Team Project: Cost Management in Project Management

ETM 545 - Project Management in Engineering and Technology

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1. Abstract

This paper aims to provide a detailed analysis of cost management in the context of project management and provides a brief description of the tools and techniques used in the process of cost management. The project methodology comprises use of both primary and secondary sources for research. The paper begins by identifying the importance of cost management in project management. Cost management is the process which allows companies to control and plan the costs involved in doing a business. It allows a business to predict future expenditures to help reduce the chance of going over budget. Starting a project with cost management helps avoid certain pitfalls that may be present otherwise. The purpose of cost management is to ensure sufficient supply of funds in a timely manner to the firm to meet its funding needs. It therefore becomes imperative to perform a cost benefit analysis of various alternatives before acquiring funds from any particular source. Cost Management is a key contributing factor of business success and provides a metric for measurement of performance.

The study then identifies four commonly used steps for cost management - Resource Planning, Cost Estimating, Cost Budgeting and Cost Control. Resource Planning is the process of determining the actual requirements of people, equipment and materials in order to perform project activities. Cost Estimating is the process of developing an approximate estimation of the cost needed to complete the project activities. Cost Budgeting is the process of aggregating the estimated costs of individual activities or work packages establish a total cost baseline for measuring project performance. Cost Control is the process of monitoring the status of the project to update the project budget and managing changes to the cost baseline. A detailed analysis of all the four processes identifying the inputs, tools and techniques and outputs to each process is provided.

The remaining part of the paper highlights the common errors and biases that plague the cost estimation process in project management such as committing to the best case scenario, using false analogies, estimation by the wrong personnel etc. The paper concludes by providing key recommendations for sound cost management and overall project management.

2. Introduction & Objectives of Study

Objectives - The study aims to provide a detailed analysis of cost management in the context of project management and provides a brief description of the tools and techniques used in the process of cost management. It also sheds light on some of the common issues related to cost management plaguing project managers and project teams. The study further provides recommendations for avoiding the pitfalls associated with project cost management.

Methodology - The project methodology comprises collating information from relevant literature using secondary research, leveraging tools and frameworks discussed in the prescribed text, lectures and so forth and subsequently analyzing the critical issues in project cost management based on interviews with project managers from reputed firms.

Expected Outcome

- To gain an understanding of the cost management aspect of project management.
- To gain an understanding of tools and techniques available for planning, estimating and budgeting.
- To understand the challenges in cost management and how they could be dealt with.

3. Overview of Cost Management

Cost management is the process which allows companies to control and plan the costs involved in doing a business. It allows a business to predict future expenditures to help reduce the chance of going over budget [1].Cost management is employed by many businesses as an integral part of business management. Individual projects have their own customized cost management plans, and companies in their entirety also include cost management into their overall business model.

When cost management is applied to a specific project, the expected costs in the business are analyzed in the beginning phase of the planning period. The project manager (PM) then approves the predicted expenses in purchasing the materials required for the project. The costs and expenses are recorded and monitored during the project execution period to ensure that the cost is in line with the actual cost management plan. Once the project is complete, the actual costs are compared with the predicted costs, helping future cost management predictions and budgets [2].

Starting a project with cost management helps avoid certain pitfalls that may be present otherwise. Unclear, undefined or constantly changing project objectives likely lead to cost over-runs. If costs are not fully researched before the project, they may be underestimated, thereby inflating the expectation of the project's success unrealistically.

Clearly defined project objectives enable effective management of the costs the project is likely to incur. Effective cost management strategies help a team deliver a finished project within the allocated budget, while also making it as valuable as possible to the company [3]. While there is always the possibility of unexpected costs, being prepared by having an effective cost management makes it much easier to deal with the unexpected costs as and when they occur.

4. Significance of Cost Management

The purpose of cost management is to ensure sufficient supply of funds in a timely manner to the firm to meet its funding needs. It is therefore imperative to perform a cost benefit analysis of various alternatives before acquiring funds from any particular source [4]. Some of the significances of cost management include:

- **Key contributing factor of business success-** Existence, success and growth of a company is dependent on sound cost management. Cost management makes possible the use of available resources in the form of manpower, materials and infrastructure more effectively. It therefore helps in preparation of plans for development & expansion and their successful executions.

- **Focal point of decision making -** It provides scientific analysis of facts and figures thereby helping in evaluating the profitability of the project in the given circumstances so that a proper decision may be taken to minimize the risks involved in the project.

- **Measurement of performance -** The performance of the firm can be measured by its financial results. Risk and profitability jointly determine the value of the firm. Financial decisions which increase the risk will reduce the value of the firm, and on the other hand, financial decision which increases the profitability will enhance the value of the firm.

- **Advisory role -** It plays a very important role in the success of a business by advising top management. It represents important facts and figures regarding financial position and performance to evaluate the progress of the firm and to make suitable changes.

