Project Cost Management

Chapter 7 – Information Technology Project Management
EECS 811 – Spring 2014
University of Kansas
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Roadmap

• Introduction and case study overview
• Principles of cost management
• Estimating costs
• Determining the budget
• Controlling costs
• Software and tools
**Roadmap**

- **Introduction and case study overview**
  - Principles of cost management
  - Estimating costs
  - Determining the budget
  - Controlling costs
  - Software and tools
Case Study

• Modernization of the Fiat 500e
  • Support TCU upgrade
  • Telematics infrastructure

• Cost factors
  • Non-recurring engineering (NRE)
  • Development
  • Integration and testing
  • Post-launch support

• The product
The Problem

• Most projects encounter **overrun**
  • Additional percentage or dollar amount by which actual costs exceed estimates
  • **27%** average overrun for IT projects (Harvard Business Review, 2011)

• Measuring overrun isn’t always scientific
  • and neither is management of a project’s costs
What Went Wrong

• United States Internal Revenue Service (IRS) is a prime example of how **not** to manage costs

• A series of failures in the 90’s cost taxpayers >$50 billion

• GAO (2008) reports more than 400 gov’t projects suffer from poor planning and underperformance
  • Total cost of those projects: $25 billion

• United Kingdom National Health Service electronic payments system
  • $26 billion overrun over 10 years
Cost

• **Cost** is defined as a “resource sacrificed or foregone to achieve a specific objective” (*Cost Accounting*)
  - Money
  - Time -> Money

• Project managers must understand project cost management in order to effectively control these tangibles
Project Cost Management

• Recall the triple-constraint (right)

• **Project cost management** includes the processes required to ensure that a project team completes a project within an approved budget

• Endgame: satisfy stakeholders
Processes of Cost Management

• **Estimating costs** – developing an approximation/estimate of the costs of the resources needed to complete a project

• **Determining the budget** – allocating the overall cost estimate to individual work items to establish a *baseline* for measuring performance

• **Controlling costs** – controlling changes to the project budget
Figure 7-1: Project Cost Management Summary

Planning
- Process: Plan cost management
- Outputs: Cost management plan
- Process: Estimate costs
- Outputs: Activity cost estimates, basis of estimates, project documents updates
- Process: Determine budget
- Outputs: Cost baseline, project funding requirements, project documents updates

Monitoring and Controlling
- Process: Control costs
- Outputs: Work performance information, cost forecasts, change requests, project management plan updates, project documents updates, organizational process assets updates

Project Start ———— Project Finish
Case Study - Processes

• Cost estimation based on empirical data

• Budget determination based on cost of service, hardware, and labor rate

• Cost controlling based on regular level of effort reporting against baseline
Roadmap

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Profits

- **Profits** are revenues minus expenditures

- **Profit margin** is the ratio of revenues to profits
  - Example: $100 revenue generates $2 profit
    - 2% profit margin
    - Deduction: $98 invested

- Executives primarily concerned with profits
Life Cycle Costing

- **Life cycle costing** allows you to see a big-picture view of the cost of a project throughout its life cycle

  - Considerations:
    - Total cost of ownership
    - Development plus support costs

- Project managers must make estimates of the costs and benefits of a project throughout its life cycle

- Life cycle cost should emphasize spending **up front** to reduce defect repair costs after implementation
### Cost of Downtime for IT Applications

<table>
<thead>
<tr>
<th>Type of IT Application</th>
<th>Cost/Minute</th>
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<tr>
<td>Securities trading</td>
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<td>Enterprise Requirements Planning (ERP)</td>
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<td>Order processing</td>
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<td>Electronic commerce</td>
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<td>Supply chain</td>
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<td>Point of sale (POS)</td>
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<tr>
<td>Automatic teller machine (ATM)</td>
<td>$3,600</td>
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<td>E-mail</td>
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Cash Flow Analysis

• **Cash flow analysis** is a method for determining the estimated annual costs and benefits for a project and the resulting annual cash flow.
  • Used to determine NPV (net present value)

• Cannot have too many concurrent projects with high cash flow needs
  • Example: Network Vision
  • Capital expenses
Tangibles vs Intangibles

• **Tangible costs/benefits** are those costs or benefits that an organization can easily measure in dollars
  • Example: it costs $100,000 to perform internal labor on a project versus $75,000 to outsource

• **Intangible costs/benefits** are costs or benefits that are difficult to measure in monetary terms
  • Examples: goodwill, political capital, prestige
Costs

• **Direct costs** are costs that can be directly related to producing the products and services of a project.

