

## PROJECT COST MANAGEMENT

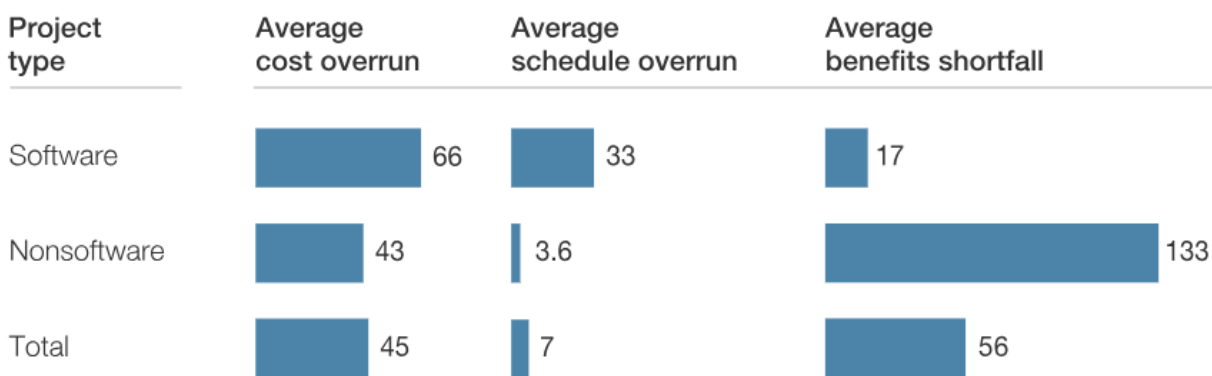
### Cost

Cost is one of the constraints in project management that is usually measured by monetary value such as pesos or dollars. According to accountants, cost is a “resource sacrificed or foregone to achieve a specific objective.” Based on Webster’s dictionary, cost is defined as “something given up in exchange.” Cost is basically something that should be spent in order to gain something else such as goods, services, or anything of value.

### Significance of Cost Management

A collaborative study done by McKinsey and the University of Oxford on 2011, has reported that large IT projects, on average, exceed their budget by 45% and complete a project with reduced value by 56% compared to what’s initially predicted. Software projects, specifically, has higher risk of cost overruns.

% of IT projects with given issue (for those with budgets >\$15 million in 2010 dollars)



Source: McKinsey–Oxford study on reference-class forecasting for IT projects

Figure 1. Percentage of large IT projects with given issue

This result is from a study conducted on over 5,400 IT projects wherein budgets, schedules, and predicted benefits with actual costs and results were all compared. They found out that scheduling a project longer than it should be presents a higher risk of cost overrun by 15 percent.

Some projects, though, failed terribly and caused severe consequences to the company’s overall state. These failures are often caused by “black swans” which are rare, unpredictable, and paradigm-shifting events. These kinds of events could render an organization helpless. (This will be discussed more in Project Risk Management)

The point here is that, cost overruns that go over 200 percent of the expected and estimated value can turn the project into a “black swan” threatening the state of the organization. Thus, cost management should not be taken lightly.

Project cost management is said to be a “weak area” of IT projects. IT professionals might think that cost management is a job intended only for accountants, however, it is safe to say that making good cost estimates is an important and sought-after skill for most professionals especially for project managers. This does not

mean that we'll do cost management without consulting a finance expert. What's important is that IT project managers must at least recognize the significance of cost management, be accountable, and understand the basic concepts of cost estimating, budgeting, and cost control. Basically, getting involved in the processes should be observed and practiced.