- **Optimal utilization of resources -** It emphasizes optimum utilization of resources of the enterprise. Effective utilization of financial resources is of great significance since it gives maximum returns by increasing the productivity of capital funds.

5. Project Cost Management Process

Project cost management (PCM) is the process of overall planning, co-ordination, and control and reporting of all cost-related aspects of a project, from “project initiation” to “operation and maintenance”. Project cost management in a project management encompasses various functions including estimating, job controls, field data collection, scheduling, accounting and design [5]. These are the vital tools for effective cost management to analyze the various aspects of the project. Starting from the initial phase to the completion of the project cost management plays an important role in every phase to minimize the

cost of the project and to complete the project within the estimated budget. Commonly an effective cost management involves four steps that are [6]:

a. **Resource Planning -**This is the process of determining the actual requirements of people, equipment and materials in order to perform project activities.
b. **Cost Estimating** - This is the process of developing an approximate estimation of the cost needed to complete the project activities.
c. **Cost Budgeting -** This is the process of aggregating the estimated costs of individual activities or work packages establish a total cost baseline for measuring project performance.
d. **Cost Control -** This is the process of monitoring the status of the project to update the project budget and managing changes to the cost baseline.

The figure below depicts the 4 components of project cost management process.

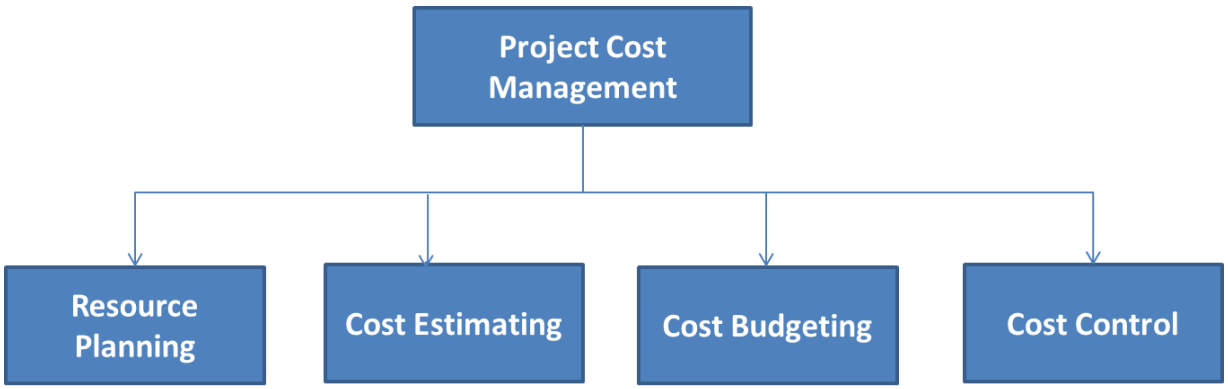

Fig 5.1 Project Cost Management Components

The subsequent sections discuss each process in depth.

6. Resource Planning

6.1 Overview

Resource planning is the process of examining the project work and determining what resources, people, and equipment are needed to complete the project. Resource planning also includes identifying the expected quantity of the needed resources so the predicted cost can be calculated [7]. The identification of the resources, the needed quantity, and the schedule of the resources are all directly linked to the expected cost of the project [8]. The figure below summarizes the inputs, tools & techniques and outputs of the resource planning process.

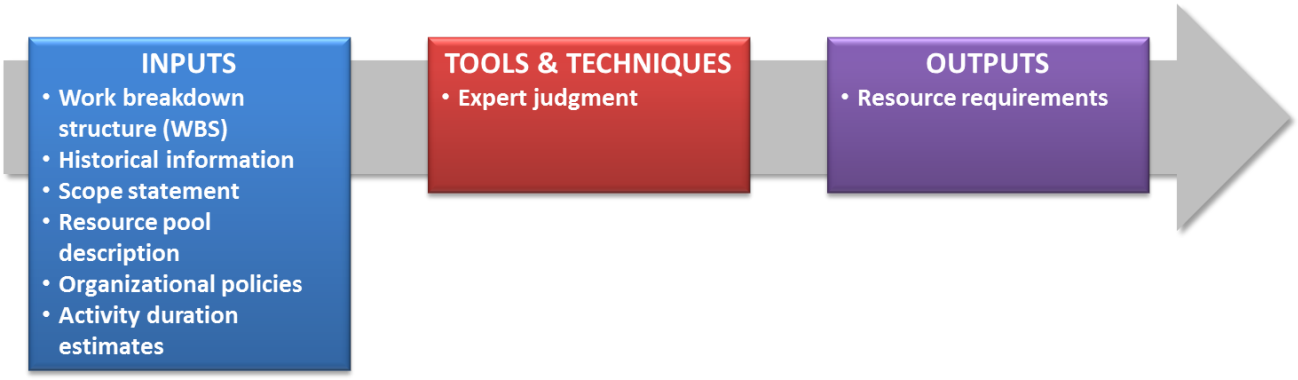

Fig 6.1 Resource Planning

6.2 Inputs to Resource Planning

The following are some common inputs to resource planning [8]:

- **Work breakdown structure (WBS) -** The WBS is a detailed activity-wise breakdown of the components of the project. It helps the project manager and the project team identifies the elements of a project that require specific people, equipment, and materials.

