Project Cost Management

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The Importance of Project Cost Management

Projects have a poor track record for meeting budget goals

- Cost overrun is the additional percentage or dollar amount by which actual costs exceed estimates
- A 2011 *Harvard Business Review* study reported an average cost overrun of 27 percent

What Went Wrong?

- The United Kingdom's National Health Service IT modernization program was called the greatest IT disaster in history with an estimated $26 billion overrun

- Program had problems due to incompatible systems, resistance from physicians, and arguments among contractors about who's responsible for what? and was scrapped in 2011

What is Cost?

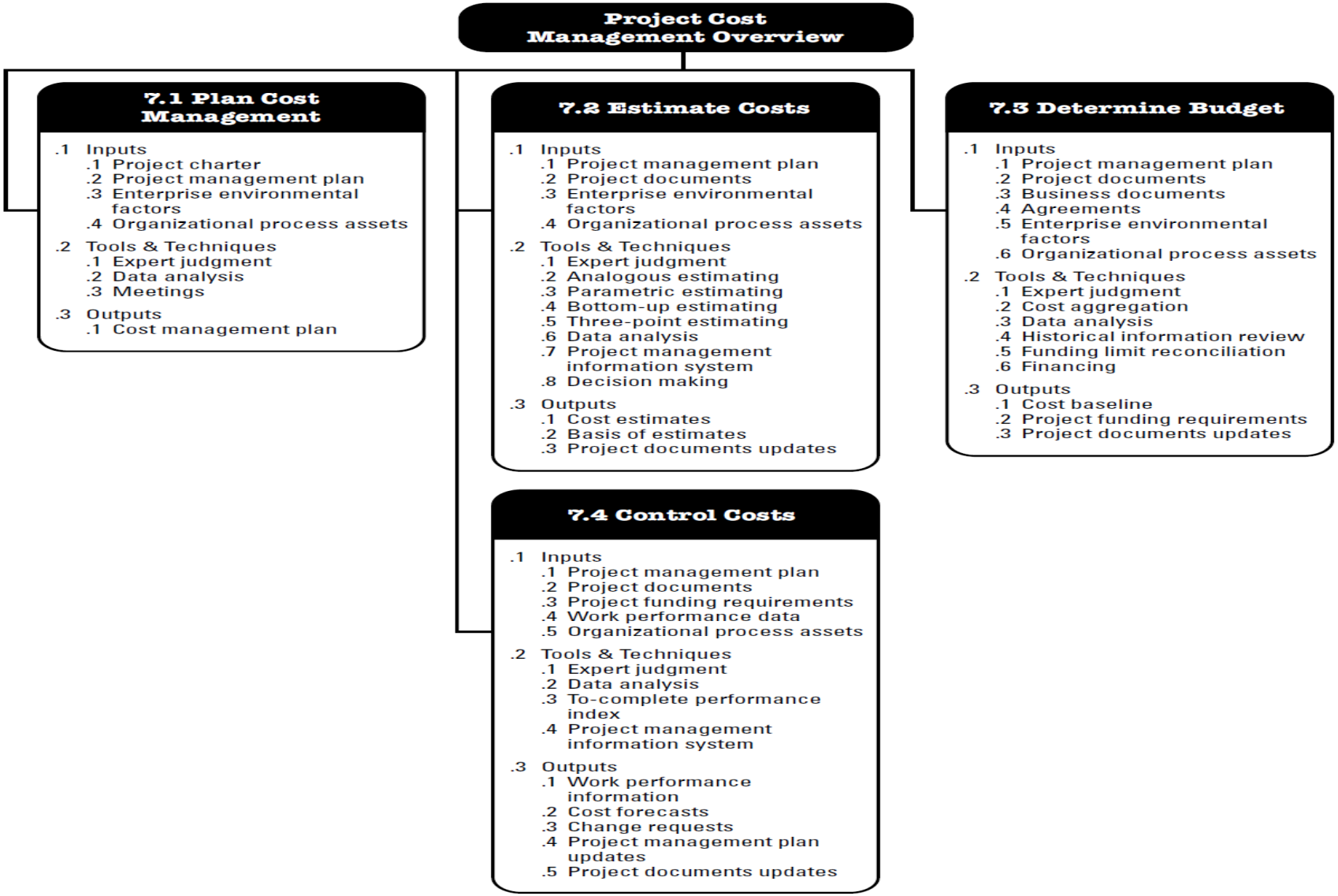
Cost is a resource sacrificed or foregone to achieve a specific objective or something given up in exchange