## Project Cost Management

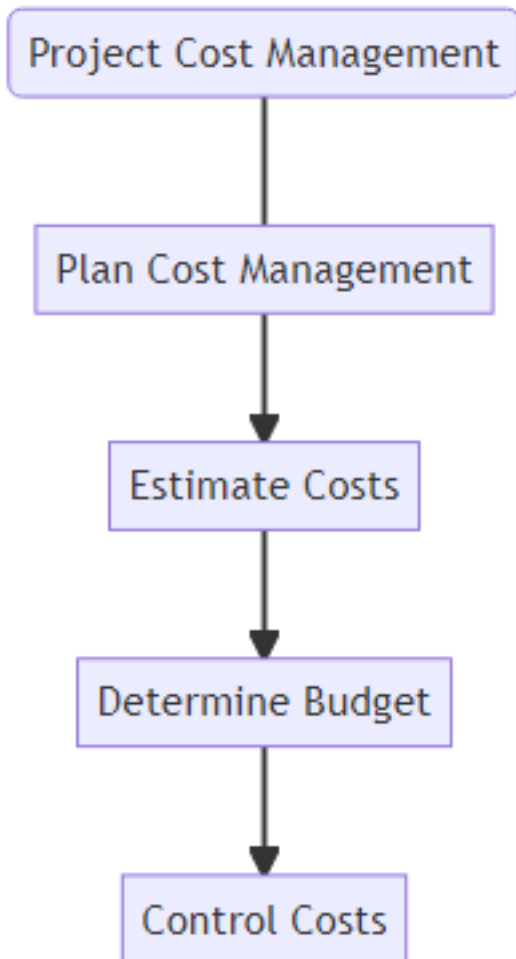


Figure 2. Overview of process in Project Cost Management

**Project Cost Management** encompasses these four main processes with the goal of completing the project within the approved budget. Based on the project scope, we try to make cost estimates, budgets, and monitor cost that stay within the approved budget. This means that it is essential to establish the scope earlier so that we can estimate the costs early as well.

In cost management, we try to keep the total project costs within the given budget as much as possible and we can do this by identifying the resources needed to complete the project. Aside from human resources such as hiring software engineers and testers, we also include materials, supplies, support and maintenance costs, and all the things needed to complete the project. Keep in mind that in this world, almost everything runs with a cost. Nothing is free anymore.

## Basic Concepts

Aside from knowing about the net present value (NPV) analysis, return on investment (ROI), and payback analysis discussed previously in Project Integration Management, there are more basic but important concepts to know about finance.

As future IT project managers, being knowledgeable about technical terms is not enough, we should be able to understand and discuss both technical and financial terms.

Below are some of the basic financial terms and concepts:

- Profits - are obtained by subtracting expenditures from revenues. When thinking of increasing profits, we can either decrease expenses and costing of delivering a product or service or just increase the revenues through sales or pricing.
- Profit Margin - ratio of profits to revenues. By knowing this, we can now measure the potential benefits of the project.
  - Example: If a revenue of Php5000.00 generated a Php100.00 worth of profits, then we can say that there is a 2% profit margin.
- Life cycle costing - is a projection of the project's total cost of development and adding the support costs as well. This is done to compute the net present value.
- Cash flow analysis - is when we identify the project's possible annual cash flow and the estimated annual costs.
- Tangible costs/benefits - are measureable by monetary values.
- Intangible costs/benefits - can't be measured quantitatively such as goodwill, prestige, reputation, or productivity.
- Direct costs - are costs incurred directly when creating the products or services of the project such as the cost of manpower, and hardware or software purchase.
- Indirect costs - are costs that are indirectly needed to work on the project. These are minor costs but are somehow needed such as the additional costs in housing employees which will include the cost of using electricity, paper towel, and other necessities. This goes to show that project managers have more control on direct costs compared to indirect costs.
- Sunk costs is basically gone money spent in a failing project that did not produce value worthy of what was spent.
- Learning curve theory - states that a repetitively produced item decreases its unit cost as more units of the item are produced.

There are more terms and concepts but in this course, this is enough introduction.

## 1 Plan Cost Management

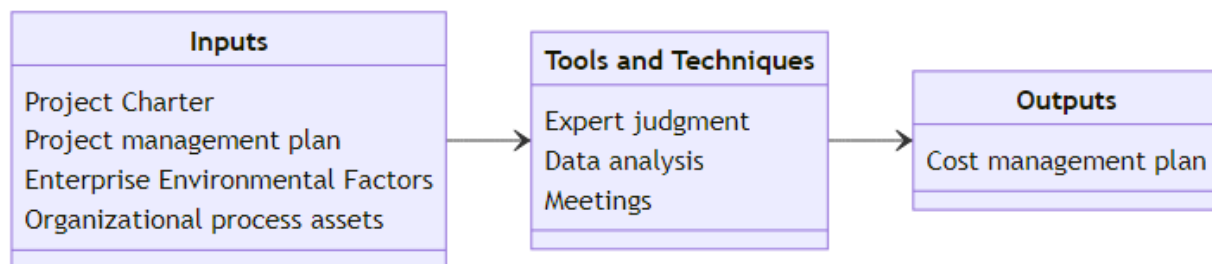


Figure 3. Processes in Planning Cost Management

We always start with planning on establishing the “hows” of the management process. Planning cost management involves the processes on determining how the costs will be estimated, budgeted, managed, monitored, and controlled. Establishing the “hows” provides direction not only for the project manager but

also for the project team in managing costs throughout the project. Just like other management plans, this can be informal and broad, or formal and detailed depending on the project scope and needs.

