

Chapter 7: Project Cost Management

Information Technology Project Management, Ninth Edition

Note: See the text itself for full citations

Chapter 7 Agenda



1

- What is cost?
- Project Cost Management

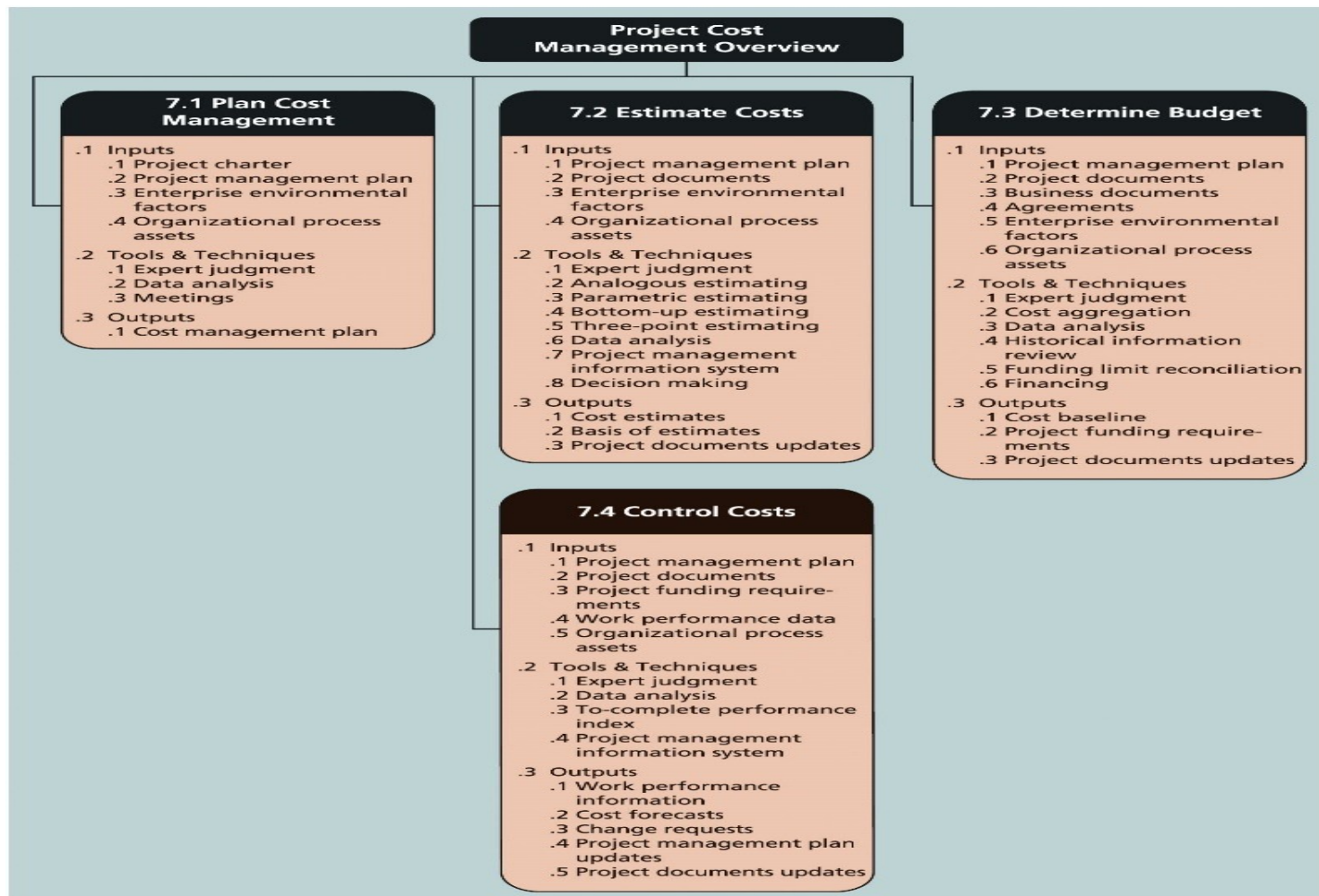
2

- Planning Cost Management
- Estimating Costs

3

- Determining Budget
- Control Cost
- Earned Value Management

What is Project Cost Management?