- **Historical information -** Historical information pertains to information on similar projects that have been previously completed. It is advisable to use historical information if it's available, as it is proven information rather than speculation.

- **Scope statement -** The scope statement serves as a key input to resource planning. It defines the objective of the project. The scope statement serves as a guide for the resource planning process, by providing justification for the project and the required work to complete the project. The required work in turn helps identify the required resources to complete the project.

- **Resource pool description -** It is very important to know that what resources and materials are likely to be needed in every activity and phase of the project. In a project life cycle, the requirements may vary in each stage and hence should be taken into consideration.

- **Organizational policies -** The performing organization's policies regarding staff acquisition must be taken into consideration. Additionally, any procurement policies to ascertain, lease, or rent equipment must be evaluated. The project manager should be aware of these requirements before planning the resource - time invested in identifying resources may be lost if the process conflicts with the organizational policies.

- **Activity duration estimates -** The duration of the activities are required to enable the project manager and the project team to perform a cost-benefit analysis of assigning more effort to reduce

tasks duration where feasible. The activity duration estimates should be readily available from the time management processes.

6.3 Tools & Techniques for Resource Planning

- **Expert judgment:** Expert judgment is the most effective tool that can be used for resource planning. This technique involves a group of trained experts to get the suggestions for resource planning. The project manager and the project team examine the project work and the available resources and then apply reason, logic, and experience in evaluating the available resources in relation to the project requirements [6]. The person or group offering the expert judgment should have the expertise, experience, or training needed to evaluate and analyze the resources that the project needs. Expert judgment can come from several sources:
  - Internal subject matter experts, such as resources from other departments
  - External subject matter experts, such as consultants
  - Trade and professional associations
  - Industry groups

6.4 Outputs from Resource Planning

- **Resource requirements -** The output of the resource planning process is the detailed availability of the total number of resources needed for the completion of entire project and in what quantities they will be need. The same can be obtained through staff acquisition or procurement.

7. Cost Estimating

7.1 Overview

Cost estimating is an approximate estimation of total cost of the resources needed to complete the project. It provides an assessment of the total cost required to deliver the final product or service as per the requirement and specifications of the project. The person or group responsible for estimating must consider the likely fluctuations, conditions, and other causes of variances that could affect the total cost of the estimate. The figure below summarizes the inputs, tools & techniques and outputs of the cost estimating process.

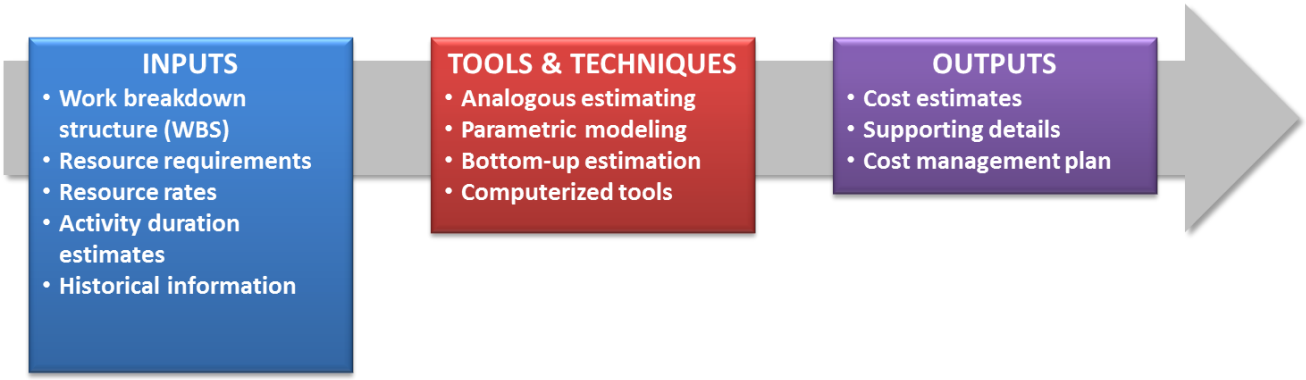

Fig 7.1 Cost Estimating

7.2 Inputs to Cost Estimating

Cost estimating is based on various project components from the initiation and planning process groups. It also relies on historical information and policies from the performing organization [9].

- **Work breakdown structure (WBS) -** This helps the project manager to organize the total cost estimates and check whether all activities that have been identified have been estimated or not.

- **Resource requirements -** Resource requirements include the analysis of all the resources and materials required for the project for proper estimation of cost. The project will have some requirement for resources - the skills of the labor, the ability of materials, or the function of equipment must all be accounted for.

- **Resource rates -** The project manager is expected to know the unit price of each of the resource needed for the project to calculate the overall cost of the entire project. If the actual prices are not known than there may be a miscalculation in the estimation.