This step is important because stakeholders might have different views on costs most especially when most stakeholders are almost always concerned about costs. It is also imperative to get to know how your stakeholders' perspective on costs and how costs are calculated. Before proceeding to the actual estimation of costs, we'll try to prevent misunderstandings and conflict by creating a cost management plan.

The cost management plan documents the guidelines on how the project costs will be estimated, managed, and controlled. This includes, but not limited to, the following parts:

- Level of Precision and Accuracy - rounding guidelines in estimating activity costs
- Units of Measure - different unit that will be used in measuring costs of resources
- Organizational Procedures Links - varies by organization.
- Control thresholds - this refers to the percentage of deviation allowed from the cost baseline.
- Rules of performance measurement - an example of this would deciding how often will you track the actual costs and how detailed would it be.
- Reporting formats - basically the template of cost reports including how many you'll be making one.
- Process descriptions - gives instructions on how to execute the other cost management processes.

## 2 Estimate Costs

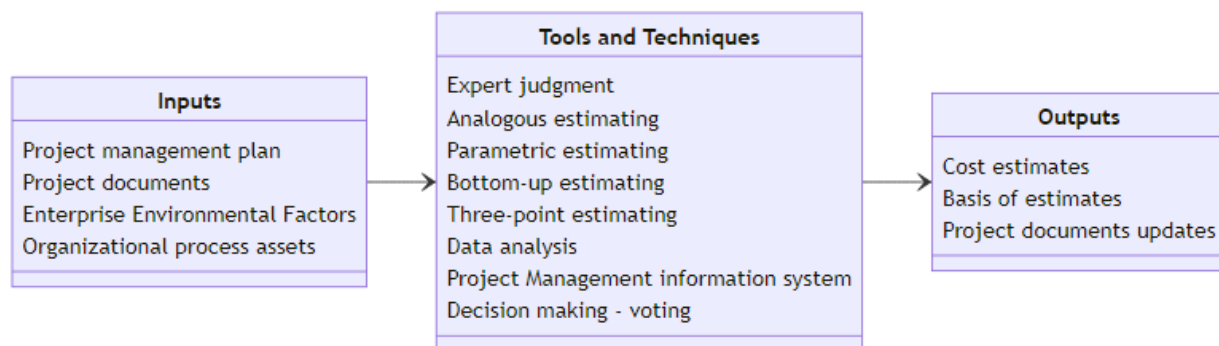


Figure 4. Processes in Estimating Costs

Estimating costs is a assessing quantitatively the costs of resources required to complete the project.

Cost estimates includes not only the human and material resources but also the maintenance and support service costs after the project is complete.

To clarify, estimating costs and product/service pricing are not similar. Pricing is more than just costs, it also includes the profit margin which is based on the project's value.

For projects with strict budget constraints, estimating costs should be done sincerely. Based on the project scope, we will also be able to come up with a resource requirements list (to be discussed more on project resource management). Our inputs will then be the scope baseline and the resource lists.

### Types of Cost Estimates

- **Rough order of magnitude (ROM).** This is aims to estimate the total project cost and done years early prior to project completion for the purpose of project selection decisions. ROM estimate is also called as the ballpark estimate, a guesstimate, or a broad gauge.
- **Budgetary estimate.** This is used in allocating resources and appropriating funds of the organization by setting aside budget periodically.

- **Definitive estimate.** This tries to estimate the project costs accurately especially for purchasing decisions.

Estimate Type	When	Range
ROM	3-5 years before project completion	-50% to +100%
Budgetary	1-2 years out	-10% to +25%
Definitive	less than a year out	-5% to +10%

Table 1. Cost Estimation Types

There are more types of cost estimates and they vary according to application area.

### Tools and Techniques

- **Analogous estimates** (top-down estimates) - takes advantage of similar previous projects as the basis of estimating cost for the current project.
- **Bottom-up estimates** - starts by estimating the costs of smaller tasks or activities and then getting the sum of related activities to get the cost estimate of the higher-level activity.
- **Three-point estimates** - same thing with schedule management. Three-point estimating uses the average of three variables: cM (cost closes to realistic effort), cO (estimate based on best-case scenario), and cP (estimate based on worst-case scenario). There are two ways to do this:
  - Triangular distribution

$$cE = \frac{(cO + cM + cP)}{3}$$

- Beta distribution

$$cE = \frac{(cO + 4cM + cP)}{6}$$

Take note that we should be careful of giving our initial estimates to the stakeholders especially the top management as they tend to care more and not forget about the first estimate. This is why there should be a process in monitoring and controlling changes in costs. It is important to keep the stakeholders up to date with the changes in cost.