• **Indirect costs** are costs that are not directly related to the products or services of the project.

• **Sunk cost** is money that has been spent in the past.
Learning Curve Theory

• **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 produces.

• **Factors:**
  • Domain knowledge
  • Relationships
  • Lessons learned
**Case Study – Costs and Curve**

- **Direct costs:** NRE for modem manufacturing, interface adapter development
- **Indirect costs:** travel to Detroit for testing
- **Sunk costs:** interface for previous generation, T-Mobile integration
- **Learning curve:** already tested and integrated once before
Reserves

- **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:
  - AKA “known unknowns”
  - Examples: employee vacations, employee turnover

- **Management reserves** allow for future situations that are unpredictable:
  - AKA “unknown unknowns”
  - Examples: illness, natural disasters, weather
Roadmap

• Introduction and case study overview
• Principles of cost management
• **Estimating costs**
• Determining the budget
• Controlling costs
• Software and tools
Planning Cost Management

• Developing a cost management plan requires the following inputs:
  • Expert judgment
  • Analytical techniques
  • Meetings

• These will drive a **cost estimation** – a variety of techniques for predicting how many resources will be required to complete an activity or collection of activities (project)
Types of Cost Estimates

• **Rough order of magnitude (ROM)** is an estimate of what a project will cost
  • AKA swag, ballpark estimate, or guesstimate
  • Accuracy is typically -50% to +100%, though may be much wider
  • Some IT professionals automatically **double** estimates for software development
Types of Cost Estimates (cont)

• A **budgetary estimate** is used to allocate money into an organization’s budget
  • Many organizations develop budgets at least two years into the future
  • More accurate than ROM -10% to +25%

• A **definitive estimate** provides an “accurate” estimate of project costs
  • Made closer to project completion
  • Accuracy -5% to +10%
  • Based on hard facts, such as cost of hardware
<table>
<thead>
<tr>
<th><strong>Type of Estimate</strong></th>
<th><strong>When Done</strong></th>
<th><strong>Why Done</strong></th>
<th><strong>How Accurate</strong></th>
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</thead>
<tbody>
<tr>
<td>Rough Order of Magnitude (ROM)</td>
<td>Very early in the project life cycle, often 3–5 years before project completion</td>
<td>Provides estimate of cost for selection decisions</td>
<td>−50% to +100%</td>
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<tr>
<td>Budgetary</td>
<td>Early, 1–2 years out</td>
<td>Puts dollars in the budget plans</td>
<td>−10% to +25%</td>
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<tr>
<td>Definitive</td>
<td>Later in the project, less than 1 year out</td>
<td>Provides details for purchases, estimates actual costs</td>
<td>−5% to +10%</td>
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**Table 7-2: Types of Cost Estimates**
Case Study – Cost Estimates

• At project inception, provided a ROM estimate for project costs for all impacted systems
  • Level of effort

• Later, provided definitive cost based on level of effort plus
  • Tools
  • Travel
Cost Management Plan

• A cost management plan is a document that describes how the organization will manage cost variances on the project
  • Based on estimation, but acted on through monitoring and controlling

• Labor costs are a large percentage of total project cost (time = money)
  • Note that labor cost per resource (run rate) is often much higher for contractors than full time employees
  • Example: $45/hr FTE, $75/hr contract
Sample Headcount (Table 7-3)

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<tr>
<th>Department</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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</table>

Maximum departmental headcounts by year for ResNet (Northwest Airlines)
Cost Estimation Tools & Techniques

• Developing a cost estimate is difficult, but can be made easier with tools and processes