- **Activity duration estimates -** Activity duration estimates is the estimated time an activity is likely to take for completion. This can affect the cost estimate for the project as the project budget includes the financial allowance for a certain period.

- **Historical information -** Historical information can prove quite helpful in cost estimation and can be a good reference for the project managers to calculate the approximate cost. It can come from several sources:

    - **Project files -** Past projects within the organization can be used as a reference to predict costs and time. However, it is important that the records referenced are accurate, somewhat current, and represent what was actually experienced in the historical project.

- **Commercial cost-estimating databases -** These databases provide estimates of what the project should cost based on the variables of the project, resources, and other conditions.

- **Project team knowledge -** The team or member involved in previous projects can have adequate knowledge of the cost due to previous experiences and hence can be useful.

7.3 Tools & Techniques for Cost Estimating

- **Analogous estimating:** Analogous estimating also known as top-down estimating uses historical information from similar projects to predict the cost of the current project. The cost of the historical project is applied to the cost of the current project, taking into account the scope and size of the current project as well as other known variables [7]. It is quite useful for estimating cost of a project when limited amount of information for the project is available. Analogous estimating is a form of expert judgment and takes less time to complete than other estimating models, but is also less accurate. This top-down approach is good for fast estimates to get a general idea of what the project may cost.

- **Parametric modeling -**Parametric modeling is the technique that uses the project characteristics or parameters for cost estimation using a mathematical tool [7][8]. The mathematical too used can be simple or complex depending upon the type of project. These tools depends upon various factors including:
  1. The accuracy of the historical information used to develop the model,
  2. The parameters used in the model should be quantifiable and
  3. The model is scalable

- **Bottom-up estimating -** Bottom-up estimating is the technique that involves the estimation of cost for each activity of the project and then rolling them together to get the total cost of the project [7]. It can be one of the most time-consuming methods to predict project costs. While this method is more expensive, it is also one of the most accurate. A fringe benefit of completing a bottom-up estimate is the project team may buy-into the project work as they see they cost and value of each activity within the project

- **Computerized tools -** A number of computerized tools such as project management software and spreadsheets are available today that helps in the cost estimating process and make the process very simple as well as efficient.

7.4 Outputs from Cost Estimating

- **Cost estimates -** Cost estimates are quantitative assessments of probable costs required to complete the project work. The estimate can be presented in detail against the WBS components or summarized in terms of a grand total, by phases of the project. Each resource in the project must be accounted for and assigned to a cost category. Categories include the labor, materials, travel, supplies, hardware, software, inflation, among other things. The cost of the project is expressed in monetary terms, such as dollars, euros, or yen, so management can compare projects based on costs.

- **Supporting detail -** Once the estimates have been completed, supporting detail must be organized and documented to show how the estimates were created. Specifically, the supporting detail includes the following:
    - Detailed description of the project scope work.
    - Proper documentation of process and procedures followed in the estimation along with any assumptions made
    - Information on the range of variance in the estimate

- **Cost management plan -** The cost management plan describes how to manage the cost variances in the project. It can be formal or informal based on the requirement of the stakeholders.

8. Cost Budgeting

8.1 Overview

Cost budgeting involves the allocation of the total estimated cost to the individual activities or work packages for establishing a cost baseline for measuring project performance. Cost budgeting and cost estimates may go hand-in-hand; however estimating should be completed before a budget is requested - or assigned. The difference between cost estimates and cost budgeting is that cost estimates show costs by category, whereas a cost budget shows costs across time. The figure below summarizes the inputs, tools & techniques and outputs of the cost budgeting process.

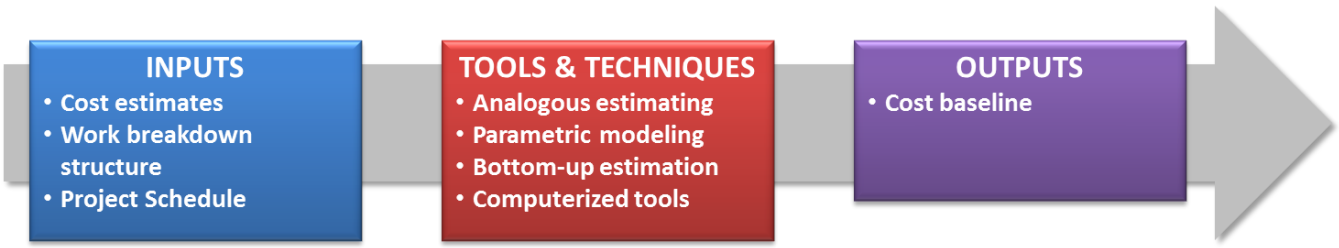

Fig 8.1 Cost Budgeting

8.2 Inputs to Cost Budgeting

Cost budgeting and cost estimating being so closely related share several inputs. The inputs to cost budgeting are [7][10]:

- **Cost estimates -** It includes the detailed estimation of all types of expenses to be made in each and every activity or work item for the successful completion of the project.