Cost Estimate									
Project Name:		Date:							
Note: Enter your WBS, hours, labor rates, etc. Add/delete rows and columns as needed and check all formulas (bolded below).									
	Internal	\$/hour	Internal	External	\$/hour	External	Total	Non-labor \$	Total Cost
WBS Categories	Labor		\$ Total	Labor		\$ Total	Labor		
1. Initiating	200	\$ 65	\$13,000			\$ -	\$ 13,000		\$ 13,000
2. Planning	600	\$ 60	\$36,000			\$ -	\$ 36,000		\$ 36,000
3. Executing			\$ -			\$ -	\$ -		\$ -
3.1 Course design and development			\$ -			\$ -	\$ -		\$ -
3.1.1 Supplier management training	600	\$ 60	\$36,000	600	\$ 150	\$90,000	\$ 126,000	\$ 100,000	\$226,000
3.1.2 Negotiating skills training	300	\$ 55	\$16,500	300	\$ 150	\$45,000	\$ 61,500	\$ 50,000	\$111,500
3.1.3 Project management training	400	\$ 60	\$24,000	400	\$ 150	\$60,000	\$ 84,000	\$ 50,000	\$134,000
3.1.4 Software applications training	400	\$ 60	\$24,000	400	\$ 150	\$60,000	\$ 84,000	\$ 50,000	\$134,000
3.2 Course administration	400	\$ 55	\$22,000	300	\$ 250	\$75,000	\$ 97,000	\$ 80,000	\$177,000
3.3.Course evaluation	300	\$ 55	\$16,500			\$ -	\$ 16,500		\$ 16,500
3.4 Stakeholder communications	300	\$ 55	\$16,500			\$ -	\$ 16,500		\$ 16,500
4. Monitoring and Controlling	500	\$ 55	\$27,500			\$ -	\$ 27,500		\$ 27,500
5. Closing	200	\$ 55	\$11,000			\$ -	\$ 11,000		\$ 11,000
Subtotal									\$903,000
Reserves			\$ -			\$ -	\$ -		90,300.0
Total	4,200		243,000	2,000	850	330,000	573,000	330,000	\$993,300

Figure 5. An example of cost estimates

It is recommended that the project cost estimate should be reviewed by concerned people such as those with expertise, with past experience of similar projects, with the project team, top management, and other involved stakeholders. This is to check if the estimates are reasonable enough and this can be presented together with attachments of other documents supporting the cost estimate.

### Albrecht's Function Point Method

There are already established means in measuring software size and one of them is Allen Albrecht's function point method initially defined in the 1970s. In 2002, it became an international ISO standard used in measuring software sizes making it the most commonly used software size metric.

Function point metric is a standardized method in measuring software sizes based on what the software can do for the end users. This means that the functionality of the software is being measured from the perspective of the end users.

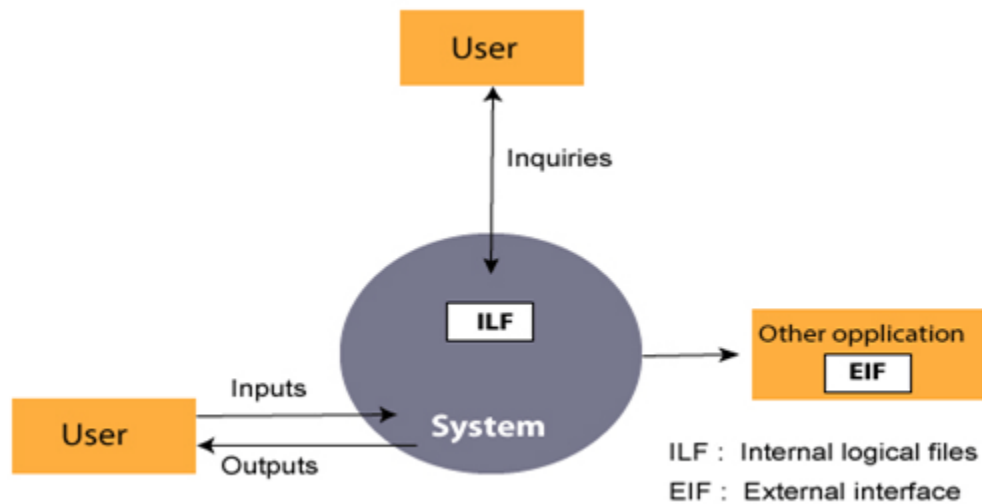


Figure 1: Functional Units System

Figure 6. Diagram of the functional units

This method has five functional units or attributes: - External Input (EI) - a transactional functional type which refers to the number of external inputs wherein data moves from outside to inside. - External Output (EO) - a transactional functional type which refers to the number of external output wherein data moves from inside to outside of the system's boundary. - External Inquiries (EQ) - another transaction functional type which refers to the number of external queries wherein both input and output components are involved resulting to an extraction of information from an internal or external database. - Internal Logical File (ILF) - a data functional type which refers to the data that is present within in the system. - External Interface File (EIF) - a data functional type which refers to the data stored in an external resource.

