

CONTROL COSTS

Aastha Trehan, Ritika Grover, Prateek Puri
Dronacharya College Of Engineering, Gurgaon

Abstract- Project Cost Management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget. This paper describes in detail about the Control Costs. It is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline. It highlights the Inputs, Tools and Outputs of the control costs.

Index Terms- Project Cost Control, Earned Value Management (EVM), Forecasting, Performance Reviews, To-complete Performance Index (TCPI)

I. INTRODUCTION

Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline. The key benefit of this process is that it provides the means to recognize variance from the plan in order to take corrective action and minimize risk.

Updating the budget requires knowledge of the actual costs spent to date. Any increase to the authorized budget can only be approved through the Perform Integrated Change Control process (Section 4.5). Monitoring the expenditure of funds without regard to the value of work being accomplished for such expenditures has little value to the project, other than to allow the project team to stay within the authorized funding. Much of the effort of cost control involves analyzing the relationship between the consumption of project funds to the physical work being accomplished for such expenditures. The key to effective cost control is the management of the approved cost baseline and the changes to that baseline.

Project cost control includes:

- Influencing the factors that create changes to the authorized cost baseline;
- Ensuring that all change requests are acted on in a timely manner;

- Managing the actual changes when and as they occur;
- Ensuring that cost expenditures do not exceed the authorized funding by period, by WBS component, by activity, and in total for the project;
- Monitoring cost performance to isolate and understand variances from the approved cost baseline;
- Monitoring work performance against funds expended;
- Preventing unapproved changes from being included in the reported cost or resource usage;
- Informing appropriate stakeholders of all approved changes and associated cost; and
- Bringing expected cost overruns within acceptable limits.

II. CONTROL COSTS: INPUTS

A. Project Management Plan

The project management plan contains the following information that is used to control cost:

- **cost baseline:** The cost baseline is compared with actual results to determine if a change, corrective action, or preventive action is necessary.
- **cost management plan:** The cost management plan describes how the project costs will be managed and controlled .

B. Project Funding requirements

The project funding requirements include projected expenditures plus anticipated liabilities.

C. Work Performance data

Work performance data includes information about project progress, such as which activities have started, their progress, and which deliverables have finished. Information also includes costs that have been authorized and incurred.

D. Organizational Process Assets

The organizational process assets that can influence the Control Costs process include, but are not limited to:

- Existing formal and informal cost control-related policies, procedures, and guidelines;
- Cost control tools; and
- Monitoring and reporting methods to be used.

III. CONTROL COSTS: TOOLS AND TECHNIQUES

A. Earned Value Management

Earned value management (EVM) is a methodology that combines scope, schedule, and resource measurements to assess project performance and progress. It is a commonly used method of performance measurement for projects. It integrates the scope baseline with the cost baseline, along with the schedule baseline, to form the performance baseline, which helps the project management team assess and measure project performance and progress. It is a project management technique that requires the formation of an integrated baseline against which performance can be measured for the duration of the project. The principles of EVM can be applied to all projects in any industry. EVM develops and monitors three key dimensions for each work package and control account:

- **Planned value:** Planned value (PV) is the authorized budget assigned to scheduled work. It is the authorized budget planned for the work to be accomplished for an activity or work breakdown structure component, not including management reserve. This budget is allocated by phase over the life of the project, but at a given moment, planned value defines the physical work that should have been accomplished. The total of the PV is sometimes referred to as the performance measurement baseline (PMB). The total planned value for the project is also known as budget at completion (BAC).
- **Earned value:** Earned value (EV) is a measure of work performed expressed in terms of the budget authorized for that work. It is the budget associated with the authorized work that has been completed. The EV being measured needs to be related to the PMB, and the EV measured cannot be greater than the authorized PV budget for a component. The EV is often used to

calculate the percent complete of a project. Progress measurement criteria should be established for each WBS component to measure work in progress. Project managers monitor EV, both incrementally to determine current status and cumulatively to determine the long-term performance trends.

- **Actual cost:** Actual cost (AC) is the realized cost incurred for the work performed on an activity during a specific time period. It is the total cost incurred in accomplishing the work that the EV measured. The AC needs to correspond in definition to what was budgeted in the PV and measured in the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs). The AC will have no upper limit; whatever is spent to achieve the EV will be measured. Variances from the approved baseline will also be monitored:
- **Schedule variance :** Schedule variance (SV) is a measure of schedule performance expressed as the difference between the earned value and the planned value. It is the amount by which the project is ahead or behind the planned delivery date, at a given point in time. It is a measure of schedule performance on a project. It is equal to the earned value (EV) minus the planned value (PV). The EVM schedule variance is a useful metric in that it can indicate when a project is falling behind or is ahead of its baseline schedule. The EVM schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned. Schedule variance is best used in conjunction with critical path methodology (CPM) scheduling and risk management. Equation: $SV = EV - PV$
- **Cost variance:** Cost variance (CV) is the amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and the actual cost. It is a measure of cost performance on a project. It is equal to the earned value (EV) minus the actual cost (AC). The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent. The CV is particularly critical because it indicates the relationship of physical performance to the costs spent. Negative CV is often difficult for the project to recover. Equation: $CV = EV - AC$.

The SV and CV values can be converted to efficiency indicators to reflect the cost and schedule performance of any project for comparison against all other projects or within a portfolio of projects. The variances are useful for determining project status.

- Schedule performance index:** The schedule performance index (SPI) is a measure of schedule efficiency expressed as the ratio of earned value to planned value. It measures how efficiently the project team is using its time. It is sometimes used in conjunction with the cost performance index (CPI) to forecast the final project completion estimates. An SPI value less than 1.0 indicates less work was completed than was planned. An SPI greater than 1.0 indicates that more work was completed than was planned. Since the SPI measures all project work, the performance on the critical path also needs to be analyzed to determine whether the project will finish ahead of or behind its planned finish date. The SPI is equal to the ratio of the EV to the PV. Equation: $SPI = EV/PV$.
- Cost performance index:** The cost performance index (CPI) is a measure of the cost efficiency of budgeted resources, expressed as a ratio of earned value to actual cost. It is considered the most critical EVM metric and measures the cost efficiency for the work completed. A CPI value of less than 1.0 indicates a cost overrun for work completed. A CPI value greater than 1.0 indicates a cost underrun of performance to date. The CPI is equal to the ratio of the EV to the AC. The indices are useful for determining project status and providing a basis for estimating project cost and schedule outcome. Equation: $CPI = EV/AC$ The three parameters of planned value, earned value, and actual cost can be monitored and reported on both a period-by-period basis (typically weekly or monthly) and on a cumulative basis.

B. Forecasting

As the project progresses, the project team may develop a forecast for the estimate at completion (EAC) that may differ from the budget at completion (BAC) based on the project performance. If it becomes obvious that the BAC is no longer viable, the project manager should consider the forecasted EAC. Forecasting the EAC involves making projections of conditions and events in the project's future based on current performance information and other knowledge available at the time of the forecast.

Forecasts are generated, updated, and reissued based on work performance data that is provided as the project is executed. The work performance information covers the project's past performance and any information that could impact the project in the future.

EACs are typically based on the actual costs incurred for work completed, plus an estimate to complete (ETC) the remaining work. It is incumbent on the project team to predict what it may encounter to perform the ETC, based on its experience to date. The EVM method works well in conjunction with manual forecasts of the required EAC costs. The most common EAC forecasting approach is a manual, bottom-up summation by the project manager and project team.

The project manager's bottom-up EAC method builds upon the actual costs and experience incurred for the work completed, and requires a new estimate to complete the remaining project work. Equation: $EAC = AC + \text{Bottom-up ETC}$.

The project manager's manual EAC is quickly compared with a range of calculated EACs representing various risk scenarios. When calculating EAC values, the cumulative CPI and SPI values are typically used. While EVM data quickly provide many statistical EACs, only three of the more common methods are described as follows:

- EAC forecast for Etc work performed at the budgeted rate. This EAC method accepts the actual project performance to date (whether favorable or unfavorable) as represented by the actual costs, and predicts that all future ETC work will be accomplished at the budgeted rate. When actual performance is unfavorable, the assumption that future performance will improve should be accepted only when supported by project risk analysis. Equation: $EAC = AC + (BAC - EV) \cdot CPI$ EAC forecast for Etc work performed at the present cPI. This method assumes what the project has experienced to date can be expected to continue in the future. The ETC work is assumed to be performed at the same cumulative cost performance index (CPI) as that incurred by the project to date. Equation: $EAC = BAC / CPI$
- EAC forecast for Etc work considering both SPI and cPI factors. In this forecast, the ETC work will be performed at an efficiency rate that considers both the cost and schedule performance indices. This method is most useful when the project schedule is a factor impacting the ETC effort. Variations of this method weight

the CPI and SPI at different values (e.g., 80/20, 50/50, or some other ratio) according to the project manager's judgment. Equation: $EAC = AC + [(BAC - EV) / (CPI \times SPI)]$ Each of these approaches is applicable for any given project and will provide the project management team with an "early warning" signal if the EAC forecasts are not within acceptable tolerances.

C. To-complete Performance Index (TCPI)

The to-complete performance index (TCPI) is a measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget. TCPI is the calculated cost performance index that is achieved on the remaining work to meet a specified management goal, such as the BAC or the EAC. If it becomes obvious that the BAC is no longer viable, the project manager should consider the forecasted EAC. Once approved, the EAC may replace the BAC in the TCPI calculation. The equation for the TCPI based on the BAC: $(BAC - EV) / (BAC - AC)$.

The equation for the TCPI is shown in the lower left as the work remaining (defined as the BAC minus the EV) divided by the funds remaining (which can be either the BAC minus the AC, or the EAC minus the AC).

If the cumulative CPI falls below the baseline, all future work of the project will need to be performed immediately in the range of the TCPI (BAC) to stay within the authorized BAC. Whether this level of performance is achievable is a judgment call based on a number of considerations, including risk, schedule, and technical performance. This level of performance is displayed as the TCPI (EAC) line. The equation for the TCPI based on the EAC: $(BAC - EV) / (EAC - AC)$.

D. Performance reviews

Performance reviews compare cost performance over time, schedule activities or work packages overrunning and under running the budget, and estimated funds needed to complete work in progress. If EVM is being used, the following information is determined:

1. **Variance analysis:** Variance analysis, as used in EVM, is the explanation (cause, impact, and corrective actions) for cost (CV

= EV - AC), schedule (SV = EV - PV), and variance at completion (VAC = BAC - EAC) variances. Cost and schedule variances are the most frequently analyzed measurements. For projects not using earned value management, similar variance analyses can be performed by comparing planned activity cost against actual activity cost to identify variances between the cost baseline and actual project performance. Further analysis can be performed to determine the cause and degree of variance relative to the schedule baseline and any corrective or preventative actions needed. Cost performance measurements are used to assess the magnitude of variation to the original cost baseline. An important aspect of project cost control includes determining the cause and degree of variance relative to the cost baseline and deciding whether corrective or preventive action is required. The percentage range of acceptable variances will tend to decrease as more work is accomplished.

2. **Trend analysis:** Trend analysis examines project performance over time to determine if performance is improving or deteriorating. Graphical analysis techniques are valuable for understanding performance to date and for comparison to future performance goals in the form of BAC versus EAC and completion dates.
3. **Earned value performance:** Earned value performance compares the performance measurement baseline to actual schedule and cost performance. If EVM is not being used, then the analysis of the cost baseline against actual costs for the work performed is used for cost performance comparisons.

E. Project Management Software

Project management software is often used to monitor the three EVM dimensions (PV, EV, and AC), to display graphical trends, and to forecast a range of possible final project results.

F. Reserve Analysis

During cost control, reserve analysis is used to monitor the status of contingency and management reserves for the project to determine if these reserves are still needed or if additional reserves need to be

requested. As work on the project progresses, these reserves may be used as planned to cover the cost of risk mitigation events or other contingencies. Or, if the probable risk events do not occur, the unused contingency reserves may be removed from the project budget to free up resources for other projects or operations. Additional risk analysis during the project may reveal a need to request that additional reserves be added to the project budget.

IV. CONTROL COSTS: OUTPUTS

A. Work Performance Information

The calculated CV, SV, CPI, SPI, TCPI, and VAC values for WBS components, in particular the work packages and control accounts, are documented and communicated to stakeholders.

B. Cost Forecasts

Either a calculated EAC value or a bottom-up EAC value is documented and communicated to stakeholders.

C. Change Requests

Analysis of project performance may result in a change request to the cost baseline or other components of the project management plan. Change requests may include preventive or corrective actions, and are processed for review and disposition through the Perform Integrated Change Control process

D. Project Management Plan Updates

Elements of the project management plan that may be updated include, but are not limited to:

- **Cost baseline:** Changes to the cost baseline are incorporated in response to approved changes in scope, activity resources, or cost estimates. In some cases, cost variances can be so severe that a revised cost baseline is needed to provide a realistic basis for performance measurement.
- **Cost management plan:** Changes to the cost management plan, such as changes to control thresholds or specified levels of accuracy required in managing the project's cost, are incorporated in response to feedback from relevant stakeholders.

E. Project Documents Updates

Project documents that may be updated include, but are not limited to:

- Cost estimates, and
- Basis of estimates.

F. Organizational Process Assets Updates

Organizational process assets that may be updated include, but are not limited to:

- Causes of variances
- Corrective action chosen and the reasons,
- Financial databases, and
- Other types of lessons learned from project cost control.

V. CONCLUSION

Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline. There are possibilities of variances in the budgeted costs and the actual costs. This paper details the tools and techniques to control costs and also the methods for forecasting the EAC (Estimate at Completion) viz-a-viz the BAC (Budget at Completion). It also highlights the key inputs for cost control, i.e., EVM, Forecasting, TCPI, Performance reviews, project Management Software and Reserve Analysis to achieve the desired outputs in the form of Work Performance Information, Cost Forecasts, Change Requests, Project Management Plan Updates, Project documents Updates and Organizational Process Assets Updates.

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