• Will discuss:
  • Analogous cost estimating
  • Bottom-up estimating
  • Parametric modeling
  • Cost of quality
  • Software
  • Vendor bid analysis
  • Reserve analysis
Estimation Techniques

• Analogous estimates use the actual cost of a previous, similar project as the basis for estimating the cost of the current project
  • AKA top-down estimate
  • Less costly than other techniques, but may be less accurate

• Bottom-up estimates involve estimating individual work items (activities) and summing to the project total
  • Preferred if there is a detailed WBS available
Estimation Techniques (cont)

• **Parametric modeling** uses project characteristics (parameters) in a mathematical model to estimate project costs
  • Example: cost per line of code based on difficulty, talent, and size
  • Most reliable when model has empirical input for parameters
  • Downside: can be more inaccurate than other models if executed incorrectly (lack of experience)

• **COCOMO II** is a well-known example of a parametric model for development costs
  • [http://csse.usc.edu/tools/COCOMOII.php](http://csse.usc.edu/tools/COCOMOII.php)
Case Study – Estimation Techniques

• **Question:** what type of modeling would be most effective for the 500e project? What was actually used?

• **Answer:** bottom-up estimation was used, and was probably the best choice
Estimation Challenges

• Estimates are often done too quickly

• Many people asked to do estimation lack experience

• Human beings are biased towards underestimation -> overrun

• Most challenging to balance, management wants accuracy
Sample Cost Estimate

• Task: create a cost estimate to upgrade the telematics unit in the next generation of Fiat 500e electric vehicles

• Overview:
  • Upgrade modem from 2G T-Mobile to 4G LTE Sprint
  • Change interface from legacy NGTP to lightweight messaging
  • All changes must be fully qualified before VP-A build date
Sample Cost Estimate Assumptions

• Work breakdown structure (WBS) exists
• Testing is 10% of development costs
• Risk and overhead is 10% of development costs
  • Reserves, project management, architecture
• An inventory of required tools will be generated and quoted
• Three weeks of on-site work in Detroit will be required
Sample Cost Estimate (cont)

• Development costs
  • WBS contains four development activities:
    • TCU client re-write
      • 3 contract resources for 3 weeks
    • Adapt provisioning portal to support new embedded SIM provider
      • 1 full time resource for 1 week
    • Write service adapter for current production units (sunsetting existing dispatcher)
      • 5 contract resources for 8 weeks
    • Add components to rights management for new model support
      • 1 contract resource for 1 week
  • Contract run rate is $75/hr
  • Full time run rate is $45/hr
Sample Cost Estimate (cont)

• Tool support:
  • Develop new simulations for new vehicle (testing)
    • Outsourced for $15,000
  • Vehicle diagnostic tool for logging vehicle messages
    • Licensing cost of $10,000
  • Benchtop fabrication (for testing TCU client prior to vehicle integration)
    • Outsourced for $7,000

• Travel costs:
  • 3 round trips flights to Detroit and 15 hotel nights
    • $5,000
<table>
<thead>
<tr>
<th>WBS Items</th>
<th>#Units/hrs</th>
<th>Cost per</th>
<th>Subtotals</th>
<th>Level 2 Totals</th>
<th>% of Total</th>
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<tr>
<td><strong>Development</strong></td>
<td></td>
<td></td>
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<tr>
<td>TCU Client</td>
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<td><strong>Tools</strong></td>
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<td><strong>TOTAL COST ESTIMATE</strong></td>
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</table>
What could be improved?