### 3 Determine Budget

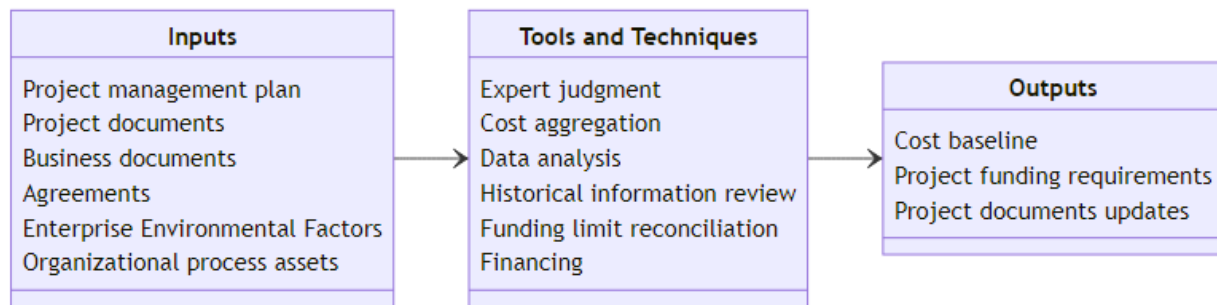


Figure 7. Processes in Determining the Budget

The goal of the determining the budget is to establish a cost baseline covering all the processes of the project including the monitoring and controlling processes and reserve funds that might unexpectedly emerge due to unanticipated events.

You might be wondering how different is estimating cost to determining budget. Aren't they practically the same process? What was done in the previous step was just estimate the cost of all the resources needed to complete all activities from the scope baseline. However, that is not all that is needed to determine the cost baseline. We still have to allocate funds for other important things such as the Contingency Reserve.

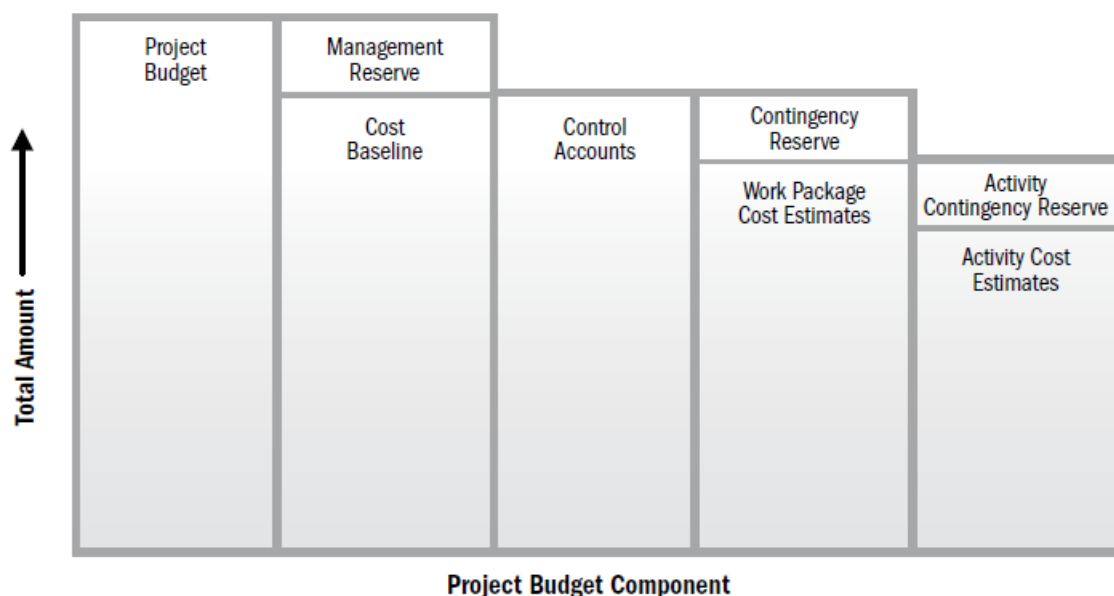


Fig-

ure 8. Components of a Project Budget

Reserves are cost estimates to mitigate risks in preparation for future expected and unprecedented events. Contingency reserves are included in the cost baseline and is intended for future situations that are “known unknowns.” Management reserves are for unpredictable situations or called as “unknown unknowns” but is not included in the cost baseline.