- **Work breakdown structure -** The work breakdown structure identifies the total elements of the project to which the cost is to be allocated.

- **Project schedule -** This includes the plan of time to start the project and the finishing date of the project. This information is required for assigning costs to the time period and when the cost will be incurred.

8.3 Tools & Techniques for Cost Budgeting

All the tools and techniques used to create the project cost estimates are also used to create the project budget. These tools as described in the previous section (section 7.3) are:

- **Analogous estimating**
- **Parametric modeling**
- **Bottom-up estimating**
- **Computerized tools**

8.4 Outputs from Cost Budgeting

- **Cost baseline -** The cost baseline shows what is expected to be spent on the project. It is obtained by adding estimated costs by period and is usually represented in the form of an S-curve. It allows the project manager and management to predict when the project will be spending money and over what time period. The purpose of the cost baseline is to measure and predict project performance. A project, especially larger one, can have various cost baselines to measure different aspects of cost performance.

9. Cost Control

9.1 Overview

Cost control involves controlling the effect of the variance in the cost baseline to ensure that changes are beneficial [10]. It also determines, whether the cost baseline has changed and if so, how to manage the changes. Cost control includes:

- Monitoring cost performance to detect variances from plan.
- Ensuring that all appropriate changes are recorded accurately in the cost baseline.

- Preventing incorrect, inappropriate, or unauthorized changes from being included in the cost baseline.
- Informing appropriate stakeholders for the authorized changes.

The figure below summarizes the inputs, tools & techniques and outputs of the cost estimating process.

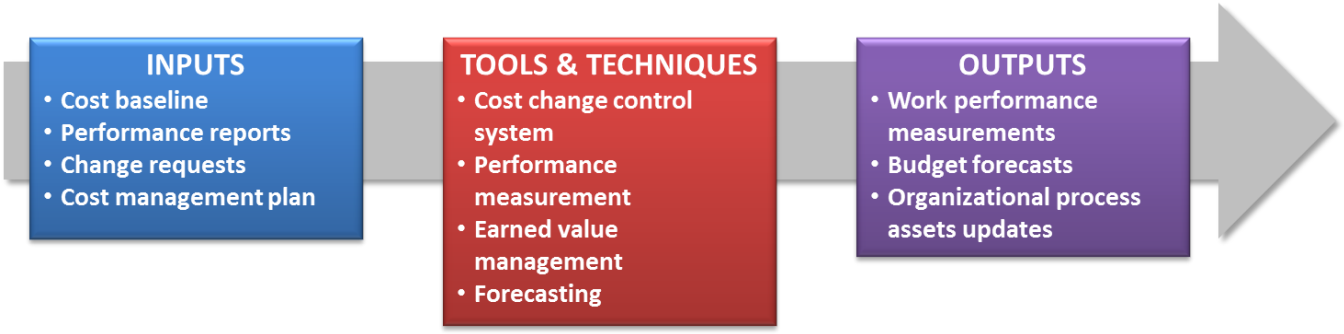

Fig 9.1 Cost Control

9.2 Inputs to Cost Control

To implement cost control, the project manager must rely on several documents and processes [7][10]:

- **Cost baseline -** The cost baseline is the expected cost the project will incur. This time-phased budget reflects the amount that will be spent throughout the project. It is used to measure and monitor the cost performance of the project.

- **Performance reports -** Performance reports helps to analyze the cost performance of each activity of the project by providing the information about which activity has met the budget estimation and which does not. It can also help the project managers know about the possible problems that may arise in future.

- **Change requests -** When changes to the project scope are requested, an analysis of the associated costs to complete the proposed change is required. Change requests may occur in oral or written, direct or indirect, external of internal, mandatory or optional forms. Changes can lead to increase in the budget or even decrease of budget.

- **Cost management plan -** The cost management plan helps to manage the cost variances in the project effectively. A cost management plan can be formal or informal depending upon the requirement of the customers.

9.3 Tools & Techniques for Cost Control

- **Cost change control system -** A cost change control system defines various procedures through which the cost baseline can be changed as per the need. This includes paperwork, tracking systems, and approval levels essential for authorizing changes.

- **Performance measurement -** A Performance measurement technique helps in accessing the variations in the project budget if any. This also helps to find the reasons for the variations and the possible problems that may occur due to these changes in future and what corrective measures should be taken to combat that changes. An important part of cost control is to determine the variance, the magnitude of the variance, and to decide if the variance requires corrective action. Earned Value Management is a technique widely used in performance measurement.

- **Earned Value Management -** Earned Value Management (EVM) is the process of measuring performance of project work against a plan to identify variances [7]. It can also be useful in predicting future variances and the final costs at completion. It compares work performed against work planned and measures the actual cost of the work performed. EVM is an important part of cost control as it allows a project manager to predict future variances from the expenses to date within the project. The earned value technique involves developing the following key values for each schedule activity, work package, or control account:

    - **Planned value (PV)** - PV is the budgeted cost for the work scheduled to be completed on an activity or WBS component up to a given point in time.