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FIGURE 7-1 Project cost management overview

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 like dollars that must be paid to acquire goods and services
 - Other cost is lost compute time, lab space, etc.
- **Opportunity cost** – the loss of potential gain from other alternatives when one alternative is chosen
- Using your engineers on project X vs. Y
 - Y was a leading edge project that could have been the first smart speaker
 - You spent it on X
 - Loss – not necessarily \$ per se, more strategic and leadership/ market creation.

The **Importance?** of Project Cost Management

- IT 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%**
 - Most important finding was the discovery of a large number of gigantic overages or “**black swans**”; a high-impact **event that is rare** and unpredictable, **but not improbable** in retrospect
- E.g. In buy vs. make scenario, a vendor that has delivered consistently before, you decide to buy
 - Low probability but high impact
 - Delivers software late (and you get notified last minute)
 - Best to monitor the progress of the vendor – be the customer – ask questions to see if there is risk there
 - Ask for drops to ensure progress lines up
 - Schedule risk here as well. You can do fixed-cost projects with the vendor
 - Vendor may not want fixed-cost.

“Everyone has a Plan A, good have a plan B,
what actually happens is Plan ADAPT.” - Vijay Suthar ☺

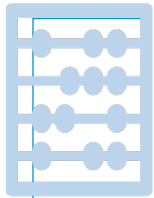
What is Project Cost Management?

- Project **cost management** includes the processes required to ensure that the project is completed within an approved budget
 1. **Planning** cost management: determining the **policies, procedures, and documentation** that will be used for planning, executing, and controlling project cost
 2. **Estimating** costs: developing an approximation or estimate of the costs of the resources needed to complete a project
 3. Determining the **budget**: allocating the overall cost estimate to individual work items to establish a baseline for measuring performance
 4. **Controlling** costs: controlling changes to the project budget
- *True Actual* cost may be hard to come by – bit noisy
 - Again accuracy vs precision
- IT differs from core business
 - IT will be more formal but if its core may be more relaxed
 - Seriousness also depends on size of company as well

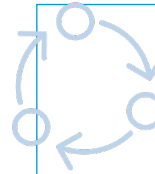
Depending on your company, project cost can be quite complex and may be done at the division level.

Basic Principles of Cost Management

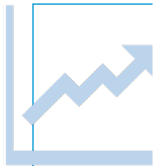
- Most members of an executive board better understand and are more interested in financial terms than IT / software terms; they need to be able to present and discuss project information in both



Profits: revenues minus expenditures (can be + or -)



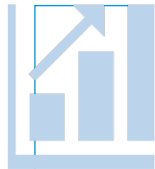
Life cycle costing: considers **total cost over lifespan**, or **development** plus support costs, for a project



Cash flow analysis: determines estimated annual costs and benefits for a project and resulting annual cash flow



Return on Investment ROI :
Profit / total investment



Profit Margin ratio of profits to revenues

- But outside our scope.

ROI : Return on Investment

- You cannot measure ROI unless you have a “benefits” (\$ may not be only consideration) measurement process in place
 - The return / benefit of the project can be defined many ways
 - E.g. a benefit could be market leadership
 - If not done well, success will be elusive
 - Its also important to predict and validate the benefit and improve over time.
 - Useful to decide between multiple projects when you can't do them all