By aggregating the costs of all WBS work packages, we get the control accounts which includes the contingency reserves which then by adding all control accounts, will make our cost baseline.

Cost baseline is also known as the project's time-phased budget which means it gives us the expected cash flows over time based on requirements.

Cost Estimate													
Project Name:	Date:												
Note: Enter your WBS and costs each month. Add/delete rows and columns as needed and check all formulas (bolded below).													
	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	Total Cost
WBS Categories													
1. Initiating	13,000												\$ 13,000
2. Planning	6,000	16,000	8,000	1,000	1,000	1,000	1,000	1,000	1,000				\$ 36,000
3. Executing			-			-	-						\$ -
3.1 Course design and development			-				-						\$ -
3.1.1 Supplier management training			5,000	73,667	73,667	73,667							\$226,000
3.1.2 Negotiating skills training			5,000	35,500	35,500	35,500							\$111,500
3.1.3 Project management training			5,000	43,000	43,000	43,000							\$134,000
3.1.4 Software applications training			5,000	43,000	43,000	43,000							\$134,000
3.2 Course administration						17,000	53,333	53,333	53,333				\$177,000
3.3.Course evaluation							3,000	3,000	3,000	7,500			\$ 16,500
3.4 Stakeholder communications		1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	\$ 16,500
4. Monitoring and Controlling	1,000	2,000	2,000	2,000	3,000	3,500	3,000	3,000	2,000	3,000	2,000	1,000	\$ 27,500
5. Closing											8,000	3,000	\$ 11,000
Subtotal													\$903,000
Reserves*			-			-	-					90,300	\$ 90,300
Total	20,000	19,500	31,500	199,667	200,667	218,167	61,833	61,833	60,833	12,000	11,500	95,800	993,300

Figure 8. An example of Cost Baseline

By determining our cost baseline, we can now plot our project funding requirements. The total Project funding is not always given all at once. In some projects, not all funds are available right away at the start. Parts of the funds are released periodically mostly aligning with the schedule of milestones which means that all funds will be disbursed over time until project completion.

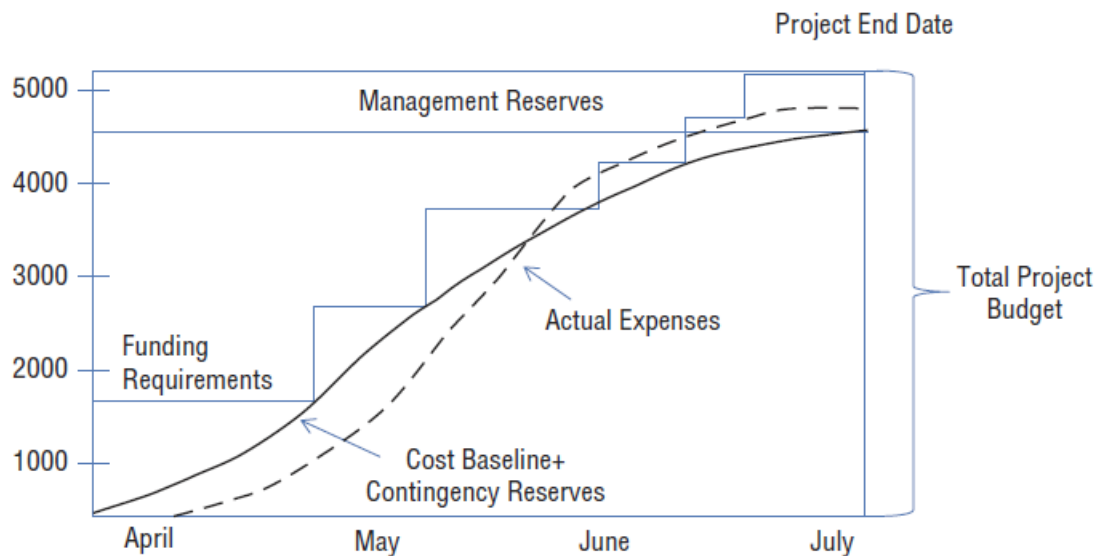


Figure 10.

Cost baseline, funding requirements, and cash flow.

The expected cash flows don't always match the cost baseline. In the figure above, the actual expenses went over the cost baseline halfway through the project timeline. The actual expenses are plotted during the monitoring phase of the project already so, this can be excluded at the start of the project.



## 4 Control Costs

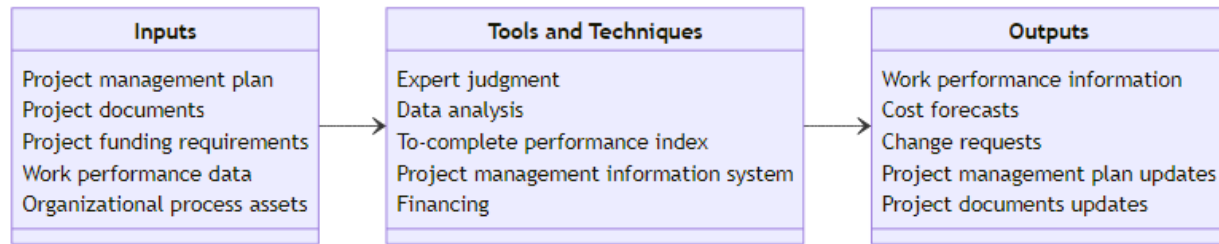


Figure 11. Processes in Controlling Costs

All project constraints and areas need to be monitored especially the project cost. Controlling costs is basically the process of monitoring the state of the project in terms of costs and work done compared against the cost baseline. This will help in decision making when changes in cost and resources arise.

### Earned Value Management (EVM)

Data analysis are usually done when controlling costs. One popular technique is the Earned Value Management (EVM) which uses Earned Value Analysis (EVA) as the method of computing the value of the actual work performed. EVM integrates cost, scope, and time data to measure project performance.

There are key values to be identified initially:

- **Planned Value (PV)** - the approved budget initially assigned to a scheduled activity.
- **Actual Cost (AC)** - the costs of the actual execution of the activities during a specified time.
- **Earned Value (EV)** - is also known as the “budgeted cost of work performed” or BCWP which is also equal to the sum of the planned values of all the completed work on a certain point in time.
- **Budget at Completion (BAC)** - is the total approved budget of the project which is also the total planned value.

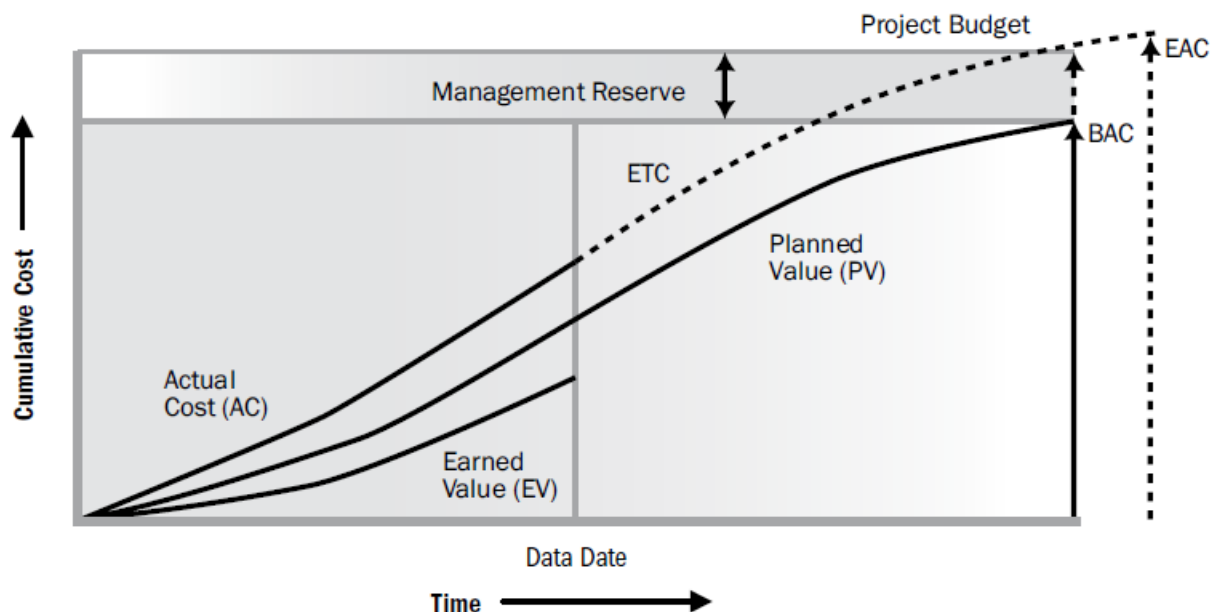


Figure 12. Earned value, planned value, and actual costs

From the three key values, we can then conduct a variance analysis. PMBOK® Guide describes variance as “a quantifiable deviation, departure, or divergence away from a known baseline or expected value.” This is done to assess the actual values against the planned values. By being able to determine variances, we can investigate its causes and decide if a corrective or a preventive action is needed to solve it.