    - **Earned value (EV)** - EV is the budgeted amount for the work actually completed on the schedule activity or WBS component during a given time period.

    - **Actual cost (AC)** - AC is the actual cost incurred in accomplishing work on the schedule activity or WBS component during a given time period. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g. direct hours only, direct cost only, or all costs including indirect costs).

  Variances from approved baseline are also monitored. The most commonly used measures are cost variance (CV) and schedule variance (SV).

    - **Cost Variance (CV)** - It is a measure of cost performance. It is calculated as:

$$CV = EV - AC$$

The cost variance at the end of the project will be the difference between the budget at the completion (BAC) and the actual amount spent.

- **Schedule Variance (SV)** - It is a measure of schedule performance on a project. It is calculated as:

$$SV = EV - PV$$

Schedule variance will ultimately equal zero when the project is completed because all of the planned values will ultimately equal zero when the project is completed because all of the planned values will have been earned.

These two values, the CV and SV, can be converted to efficiency indicators to reflect the cost and schedule performance of any project.

- **Cost performance index (CPI)** - CPI is a measure of work completed versus the actual cost. It is calculated as:

$$CPI = EV/AC$$

A CPI value less than 1 indicates a cost overrun of the estimates. A CPI value greater than 1 indicates a cost under-run of the estimates.

- **Scheduled Performance Index (SPI)** - The SPI is a measure of progress achieved compared to progress planned on a project. It is used in addition to the schedule status to predict the completion date and is sometimes used in conjunction with the CPI to forecast the project estimates. It is calculated as:

$$SPI = EV/PV$$

- **Forecasting -** Forecasting includes making estimates or predictions of conditions in the project's future based on the information and knowledge available at the time of the forecast [7][10]. As the project progresses, the forecasts are adjusted. Forecasts are generated, updated and reissued based on work performance information provided as the project is executed and progressed. The parameters used in forecasting are discussed below.

  - **Budget At Completion (BAC) -** BAC is equal to the total PV at completion for a schedule activity, work package, control account, or other WBS component.

BAC=total cumulative PV to the completion

- **Estimate To Complete (ETC)** - ETC is the estimate for completing the remaining work for a schedule activity, work package, or control account. This more accurate and comprehensive completion for all the work remaining considers the performance estimate to complete all the work remaining and the performance or production of the resource to date. Alternatively, to calculate ETC using earned value data, one of the two formulas is typically used:

  a) ETC based on a typical variances - This approach is most often used when current variances are seen as atypical and the project management team expectations are that similar variance will not occur in the future. ETC equals the BAC minus the cumulative earned value to date (EVC).

  $$ETC= (BAC - EVC)$$

  b) ETC based on typical variances - This approach is most often used when current variances are seen as typical of future variances. ETC equals the BAC minus the cumulative EVC (the remaining PV) divided by the cumulative cost performance index (CPIC).

  $$ETC= (BAC - EVC) / CPI$$

- **Estimate at Completion (EAC)** - EAC is the projected or anticipated total final value for a schedule activity, WBS component, or project when the defined work of the project is completed. One EAC forecasting technique is based upon the performing organization providing an estimate at completion:

- **EAC using a new estimate** - This approach is often used when past performance shows that original estimating assumptions were fundamentally flawed or that they are no longer relevant due to change in conditions. It is calculated as:

  $$EAC = AC + ETC$$

- Two ways for calculating EAC using earned value data are:

  a) **EAC based on a typical variances -** This approach is most often used when current variances are seen as atypical and the project management team expectations are that similar variance will not occur in the future.

  $$EAC = AC + BAC – EV$$

b) **EAC based on typical variances** - This approach is most often used when current variances are seen as typical of future variances.

$$EAC = AC + ((BAC - EV) / CPI$$

Earned Value Chart as shown below is a common representation of all the parameters used in the cost control process.