Usually measured in monetary units that must be paid to acquire goods and services

Project Cost Management

- 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.
- The Project Cost Management processes are:
- **Plan Cost Management :** The process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled.
- **Estimate Costs** : The process of developing *an approximation of the monetary resources needed* to complete project work.
- **Determine Budget** : The process of *aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline*.
- **Control Costs** : The process of monitoring the status of the project to update the project costs and manage changes to the cost baseline.

Project Cost Management Overview



Basic Principles of Cost Management

Most members of an executive board members better understand and are more interested in financial terms than project terms;

- **Profits**: revenues minus expenditures
- **Profit margin:** ratio of profits to revenues
- **Life cycle costing** considers total cost of ownership, or development plus support costs, for a project
- **Cash flow analysis**: determines estimated annual costs and benefits for a project and resulting annual cash flow

Basic Principles of Cost Management

Types of costs and benefits

- **Tangible costs** or benefits are those costs or benefits that an organization can easily measure in dollars
- **Intangible costs** or benefits are costs or benefits that are difficult to measure in monetary terms
- **Direct costs** are costs that can be directly related to producing the products and services of the project
- **Indirect costs** are costs that are not directly related to the products or services of the project, but are indirectly related to performing the project
- **Sunk cost** is money that has been spent in the past; when deciding what projects to invest in or continue, you should not include sunk costs

Basic Principles of Cost Management

Additional concepts:

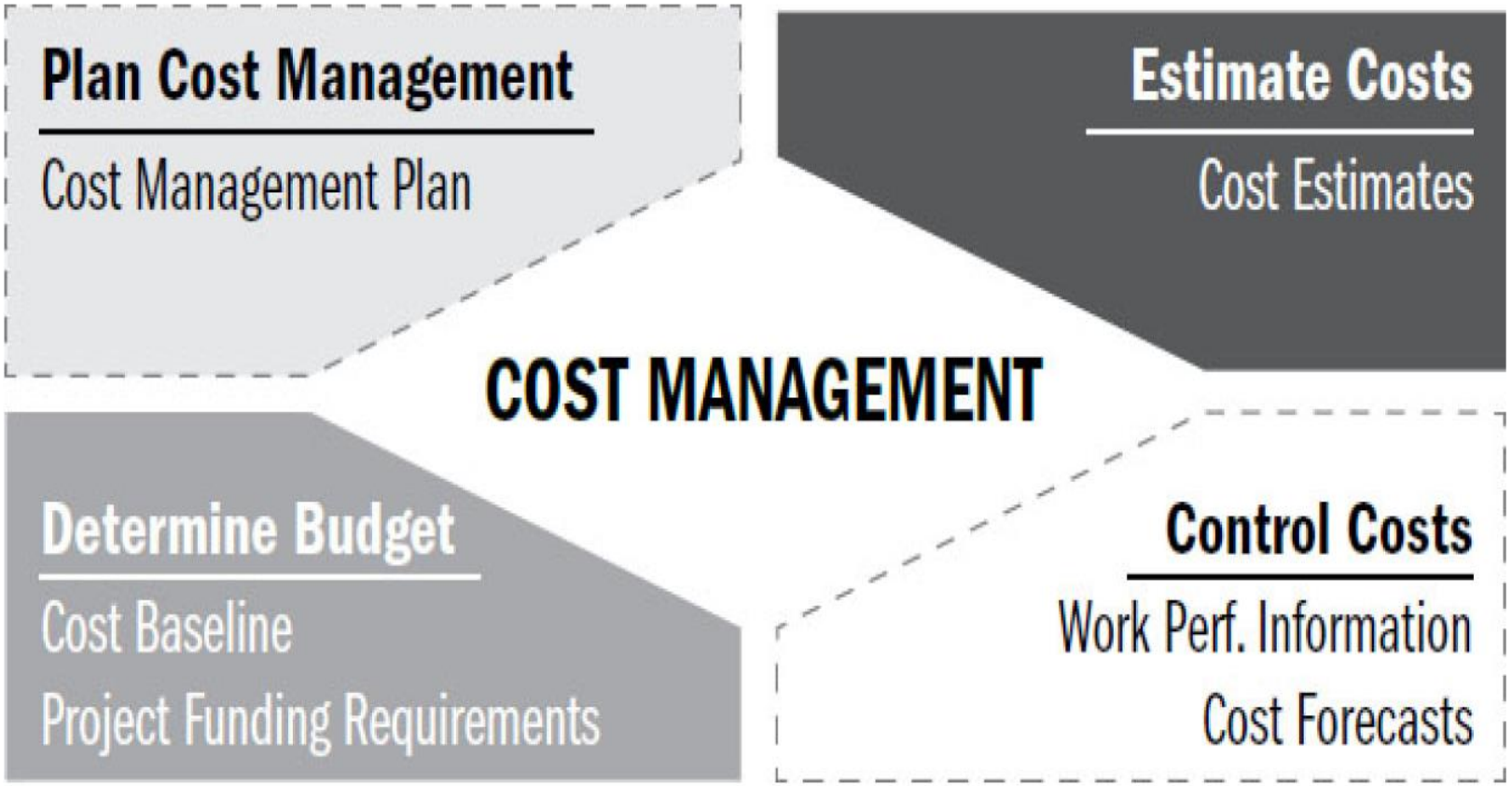
- Learning curve theory states that when many items are produced repetitively, the unit cost of those items decreases in a regular pattern as more units are produced