- **Cost Variance (CV)** - is the amount of deficit or surplus in the budget.

$$CV = EV - AC$$

- **Schedule Variance (SV)** - tells us how much the project is ahead or behind schedule based on the schedule baseline.

$$SV = EV - PV$$

- **Variance at Completion (VAC)** - projected amount of budget surplus or deficit at completion

$$VAC = BAC - EAC$$

- **Cost Performance Index (CPI)** - measures the efficiency of cost based on budget

$$CPI = \frac{EV}{AC}$$

- **Schedule Performance Index (SPI)** - measures the efficiency of schedule

$$SPI = \frac{EV}{PV}$$

We can then do trend analysis to see if the project's performance is getting better or worse. using the following values:

- **Estimate at Completion (EAC)** - forecasted total cost of project completion based on current trend. There are multiple ways to get EAC.
  - If CPI is expected to be constant for the remaining project activities:

$$EAC = \frac{BAC}{CPI}$$

- If the succeeding activities will be finished at the planned pace:

$$EAC = AC + BAC - EV$$

- If the initial plan is deemed invalid:

$$EAC = AC + Bottom - upETC$$

- If CPI and SPI affects the remaining project work:

$$EAC = AC + \frac{(BAC - EV)}{(CPI \times SPI)}$$

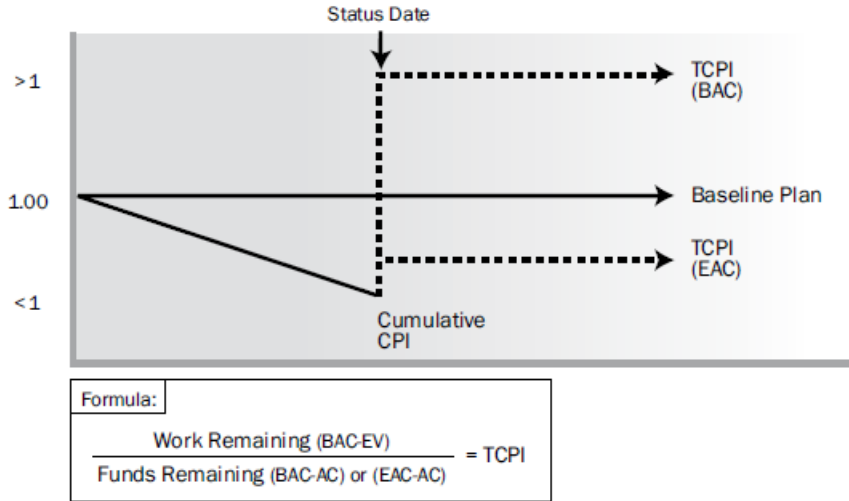


Figure 13. TCPI

- **To-complete performance index (TCPI)** - gives the needed cost performance using the remaining resources in order to complete the project. Value greater than 1.0 means it would be harder to complete while value less than 1.0 means it would be easier to complete the project.
  - If we want to get the efficiency to be maintained in order to complete the project as planned:

$$TCPI = \frac{(BAC - EV)}{(BAC - AC)}$$

- If we want the efficiency needed in order to complete the project based on EAC:

$$TCPI = \frac{(BAC - EV)}{(EAC - AC)}$$

How do we interpret the result of each equation? Here is a summary table to answer that question.

Table 2. Calculation Summary Table

Name	Equation	Result Interpretation
Cost Variance	$CV = EV - AC$	Positive - under planned cost; Neutral - on planned cost; Negative - over planned cost
Schedule variance	$SV = EV - PV$	Positive - ahead of schedule; Neutral - on schedule; Negative - behind schedule
Variance at Completion	$VAC = BAC - EAC$	Positive - under planned cost; Neutral - on planned cost; Negative - over planned cost
Cost Performance Index	$CPI = EV / AC$	> 1.0 - under planned cost; < 1.0 - on planned; <1.0 - over planned cost
Schedule Performance Index	$SPI = EV / PV$	>1.0 - ahead of schedule; == 1.0 - On schedule; <1.0 - Behind schedule

To clarify about the result interpretation, let's take for example the Cost Variance. CV is equal to the difference of Earned Value and Actual Cost which means that when CV is negative, it tells us that the Actual Cost has a value greater or over the planned value or in other words "under budget."

## **Cost Management in Agile Environments**

In agile and adaptive environments, detailed and complete cost estimates are not achievable due to the uncertainty of scope and frequency of changes. What we can do is to reserve the detailed estimates for short-term planning horizons which is somewhat like a rolling wave planning approach. Detailed estimates are done for near and upcoming iterations. In projects where there is a strict budget, though, the other constraints such as scope and schedule will have to adjust accordingly in order to operate still within the approved budget.