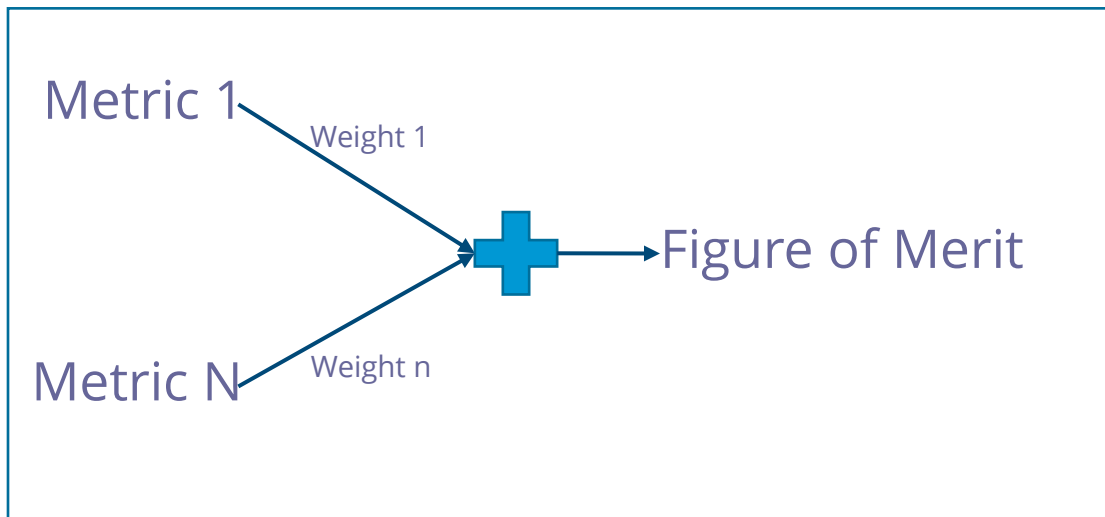
Benefit Measurement: Project selection

- **Murder Board Method** – experts and sr managers scrutinize the projects and decide which ones should **NOT** be selected.
- **Peer Review Method** – Have peer PMs review and give input on the selection process
- **Scoring Model** – use relevant criteria to select a project
 - One way - Figure of Merit or weighted sum
- **Economic Models** – judge projects on their economic return
- **Economic Value Added** – select metrics to calculate the worth created for the company/org
- **Opportunity Cost** – calculate cost you give up by selecting this project over other candidate projects.

So how do you make a decision say with 3 metrics and 5 projects?

Figure of Merit (FOM)

- How do say which selection is better when there is no single metric that can decide it?
 - PC/other Benchmarks use this technique
- Used in different contexts as well – when there is one metric



Metrics:

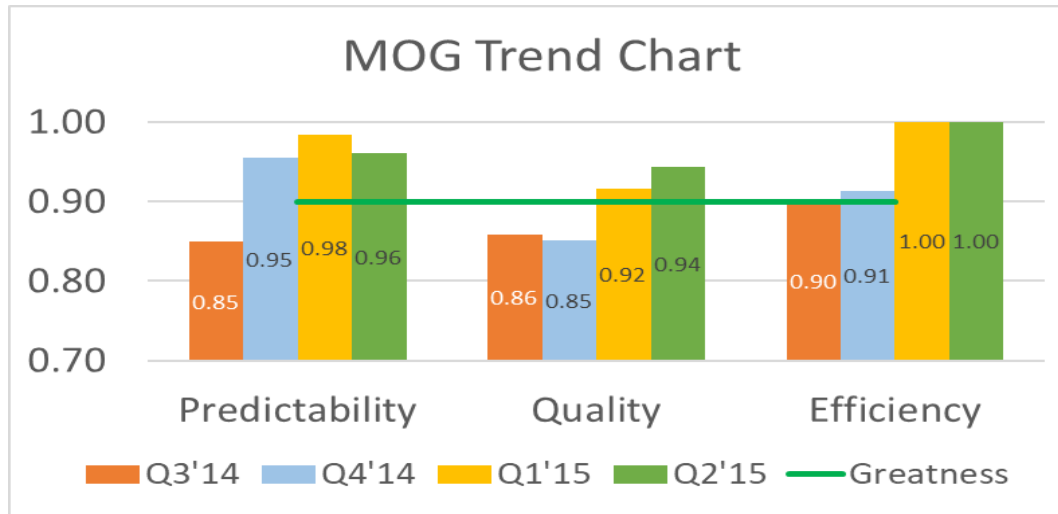
- Normalize from 0-1
- Larger is better

Weights:

- Assign 0-1 based on importance
- Should sum to 1.0

Note: Application of using weighted sum already discussed in C4 (integration)

Real usage of FOM technique – Measure of Greatness (MOG)



Predictability Vector	Weight	Goal	Score 0.8	Q3'14	Q4'14	Q1'15	Q2'15
PV Timeliness	20%	1	+1 week	0.66	No Data	1.00	1
Pre-PV Timeliness	15%	1	+1 week	0.66	1.00	1.00	1
Pre-Si Timeliness	15%	1	+1 week	1.00	No Data	1.00	NA
Feature Timeliness	15%	1	+1 week	1.00	0.97	1.00	1
Review Timeliness	5%	1	+1 week	0.89	0.96	1.00	1
Cust bugs backlog cleaning TPT*	10%	2	2.2	1.20	1.22	0.00	0.00
Cust bug fix TPT post PV* CR (days)	5%	21	28	21.00	No Data	27.00	13.50
Cust bug fix TPT post PV* Hi (days)	5%	28	35	30.00	56	28.00	62.67
Patch backlog cleaning TPT*	10%	1.5	1.7	0.00	1.57	1.25	1.30
Total	100%	0.9		0.85	0.95	0.98	0.96

Example

- Say you have 3 projects to select from and the benefits of the projects are profit Margin, risk level and strategic value to the corporation. Furthermore assume the company is currently financially strapped and needs money quickly. Assume you are using the weighted sum / FOM.

What metrics
would you use?

What weighting
might you
suggest

Who do you think
you should get it
ratified from?

Basic Principles of Cost Management

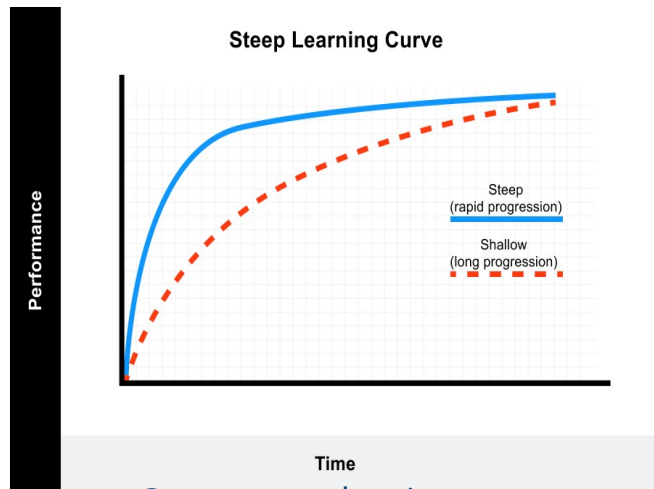
- Categorization of costs and benefits
 - **Tangible** costs or benefits are those costs or benefits that an organization can easily measure in dollars
 - **Intangible** costs or benefits are costs or benefits that are difficult to measure in monetary terms
 - E.g. loss / gain of product leadership
 - Brand value
 - **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
 - E.g. office space,
 - **Sunk** cost is money that has been spent in the past/already; when deciding what projects to invest in or continue, you generally do not include sunk costs
 - E.g. factory has already been built – You wouldn't factor in that cost to produce a product

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
 - Should be intuitively pleasing to us, why?
 - NOTE: unit cost does not include sunk cost – just +/- for that unit!!
 - **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)

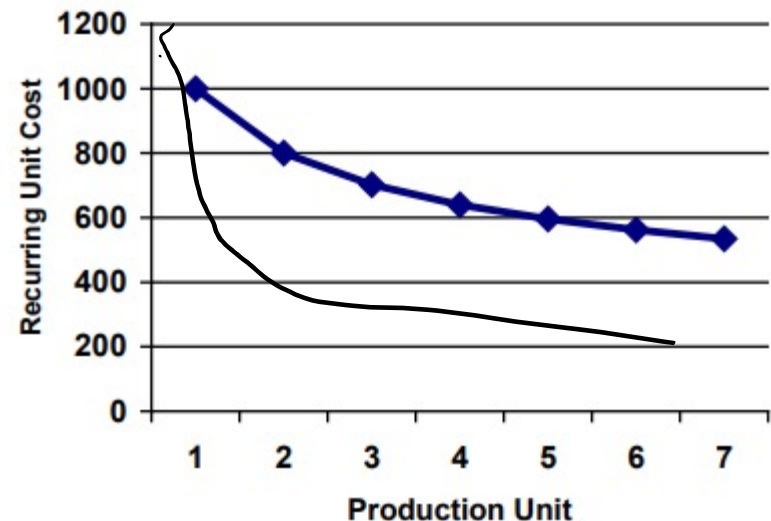
Learning Curve

- Recurring unit cost and cost to produce unit does not consider fixed cost
- As a corporation, you should also get better the more you product you produce.
- E.g. less waste, more efficiency as team learns, the organization learns as you produce more in general
- Little more difficult with just pure software over manufacturing – more like a steep curve



Courtesy valamis.com

$$Y = aX^b$$



Courtesy dau.edu

Popular definition of Steep learning curve opposite of technical one

Advice for Young Professionals

- If you have never done so, take a class or do self-study in accounting, financial statements, or financial management
 - There are many online resources and short books available on the topics of finance for the non-financial manager, how to use financial statements, or similar content
 - Financial specialists are often willing to help less-experienced people better understand the key terminology of the financial field

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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



Control thresholds



Units of measure



Rules of performance measurement



Organizational procedure links



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 IT cost estimates
- Ensure everyone is estimating it the same way and assumptions clearly called out

Estimating Costs

Type of Estimate	When Done	Why Done	Typical Range
Rough order of magnitude (ROM) ~Ball park Estimate (BPE)	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 7-1 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 and with experience
- It is important to provide **supporting details including assumptions** for estimates and updates to project documents
- A large percentage of total project costs are often **labor costs**
 - Other costs may be harder to get at – but the finance folks can help.
 - % of labor costs varies by location as well
 - Even in the US – some companies give “geo difference” for expensive areas

Estimating Costs

Department	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Information systems	24	31	35	13	13	116
Marketing systems	3	3	3	3	3	15
Reservations	12	29	33	9	7	90
Contractors	2	3	1	0	0	6
Totals	41	66	72	25	23	227

Table 7-2 Maximum FTE by department by year

Need to be able to allocate FTEs to projects as well.
Usually don't take individual salaries – take an average for that dept / estimate.

Cost Estimation Tools and Techniques

Analogous

- 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 aka like PERT

- Involve estimating the most likely, optimistic, and pessimistic costs for items
 - Could use PERT weighted average = $(Opp + 4 * ML + Pess) / 6$

Parametric estimating

- Uses project characteristics (parameters) in a mathematical model to estimate project costs

Typical Problems with IT Cost Estimates

- Reasons for inaccuracies
 - Estimates are done too quickly / limited thought
 - People lack estimating experience
 - **Human beings are biased toward underestimation**
 - Management lacking desire for accuracy (perhaps not part of culture??)
 - You will have noisy data so remember your precision level

Accuracy is generally more important than precision.
Remember precision varies.

How to Develop a Cost Estimate and Basis of Estimates

- Do your homework first
 - Look for best know practices
 - Accepted methodologies if known
 - Labor cost charts
 - Talk to finance folks for labor costs
 -

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

Make sure supporting details / sources given for each line item.

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 \times 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	$4,725 * 120$

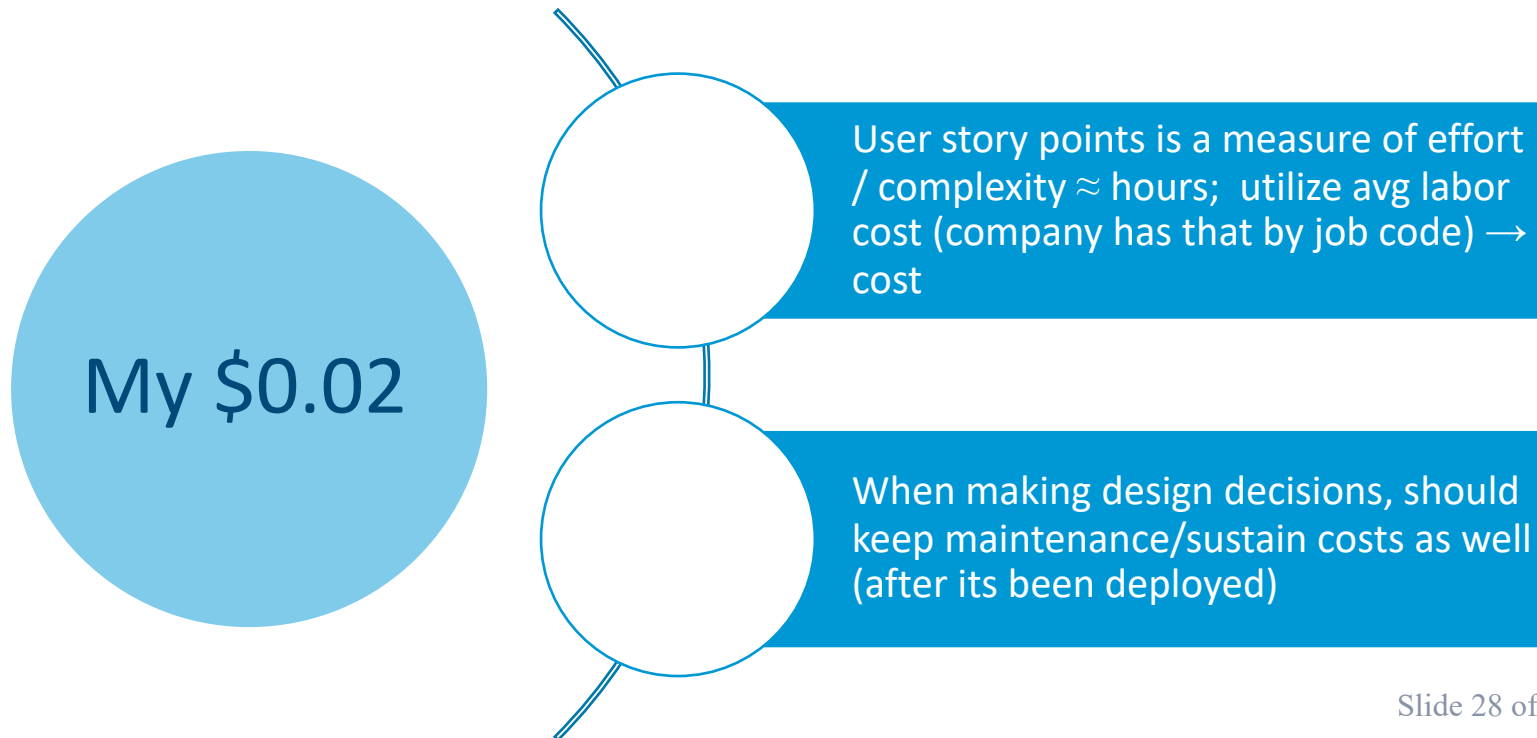
* Based on historical data

Function point estimates business functionality and measure software size. You can est cost that way

FIGURE 7-3 Surveyor pro software development estimate

Best Practice

- Alvin Alexander wrote a book called *Cost Estimating in an Agile Development Environment* in 2015
 - Function points are a means of measuring software size in terms that are meaningful to end users
 - **User stories** are a common way to describe requirements in a simple, concise way
 - Developers can analyze user stories to estimate the number of internal logical files (ILFs)—a group of logically related data/files that resides entirely within the application boundary and is maintained through external inputs



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Determining the Budget

- Budget is not just the as total cost ; its how to allocate the project total cost (estimate) to individual work items (WBS) **over time.**
- Important goal is to produce a cost baseline
 - You can track to see if you or on track or behind in terms of cost vs. baseline
 - Later in this segment – Earned Value (EV) analysis

Determining the Budget

Surveyor Pro Project Cost Baseline Created October 10*

WBS Items	Months												Totals
	1	2	3	4	5	6	7	8	9	10	11	12	
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
 - My \$0.02 - Investigate any significant deviations – ensure no scope creep, mis-understood requirements, etc
- Several tools and techniques assist in project cost control
 - Expert judgment, data analysis, project management information systems, and the to-complete performance index
- Some companies will have their own tools that each manager “assigns” his/her team to company wide projects
 - Roll up can be used for budgeting
 - Finance folks may be able to help get you reports / set up page for you

Earned Value Management (EVM)

- Much of this is not in the book
- 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 **each period**
 - Planned value – what you plan on spending on a given task
 - Actual cost – what you have spent so far on a given task
 - Earned value – is the % of total budget actually completed (can also be a \$)
 - This is usually given by the teams as % of Planned Value – can be noisy
 - **Cannot be more than PV for that task**

Earned Value Management (EVM)

Given Values	Formula	Comments
Planned Value (PV)	Planned cost per item/period	Budget to spend on this item thus far
Actual Cost (AC)	Actual cost for item so far	How much did get spent on the item thus far
Earned value (EV)	EV = PV of all completed work	How much money spent so far on project; FOR ANY INDIVIDUAL ITEMS EV cannot exceed PV
Calculations	Formula	Comments
Cost variance (CV)	$CV = EV - AC$	Absolute value of cost spent so far compared to plan; < 0, running behind spend rate
Schedule variance (SV)	$SV = EV - PV$	How much work you have done compared to plan; < 0, running behind schedule (work done)
Cost performance index (CPI)	$CPI = EV / AC$ Work done / cost so far	How team is performing in terms of cost values < 1 indicates cost overrun; > 1 means doing well
Schedule performance index (SPI)	$SPI = EV / PV$ Work done / Planned so far	How team is performing in terms of schedule Values < 1 indicates behind schedule ; > 1 mean doing well
Budget at Completion (BAC)	Budget of project	Total cost at completion – this does not change
(Cost) Estimate at completion (EAC)	$EAC = BAC / CPI$	Estimated cost assuming team works at the current efficiency
(Cost) Estimate to Complete (ETC)	$ETC = AC + (BAC - EV)$	Estimated cost, assuming any past efficiency deviations will not happen again, and the rest of the work continues as planned (at planned CPI)

Earned Value Management (EVM)

- Recall EAC = Total Cost at current efficiency to date
- ETC = Total cost if efficiency moves back to planned efficiency
- But what efficiency do you need to be at to meet original cost ?

Calculation	Formula	Comments
TCPI (complete at BAC)	$(BAC - EV) / (BAC - AC)$	Amount of work left / Amount of original budget remaining < 1 means can go slower (good) > 1 means have increase efficiency > What about if you a value > 2 or so?

Careful: Analysis only as good as EV data.

Earned Value Management (EVM)

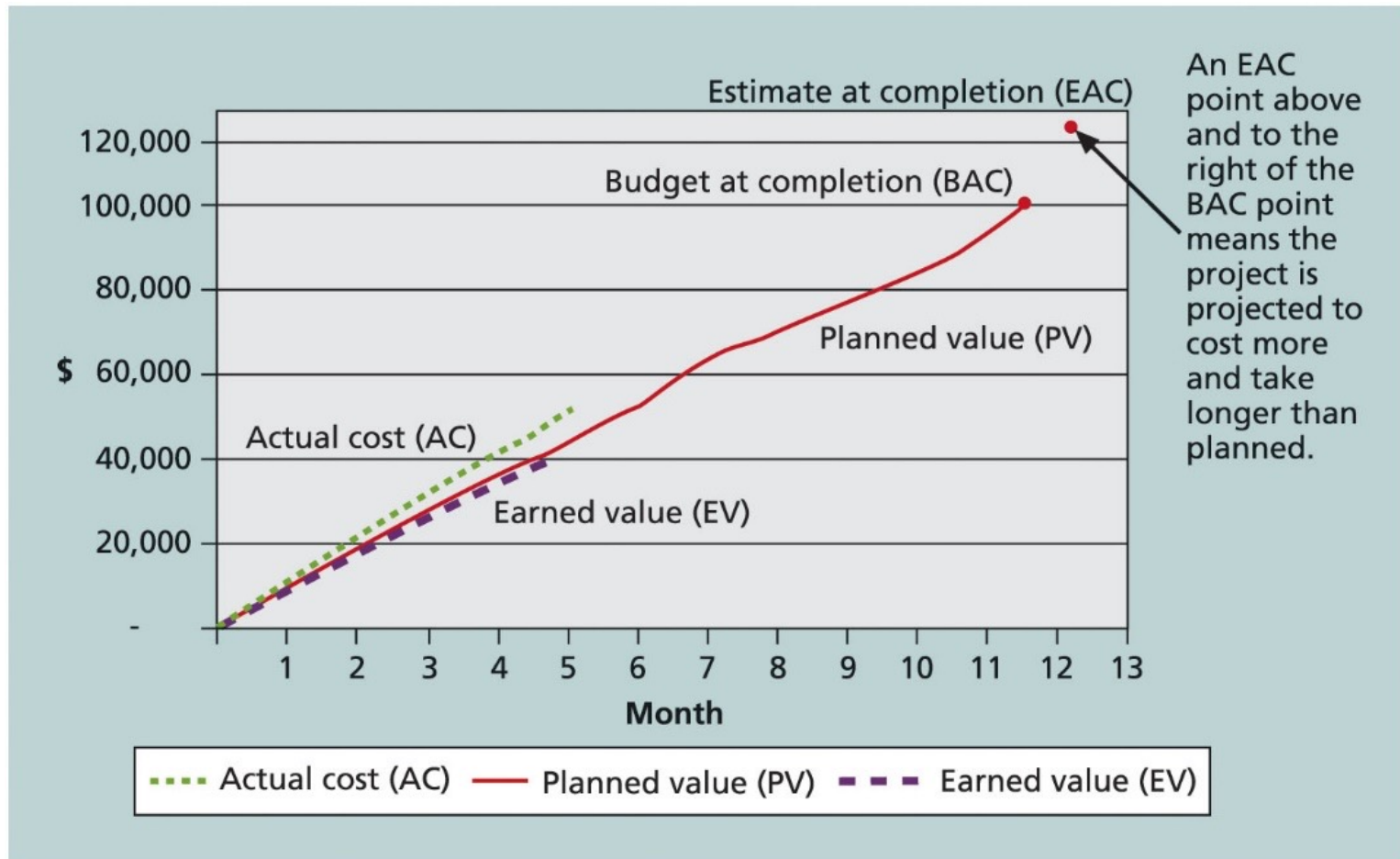


FIGURE 7-6 Earned value chart for project after five months

EVM Template (On canvas)

[Project Title]

Earned Value Analysis Report

ASU - SER 416



Earned Value Management Te

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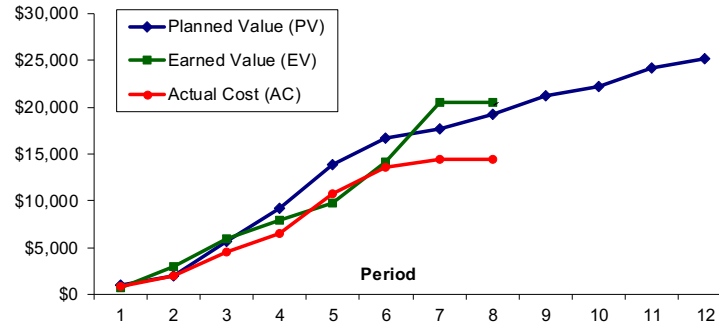
modified by Vijay Suthar 2021

Prepared By: Your name here
Date: [Report Date]

For Period: _____

Summary:

[Use this space to write a brief summary or to record specific observations or notes]



Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS)

WBS	Task Name	TBC	1	2	3	4	5	6	7	8	9	10	11	12
1.1	Task 1	3500	1000	500	2000									
1.2	Task 2	4200		500	800	900	2000							
1.3	Task 3	4500			700	2000	1000	800						
1.4	Task 4	3300			200	600	1000	1500						
1.5	Task 5	3000					700	500	1000	800				
1.6	Task 6	6700								700	2000	1000	2000	1000
		0												
		0												
		0												
		0												
		0												
		0												

Insert new rows above this one

Budget at Completion (BAC)	25200	1000	1000	3700	3500	4700	2800	1000	1500	2000	1000	2000	1000
Cumulative Planned Value (PV)		1000	2000	5700	9200	13900	16700	17700	19200	21200	22200	24200	25200

Actual Cost and Earned Value

Cumulative Actual Cost (AC)	800	1950	4550	6550	10800	13600	14500	14500					
Cumulative Earned Value (EV)	700	3010	5885	8000	9725	14105	20545	20545					

Project Performance Metrics

Cost Variance (CV = EV - AC)	-100	1060	1335	1450	-1075	505	6045	6045	-	-	-	-	-
Schedule Variance (SV = EV - PV)	-300	1010	185	-1200	-4175	-2595	2845	1345	-	-	-	-	-
Cost Performance Index (CPI = EV/AC)	0.88	1.54	1.29	1.22	0.90	1.04	1.42	1.42	-	-	-	-	-
Schedule Performance Index (SPI = EV/PV)	0.70	1.51	1.03	0.87	0.70	0.84	1.16	1.07	-	-	-	-	-
Estimated Cost at Completion (EAC=BAC/CPI)	28800	16326	19483	20633	27986	24298	17785	17785	-	-	-	-	-
Estimate To Complete (ETC=AC + BAC-EV)	25300	24140	23865	23750	26275	24695	19155	19155	-	-	-	-	-
TCPI (complete at BAC)	1.00	0.95	0.94	0.92	1.07	0.96	0.44	0.44	-	-	-	-	-

← You can change the labels for the

← Enter or edit values in the light-bl

← To add more tasks, insert rows a

← Enter the Actual Costs as calcula


← Enter the Earned Value as calcula

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**




My \$0.02



Can be misleading / noisy for partials and where plans are changing all the time

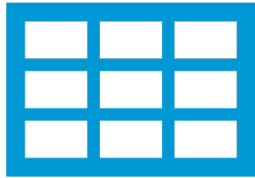


Also Earned value can be hard to estimate in a consistent fashion



When making design decisions, should keep maintenance/sustain costs as well (after its been deployed)

Using Project Management Software to Assist in Project Cost Management



Spreadsheets are a common tool for resource planning, cost estimating, cost budgeting, and cost control



Project management software can increase a project manager's effectiveness during each process of project cost management

Many companies use more sophisticated and centralized financial applications software for cost information

Sample EV template – vertex42.com (excel templates)

- <https://www.vertex42.com/ExcelTemplates/earned-value-management.html>
- **Updated version posted on canvas**

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
 - 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

Resources

- Information Technology Project Management, Ninth Edition, 2019 Cengage