- Reserves are dollars included in a cost estimate to mitigate cost risk by allowing for future situations that are difficult to predict

- Contingency reserves allow for future situations that may be partially planned for (sometimes called known unknowns) and are included in the project cost baseline

- Management reserves allow for future situations that are unpredictable (sometimes called unknown unknowns)

Project Cost Management



Trends and Emerging Practices

- Earned Schedule (ES) is an extension to the theory and practice of EVM.
- Earned schedule theory replaces the schedule variance measures used in traditional EVM (earned value − planned value) with ES and actual time (AT).
- Using the alternate equation for calculating schedule variance ES − AT, if the amount of earned schedule is greater than 0, then the project is considered ahead of schedule.
- In other words, the project earned more than planned at a given point in time.
- The schedule performance index (SPI) using earned schedule metrics is ES/AT.
- This indicates the efficiency with which work is being accomplished. Earned schedule theory also provides formulas for forecasting the project completion date, using earned schedule, actual time, and estimated duration.

Good practices

Investing in green initiatives has helped both the environment and companies' bottom lines

- Michael Dell, CEO of Dell, reached his goal to make his company "carbon neutral" in 2008.
- As of March 2012, Dell had helped its customers save almost $7 billion in energy costs.
- In 2014 Dell reported being on track toward reaching their goal of recovering two billion pounds of used electronics by 2020

Tailoring Considerations

Because each project is unique, the project manager may need to tailor the way Project Cost Management processes are applied. Considerations for tailoring include but are not limited to:

- **Knowledge management:** Does the organization have a formal knowledge management and financial database repository that a project manager is required to use and that is readily accessible?
- **Estimating and budgeting**: Does the organization have existing formal or informal cost estimating and budgeting-related policies, procedures, and guidelines?
- **Earned value management:** Does the organization use earned value management in managing projects?
- **Use of agile approach :** Does the organization use agile methodologies in managing projects? How does this impact cost estimating?
- **Governance :** Does the organization have formal or informal audit and governance policies, procedures, and guidelines?

Agile projects Considerations

- Projects with high degrees of uncertainty or those where the scope is not yet fully defined may not benefit from detailed cost calculations due to frequent changes.
- Instead, lightweight estimation methods can be used to generate a fast, high-level forecast of project labor costs, which can then be easily adjusted as changes arise.
- Detailed estimates are reserved for short-term planning horizons in a just-in-time fashion.
- In cases where high-variability projects are also subject to strict budgets, the scope and schedule are more often adjusted to stay within cost constraints.

EEFs

The enterprise environmental factors that can influence the Plan Cost Management process include but are not limited to:

- Organizational culture and structure can influence cost management.
- Market conditions describe what products, services, and results are available in the regional and global markets.
- Currency exchange rates for project costs are sourced from more than one country.
- Published commercial information such as resource cost rate information is often available from commercial databases that track skills and human resource costs, and provide standard costs for material and equipment.
- Published seller price lists are another source of information.
- Productivity differences in different parts of the world can have a large influence on the cost of projects.