• Estimation assumed 40 hours work weeks for contract labor

• Break out design and architecture from project management

• No hard datapoints based on previous experience
  • Dependent on learning curve
Roadmap

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Project Budget Overview

• Determining the project budget involves allocating the project cost estimate to individual work items over time (WBS)

• Budgeting generally includes:
  • Headcount (FTE + Contract)
  • Supplier costs
  • Travel
  • Depreciation
  • Rent/leases
Cost Baseline

• A cost baseline is a time-phased budget that project managers use to measure and monitor cost performance

• Use cost estimates for major activities to create

• Cost budgeting may result in updates to the cost management plan (monitor and controlling)
<table>
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<th>WBS Items</th>
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### Sample Baseline

#### Surveyor Pro Project Cost Baseline Created October 10*

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<td><strong>6. Reserves</strong></td>
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<td><strong>Totals</strong></td>
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<td>86,027</td>
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<td>172,027</td>
<td>223,027</td>
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<td>173,027</td>
<td>148,427</td>
<td>90,027</td>
<td>80,027</td>
<td>53,567</td>
<td>1,521,240</td>
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</table>

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

- Introduction and case study overview
- Principles of cost management
- Estimating costs
- Determining the budget
- **Controlling costs**
- Software and tools
Project Cost Controlling

• Controlling project costs includes monitoring cost performance, cost impact of changes, and stakeholder communication.

• Outputs include:
  • Work performance measurements
  • Budget forecasts
  • Organizational process asset updates
  • Change requests
  • Project management plan updates
  • Product document updates
Earned Value Management

- **Earned value management (EVM)** is a project performance measurement technique that integrates scope, time, and cost data
  - In short: actuals vs forecast
  - Uses baselines as input

- **A baseline** is the original project plan plus approved changes
Key EVM Components

• **Planned value (PV)** is the portion of approved total cost estimate planned to be spent on an activity during a given period
  • AKA budget

• **Actual cost (AC)** is the total direct and indirect costs incurred in accomplishing work on an activity during a given period
  • AKA actuals

• **Earned value (EV)** is an estimate of the value of the physical work actually completed
  • Essentially a monetary representation of all work complete to date
  • **Ratio of performance (RP)** is the ratio of actual work completed to the percentage of work planned
EVM Components (cont)

- **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
  - Used to estimate the projected cost of completing the project
- **Schedule performance index (SPI)** is the ratio of earned value to planned value
  - Used to estimate the projected time to complete the project
- **Estimate at completion (EAC)** is an estimate of what it will cost to complete the project based on performance to date
  - Can be done for schedule as well
Table 7-5: Earned Value Formulas

<table>
<thead>
<tr>
<th>Term</th>
<th>Formula</th>
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</thead>
<tbody>
<tr>
<td>Earned value (EV)</td>
<td>$EV = PV$ to date * $RP$</td>
</tr>
<tr>
<td>Cost variance (CV)</td>
<td>$CV = EV - AC$</td>
</tr>
<tr>
<td>Schedule variance (SV)</td>
<td>$SV = EV - PV$</td>
</tr>
<tr>
<td>Cost performance index (CPI)</td>
<td>$CPI = EV/AC$</td>
</tr>
<tr>
<td>Schedule performance index (SPI)</td>
<td>$SPI = EV/PV$</td>
</tr>
<tr>
<td>Estimate at completion (EAC)</td>
<td>$EAC = BAC/CPI$</td>
</tr>
<tr>
<td>Estimated time to complete</td>
<td>Original time estimate/SPI</td>
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</table>
### Table 7-4: Earned Value Calculations

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<tr>
<th><strong>Activity</strong></th>
<th><strong>Week 1</strong></th>
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<td>Earned Value (EV)</td>
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<tr>
<td>Planned Value (PV)</td>
<td>10,000</td>
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<tr>
<td>Actual Cost (AC)</td>
<td>15,000</td>
</tr>
<tr>
<td>Cost Variance (CV)</td>
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</tr>
<tr>
<td>Schedule Variance (SV)</td>
<td>-5,000</td>
</tr>
<tr>
<td>Cost Performance Index (CPI)</td>
<td>33%</td>
</tr>
<tr>
<td>Schedule Performance Index (SPI)</td>
<td>50%</td>
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</tbody>
</table>
Figure 7-5: Earned Value Chart (Five Months)

- Actual cost (AC)
- Planned value (PV)
- Earned value (EV)

An EAC point above and to the right of the BAC point means the project is projected to cost more and take longer than planned.
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.
- 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.
Project Portfolio Management

• Utilizing a portfolio for related projects enhances cost management by providing historical data

• The five levels of portfolio management:
  • