPMR) require three separate EACs in an attempt to capture information regarding the level of cost uncertainty or the magnitude of the known project risks. These reports require EACs which represent the Best Case (or lowest potential cost), the Worst Case (or highest potential cost) and the Most Likely EAC (the project manager's best estimate) with their respective forecasted completion dates---generally referred to as Estimated Completion Dates (ECDs).

Financial statements published by issuers are required to be accurate and presented in a manner that does not contain incorrect statements. Note that the financial information on CPRs and IPMRs directly feed corporate annual reports and that serious overrun or underrun conditions will effect the profit statements in these reports. The Act also imposes penalties and fines and/or imprisonment for altering, destroying, mutilating, concealing, falsifying records, documents or tangible objects with the intent to obstruct, impede, or influence a legal investigation.

Since the actual cost to date is a known value, EAC uncertainty is a function of the Estimate to Complete. The ETC is prepared by re-estimating the resources required to complete the remaining authorized work using the cost experience to date and then applying a number of other factors; such as current direct and overhead rates, Schedule Risk Assessment (SRA), Monte Carlo simulations, root cause analysis, etc.

A well conceived ETC also considers purchase order commitments, anticipated labor efficiency and rate, material price and usage, Other Direct Cost (ODC) price and usage performance, risk and opportunities, resources by type, and other factors identified by higher management. Additionally, as the ETC is being developed it should be mapped to the current schedule consistent with the Estimated Completion Date (ECD).

As a means to cross-check the EAC, a mathematical or independent estimate of the EAC is typically prepared using performance indices based upon the cost and schedule experience to date. For example, the Cost Performance Index (CPI) (cumulative Budgeted Cost for Work Performed / ACWP) can be used to complete the EAC by dividing the project BAC by the CPI. The resulting EAC is often referred to as the Independent EAC (IEAC) to distinguish it from a formal or grass roots EAC. The IEAC can be quickly prepared and then used to test the reasonableness of the current cost estimate and to indicate when a comprehensive EAC should be undertaken. It is important to note that these calculations do not consider any "thinking" about the considerations mentioned above with respect to anticipated labor efficiency and rate, risk and opportunities, SRA, etc. It is often said that they are independent of sanity, logic and judgment but are calculated for comparative analysis---an important purpose.

The capability to regularly prepare an EAC along with the calculation of the Best Case, Worst Case, and Most Likely EACs is becoming an industry best practice. At least annually, a complete “bottoms-up” EAC, called the Comprehensive EAC, is required on those projects subject to the NHAI road and flyover Earned Value Management System requirements. A comprehensive EAC is also often prepared at the start of a major project phase; such as the start of production or construction. Consequently, it can reflect the reduced uncertainty resulting from a design release and/or a released bill of material, which enables the project manager to answer these questions:

- Are the remaining authorized funds sufficient to complete the project?
- Is prior cost experience a predictor of future cost performance?
- Should the remaining project be modified based upon the performance to date?
- Will the project cost performance impact the corporate financial condition?

Thus, a timely and realistic EAC and ECD should be an integral part of both project management and corporate financial management practices. Both should require routine comparison of the EAC and ECD with the contract targets to forecast realistic financial performance for customers and stockholders.

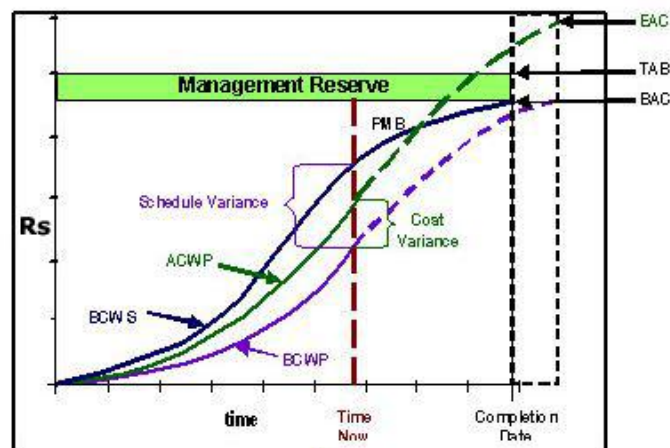


Fig.5 EVM-EAC CV & SV Relationship

2.2 Contract Performance Report (CPR)

The Contract Performance Report (CPR) is a contractually required report to the customer as defined in NHAI regulation.

The CPR is normally prepared each month to formally provide technical, schedule and cost status information for company project management and for the government customer on major projects (typically Rs200 Cr or more or as defined in the contract). The purpose of the CPR is to provide early identification of problems that may have significant cost, schedule and/or technical impacts, and report the effects of management actions and project status information for use in making and validating management decisions.

The report consists of five Formats, four contain data that measure the contractors' cost and schedule performance, and a fifth that addresses problem analysis, corrective action plans

and technical, schedule and cost impact explanations.

- Format 1 includes cost and schedule performance data by product-oriented Work Breakdown Structure (WBS) elements and includes hardware, software, and services.
- Format 2 provides the same data by the contractor's organization (functional or Integrated Product Team (IPT)) structure. Both Formats 1 and 2 include the current period and the cumulative to date Budgeted Cost for Work Scheduled (BCWS), Budgeted Cost for Work Performed (BCWP), Actual Cost of Work Performed (ACWP), their associated cost and schedule variances, the Budget at Completion (BAC) and Estimate at Completion (EAC) as well as the Variance at Completion (VAC).
- Format 3 provides the budget baseline plan against which performance is being measured as well as any changes during the reporting period.
- Format 4 provides staffing forecasts for correlation with the Estimate at Completion by the same organizational elements reported in Format 2.
- Format 5 is a narrative report used to explain significant cost and schedule variances reported in Format 1, other identified contract problems and topics, uses of Management Reserve and Undistributed Budget, an explanation of any significant shifts in the budget baseline reported on Format 3, and to provide technical, schedule and cost impacts based upon root cause analyses, corrective action plans and the anticipated results from those corrective action plans. Other explanations provided on Format 5 are the differences between the Best Case, Worst Case and Most Likely EACs. Format 5 provides the contractor's project manager an opportunity to address the overall health of the contract.

The content of the following deliverables should be considered during the development of the CPR:

- Project Charter
- Integrated Master Schedule
- Integrated Baseline Review
- Project Management Plan
- Test Plan
- Implementation Plan
- Training Plan
- Budget/Funding Deliverables & Activities
- Other Project Management Deliverables & Activities
- Change Requests
- Corrective Action Plan

Integrated Baseline Review (IBR) – During the IBR, the CPR is reviewed to ensure that it is consonant with the Work Breakdown Structure, the Schedule, and the Budget (the latter two often combined as a “time-phased budget”). This allows the government and the contractor to evaluate the readiness to start work with assurance that all required work will be monitored and controlled by the project team.

3. CONCLUSION & FUTURE SCOPE

In the years ahead, the construction industry in India has to overcome various challenges - be it with respect to housing, environment, transportation, road, fly-over and bridges. Technocrats associated with the Indian construction industry need to employ innovative technologies and skilled project handling strategies to overcome these challenges [Performance Measurement Baseline (PMB) & EVM-EAC Technique to Evaluate Contract Performance Report (CPR)]. The outstanding performance under demanding situations in the past CPR will stand in good stead and give confidence to the Indian construction industry to bring about an overall development in the infrastructure of the nation. The gains of large investments in the Infra-projects eventually will feedback to the construction industry itself in the form of better economy and improved work conditions. Predicting contract performance is of great importance especially in a highly competitive market such the case of the Indian construction market. The model described in this paper may serve a tool to predict the performance of the contractors in such markets. Application of the model in case study Fly-over construction to the case of the India is discussed and results obtained are presented. Cost and schedule records from previously accomplished projects by contractors were used to extract quantitative performance measures. Global software tool Primavera & Microsoft project help in infra project industry to evaluate contract performance report for decision making.

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