Organizational Process Assets

The organizational process assets that can influence the Plan Cost Management process include but are not limited to:

- Financial controls procedures (e.g., time reporting, required expenditure and disbursement reviews, accounting codes, and standard contract provisions);
- Historical information and lessons learned repository;
- Financial databases; and
- Existing formal and informal cost estimating and budgeting-related policies, procedures, and guidelines.

Planning Cost Management

The first step in project cost management is planning how the costs will be managed throughout the life of the project

- The project team uses expert judgment, analytical techniques, and meetings to develop the cost management plan

Cost management plan includes:

- Level of accuracy
- Units of measure
- Organizational procedure links
- Control thresholds
- Rules of performance measurement
- Reporting formats
- Process descriptions

Estimating Costs

Project managers must take cost estimates seriously if they want to complete projects within budget constraints

- Types of cost estimates
- Tools and techniques for estimating costs
- Typical problems associated with cost estimates

Estimating Costs

Type of Estimate	When Done	Why Done	Typical Range
Rough order of magnitude (ROM)	Very early in the project life cycle, often 3–5 years before project completion	Provides estimate of cost for selection decisions	-50% to + 100%
Budgetary	Early, 1–2 years out	Puts dollars in the budget plans	-10% to +25%
Definitive	Later in the project, less than 1 year out	Puts dollars in the budget plans	-5% to +10%

Table Types of cost estimates

Estimating Costs

The number and type of cost estimates vary by application area

- The Association for the Advancement of Cost Engineering International identifies five types of cost estimates for construction projects
  - Order of magnitude, conceptual, preliminary, definitive, and control
- Estimates are usually done at various stages of a project
  - Should become more accurate as time progresses
- It is important to provide supporting details for estimates and updates to project documents.
- A large percentage of total project costs are often labor costs

Cost Estimation Tools and Techniques

- Analogous or top-down estimates
  - Use the actual cost of a previous, similar project as the basis for estimating the cost of the current project
- Bottom-up estimates
  - Involve estimating individual work items or activities and summing them to get a project total
- Three-point estimates
  - Involve estimating the most likely, optimistic, and pessimistic costs for items
- Parametric estimating
  - Uses project characteristics (parameters) in a mathematical model to estimate project costs

Typical Problems with Cost Estimates

- Reasons for inaccuracies
  - Estimates are done too quickly
  - People lack estimating experience
  - Human beings are biased toward underestimation
  - Management desires accuracy

Cost Estimation

- **Analogous:** also called top down estimation, use of historical data of similar projects
- **Bottom up :** Estimate costs of individual work item or activities and summing them
- **Three Point Estimation** : Estimation of most likely, optimistic and pessimistic costs for the items
- **Parametric estimating :** use of project characteristics (parameters) in a mathematical model to estimate (50 rs per sft/ 100 Rs per hour etc)

Three-point estimating

The accuracy of single-point cost estimates may be improved by considering estimation uncertainty and risk and using three estimates to define an approximate range for an activity's cost:

- **Most likely (cM).** The cost of the activity, based on realistic effort assessment for the required work and any predicted expenses.

- **Optimistic (cO).** The cost based on analysis of the best-case scenario for the activity.

- **Pessimistic (cP).** The cost based on analysis of the worst-case scenario for the activity.

Three-point estimating

Depending on the assumed distribution of values within the range of the three estimates, the expected cost, cE, can be calculated using a formula.

Two commonly used formulas are triangular and beta distributions.

The formulas are:

- Triangular distribution. $cE = (cO + cM + cP) / 3$
- Beta distribution. $cE = (cO + 4cM + cP) / 6$

Cost estimates based on three points with an assumed distribution provide an expected cost and clarify the range of uncertainty around the expected cost

How to Develop a Cost Estimate and Basis of Estimates

See the text for a detailed example of creating a cost estimate for the Surveyor Pro project described in the opening case

Before creating an estimate gather as much information as possible about the project, ask how the organization plans to use the cost estimate, and clarify the ground rules and assumptions

How to Develop a Cost Estimate and Basis of Estimates

Surveyor Pro Project Cost Estimate Created October 5

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 2 Totals	% of Total
WBS Items					
1. Project Management				**$306,300**	**20%**
Project manager	960	$100	$96,000		
Project team members	1,920	$75	$144,000		
Contractors (10% of software development and testing)			$66,300		
2. Hardware				**$76,000**	**5%**
2.1 Handheld devices	100	$600	$60,000		
2.2 Servers	4	$4,000	$16,000		
3. Software				**$614,000**	**40%**
3.1 Licensed software	100	$200	$20,000		
3.2 Software development*			$594,000		
4. Testing (10% of total hardware and software costs)			$69,000	**$69,000**	**5%**
5. Training and Support				**$202,400**	**13%**
Trainee cost	100	$500	$50,000		
Travel cost	12	$700	$8,400		
Project team members	1,920	$75	$144,000		
Subtotal			$1,267,700		
6. Reserves (20% of total estimate)			$253,540	**$253,540**	**17%**
Total project cost estimate				**$1,521,240**	

*See software development estimate.

FIGURE 7-2 Surveyor Pro project cost estimate

How to Develop a Cost Estimate and Basis of Estimates

Surveyor Pro Software Development Estimate Created October 5

1. Labor Estimate	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	**Calculations**
Contractor labor estimate	3,000	$150	$450,000	3,000∗150
Project team member estimate	1,920	$75	$144,000	1,920∗75
Total labor estimate			**$594,000**	Sum above two values
2. Function point estimate	Quantity	Conversion Factor	Function Points	**Calculations**
External inputs	10	4	40	10∗4
External interface files	3	7	21	3∗7
External outputs	4	5	20	4∗5
External queries	6	4	24	6∗4
Logical internal tables	7	10	70	7∗10
Total function points			**175**	Sum above function point values
Java 2 language equivalency value			46	Assumed value from reference
Source lines of code (SLOC) estimate			8,050	175∗46
Productivity×KSLOC^Penalty (in months)			29.28	3.13∗8.05^1.072 (see reference)
Total labor hours (27 hours/function point)*			4,725	27*175
Cost/labor hour ($120/hour)			$120	Assumed value from budget expert
Total function point estimate			**$567,000**	4,725∗120

* Based on historical data

FIGURE 7-3 Surveyor pro software development estimate

Determining the Budget (1 of 2)

Budgeting involves allocating the project cost estimate to individual work items over time

- Material resources or work items are based on the activities in the WBS for the project

Important goal is to produce a cost baseline

- Time-phased budget that project managers use to measure and monitor cost performance

Determining the Budget

Surveyor Pro Project Cost Baseline Created October 10*

	Months												
WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Project Management													
1.1 Project manager	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	96,000
1.2 Project team members	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
1.3 Contractors		6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	66,300
2. Hardware													
2.1 Handheld devices				30,000	30,000								60,000
2.2 Servers				8,000	8,000								16,000
3. Software													
3.1 Licensed software				10,000	10,000								20,000
3.2 Software development		60,000	60,000	80,000	127,000	127,000	90,000	50,000					594,000
4. Testing			6,000	8,000	12,000	15,000	15,000	13,000					69,000
5. Training and Support													
5.1 Trainee cost									50,000				50,000
5.2 Travel cost									8,400				8,400
5.3 Project team members							24,000	24,000	24,000	24,000	24,000	24,000	144,000
6. Reserves				10,000	10,000	30,000	30,000	60,000	40,000	40,000	30,000	3,540	253,540
Totals	20,000	86,027	92,027	172,027	223,027	198,027	185,027	173,027	148,427	90,027	80,027	53,567	1,521,240

*See the lecture slides for this chapter on the Instructor website for a larger view of this and other figures in this chapter. Numbers are rounded, so some totals appear to be off.

FIGURE 7-4 Surveyor Pro project cost baseline

Controlling Costs

Activities involved in controlling project costs

- Monitoring cost performance
- Ensuring that only appropriate project changes are included in a revised cost baseline
- Informing project stakeholders of authorized changes to the project that will affect costs

Several tools and techniques assist in project cost control

- Expert judgment, data analysis, project management information systems, and the to-complete performance index

Earned Value Management (EVM)

Project performance measurement technique that integrates scope, time, and cost data

Given a baseline (original plan plus approved changes), you can determine how well the project is meeting scope, time, and cost goals

Earned value management involves calculating three values for each activity or summary activity from a project's WBS

- Planned value
- Actual cost
- Earned value

Earned Value Management (EVM)

Activity	Week 1
Earned value (EV)	5,000
Planned value (PV)	10,000
Actual cost (AC)	15,000
Cost variance (CV)	-10,000
Schedule variance (SV)	-5,000
Cost performance index (CPI)	33%
Schedule performance index (SPI)	50%

Table 7-3 Earned value calculations for one activity after week 1

Earned Value Management (EVM)

Term	Formula
Earned value (EV)	EV = PV of all completed work
Cost variance (CV)	CV = EV - AC
Schedule variance (SV)	SV = EV - PV
Cost performance index (CPI)	CPI = EV/AC
Schedule performance index (SPI)	SPI = EV/PV
Estimate at completion (EAC)	EAC = BAC/CPI
Estimated to Complete (ETC)	ETC = EAC - AC

Table Earned value formulas

Earned Value Management (EVM)

Important concepts:

- Cost variance (CV) is the earned value minus the actual cost
- Schedule variance (SV) is the earned value minus the planned value
- Cost performance index (CPI) is the ratio of earned value to actual cost
- Schedule performance index (SPI) is the ratio of earned value to planned value
- Estimate at completion (EAC) is an estimated cost of completing a project based on performance to date
- To-complete performance index (TCPI) is a measure of the cost performance that must be achieved with the remaining resources to meet a specific goal

Earned Value Management (EVM) (5 of 5)