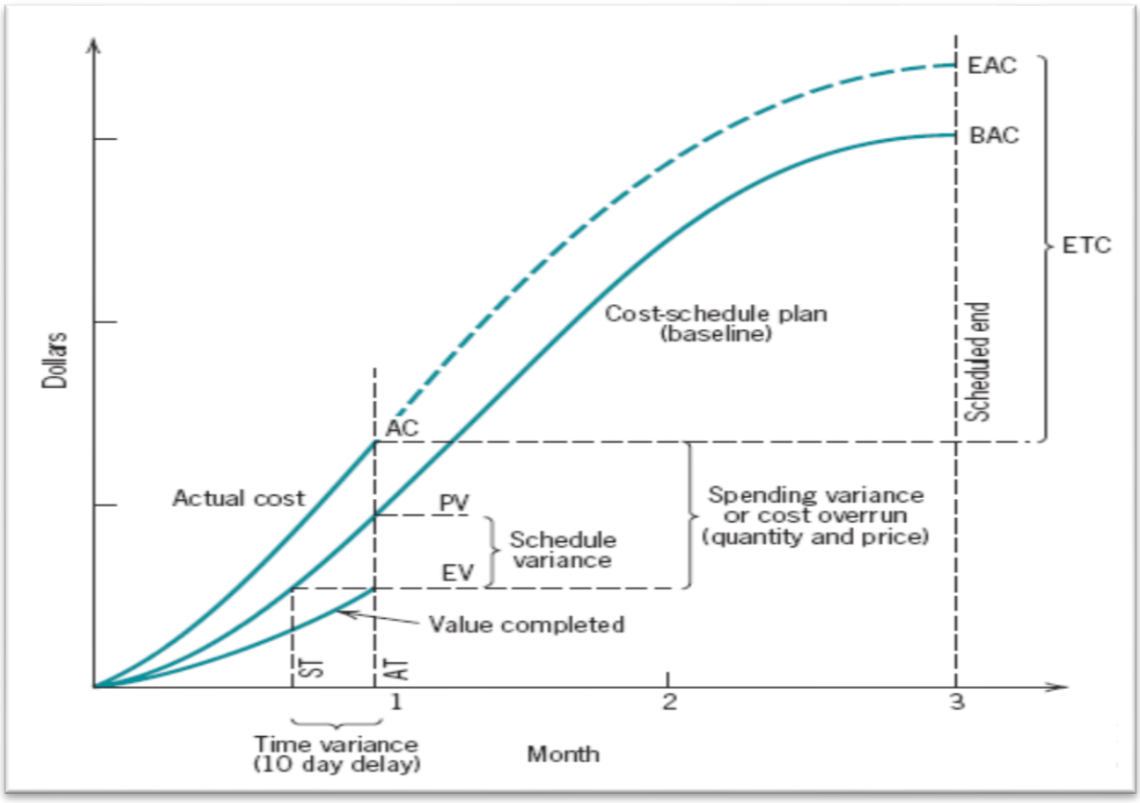

Fig 9.2 Earned Value Chart

In the figure above,

- Time Variance = ST - AT
- Schedule Variance = EV - PV
- Cost Variance = EV – AC
- BAC = total cumulative PV to the completion
- The cost variance at the end of the project is the difference between the BAC and the actual amount spent.
- Schedule variance will ultimately equal zero when the project is completed

- **Computerized tools -** Computerized tools such as project management software and spreadsheets are very effective tools for comparing the planned costs vs. actual cost and for forecasting the possible effects of the cost changes.

9.4 Outputs from Cost Control

- **Work performance Measurements -** Calculated CV, SV, CPI, and SPI values for WBS components, work packages and control accounts are documented and communicated to stakeholders.
- **Budget forecasts -** Calculated EAC value or bottom-up EAC value is documented and communicated to stakeholders
- **Organizational process assets updates** - This includes cause of variance, corrective actions chosen and the reasons and other types of lessons learned from project cost control.

10. Common Project Cost Management Mistakes

This section highlights the common errors and biases that plague the cost estimation process in project management. It also discusses the other significant factors the cause cost overruns and consequently schedule delays. The findings are based on literature research and interviews with project managers of large companies such as Nike and Tektronix.

10.1 Issues in Cost Estimation

Project estimates can go for several reasons. Some of the key reasons that standout are discussed below [11][12][13].

- **Failures to take into account the work in its entirety -** This is perhaps the most common problem, especially with preliminary, high-level estimates. Project managers are quite likely to miss some major activity that they didn't understand to be a part of the project, such as documentation or training. Typically, PMs will underestimate the size of deliverables that need to be completed or do not include all of the activities required to complete the deliverable.

- **Committing to the best case scenario -** PMs often face pressure from all fronts – from the client as well as the senior management – to get work done as quickly as possible. They are forced into thinking that the work can be done quickly. However, they get into trouble because they are only thinking about the optimistic scenario. Even if they are considering in terms of a range of effort for the work, too often they end up committing to an estimate at the lower, or optimistic, end of the range.

- **Using false analogies -** Project estimates based on historical data are generally considered to be more reliable than those developed using other methods such as expert judgment. This works as long as one

uses data from historical projects that are identical to the one at hand in relevant ways. However, in real life it is often challenging for PMs to know what is relevant and what isn't. It is all too easy to select a project that is superficially similar to the one at hand, but actually differs in critical ways.

- **Estimation by the wrong personnel -** It should be obvious that estimation must be done by those who will do the work. Unfortunately this principle is not often followed in the real world. In such cases, schedules are forced to fit into predetermined timelines, with estimates cooked up by those who have little or no idea of the actual effort involved in doing the work.

- **Subjectivity** - Estimates are plucked out of thin air and "justified" based on gut-feel and other subjective notions. Such estimates are prone to overconfidence and a range of other cognitive biases [14]. Often PMs let their personal biases can sneak into their estimates. Some are optimistic while others are pessimistic. Optimistic biases will result in underestimating the work and can include:
    - Wrongly oversimplifying scope of work
    - Thinking the team can accomplish more than they really can
    - Estimating based on the PMs ability and comfort level rather than the average team member's

  Pessimistic biases will result in overestimating the work and can include:
    - Overestimating the work because of a bad experience on a similar project in the past
    - Looking to avoid the project hoping that a high estimate will lead the project to be cancelled

- **Coordination neglect** - Projects consist of diverse tasks that need to be coordinated and integrated carefully. Unfortunately, the time and effort needed for coordination and integration is often underestimated (or even totally overlooked) by PMs. This is referred to as coordination neglect [15]. Coordination neglect is a problem in projects of all sizes, but is generally more significant for projects involving large teams as well as for projects that consist of a large number of dependent tasks or have a large number of external dependencies.

- **Estimating at a high level rather than at a micro-level -** Since large tasks are made up of smaller tasks with specific dependencies, estimates for large tasks should be built up from estimates for the smaller sub-tasks. However, teams often short-circuit the process by attempting to estimate the large task directly. Such estimates usually turn out to be incorrect because sub-tasks are overlooked.

10.2 Other Factors for Cost Overrun

In addition to the most obvious culprit – inaccurate estimates, some of the other factors leading to a project going over budget are as follows [16]:

- **Lack of real-time visibility and control** - Real-time control is all about having accurate, up-to-date information about the status of the project. The most important control factor is project tracking. By tracking all labor, equipment, materials, subcontractors, suppliers, etc., PMs can view daily reports on everything significant pertaining to the project and are therefore empowered with a wealth of information that is the ultimate key to control. They do not have to wait until the end of the month to find out what happened weeks. Every day that goes by without fixing a problem that's occurred on a project will accelerate the budget impact. Moreover, real-time control also allows PMs to keep a close eye on the suppliers and subcontractors. In the absence of a good tracking and control system in place, getting over-charged and double-invoiced can be a huge contributor to project cost overruns.

- **Poor method to monitor project progress** - Determining project progress, is also a key contributor to cost overruns during the execution phase. PMs should constantly take the pulse of their project to know if the project is on budget or on schedule. The earlier PMs can find out that they are facing a potential cost overrun in their project, the more chance they might have to correct it. Also, having agreed-upon project progress milestones and sign-off is vital to being able to control costs and get paid. Being able to seamlessly close-out a phase, level, task and the project as a whole enables PMs to stop spending money and squandering valuable time.

- **Insufficient historical information** - Insufficient historical information plagues many businesses trying to run profitable projects. It is often the case that very little data is collected during a project, so very little is known about what happened. All that is typically available to many project managers is the summary totals contained in the corporate ERP. This is only marginally helpful, as it is missing so many crucial details that help planners and estimators get better at their job. Similarly information though tracked but stored in a series of spreadsheets renders reporting and metrics that can be achieved from spreadsheets terse, vague and time-consuming.

11. Recommendations

Key recommendations for sound cost management and overall project management are provided below:

- **Proper allocation of resources -** Project managers need full visibility into the skills and workloads of all of their resources, including consultants, contractors and outsourcers, who often get left out of skills assessments even though they're doing a huge proportion of work. One project managers know who's doing what, they have to figure out how to allocate resources across myriad projects and day-to-day work. Allocating right resources to project and assessing the work they will do is the first step towards project cost estimation and control.

- **Formal change request process -** It is recommended to follow a formal change request process: The individual requesting the change in scope (e.g. additional features or functionality) needs to explain the specific changes on a change-in-scope document, and the project manager needs to determine how that request will impact the budget and timeline. The project sponsor has to sign off on the change-in-scope request.

- **Avoiding over-delivery** - Project team needs to understand what has to be delivered. Being enthusiastic and over delivering is good if the stakeholders don't get confused by all the extra features. However over-delivering should not impact the budget or the schedule of the project. Project managers need to be flexible and communicate with project sponsors and stakeholders at every stage to understand their real needs and how everything affects the project cost.

- **Attention to dependencies between projects -** Projects often dependent on other projects going on at the same time. When project managers fail to see the dependencies between projects—such as staff assigned to one project are needed on another, projects get held up. Such slowdowns can have a ripple effect on all projects. PMs should take dependencies into account during project planning. Talking with stakeholders and diagramming the project can help uncover dependencies.

- **Risk anticipation** - PMs should perform a risk assessment as part of the project planning. They should brainstorm with their team as to what could happen to slow or derail the project, to make it go over budget, or to prevent the team from delivering the expected requirements and subsequently think of ways to mitigate those risks. This exercise is enormously helpful in understanding the soft spots in a project before it even gets underway.

- **Proactive communication -** PMs need to be proactive in communicating any cost changes to the stakeholders. All necessary documents should be periodically updated and meetings with business key persons need to be held to communicate cost changes and get the necessary approvals.

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