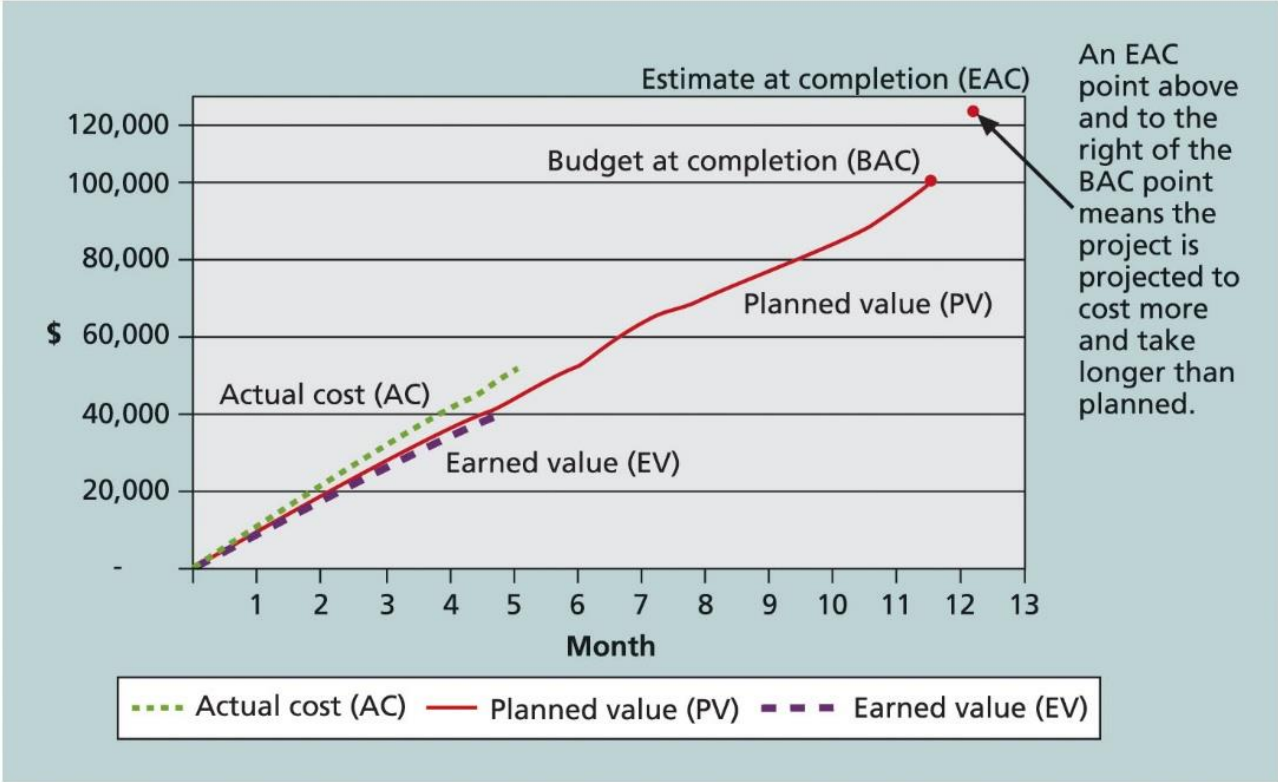


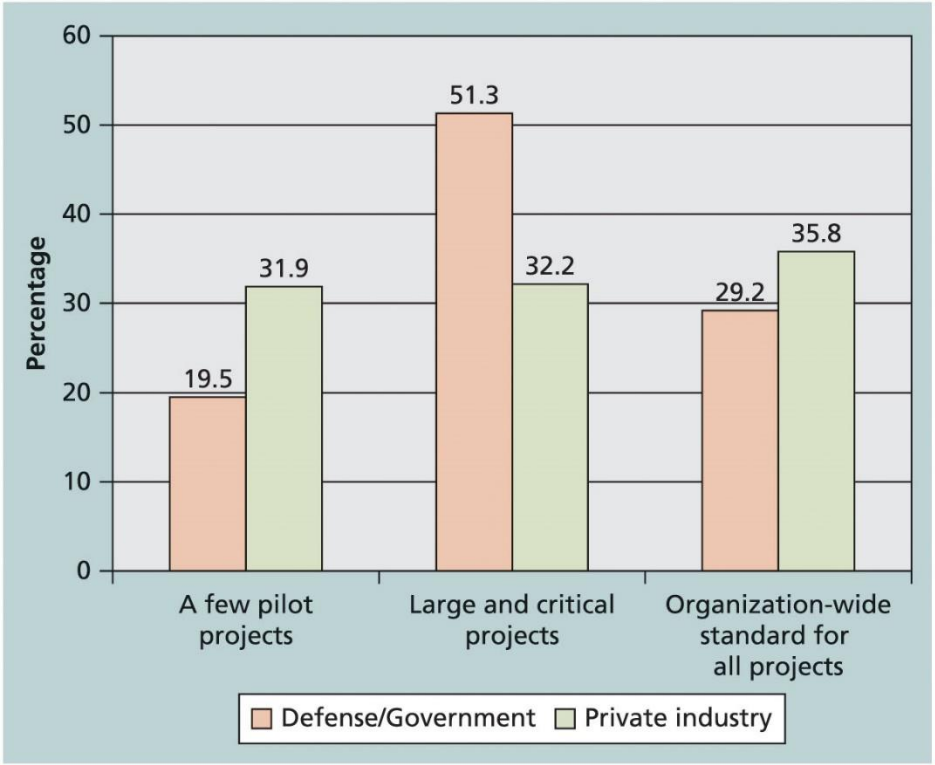
FIGURE 7-6 Earned value chart for project after five months

Global Issues

EVM is used worldwide, and it is particularly popular in the Middle East, South Asia, Canada, and Europe

- Most countries require EVM for large defense or government projects, as shown in Figure 7-7
- EVM is also used in such private-industry sectors as IT, construction, energy, and manufacturing.
  - However, most private companies have not yet applied EVM to their projects because management does not require it, feeling it is too complex and not cost effective

Global Issues



Source: Lingguang Song, "Earned Value Management: A Global and Cross-Industry Perspective on Current EVM Practice," PMI (2011), p. 36.

FIGURE 7-7 Earned value usage

Project Management Software to Assist in Project Cost Management

Recent Studies on PPM Software

- 2017 Gartner report says the market continues to grow, with annual sales over $2.3 billion
- Forrester estimates ROIs of 250 percent from PPM tools
- Pfizer and Ford use PPM software to improve transparency of the many projects they manage

Considerations for Agile/Adaptive Environments

AgileEVM is an adapted implementation of EVM

- Uses the Scrum framework artifacts as inputs, uses traditional EVM calculations, and is expressed in traditional EVM metrics
- Requires a minimal set of input parameters
  - Actual cost of a project, an estimated product backlog, a release plan that provides information on the number of iterations in the release and the assumed velocity
- All estimates can be in hours, story-points, team days or any other consistent estimate of size
  - The critical factor is that it must be a numerical estimate of some kind

Thank You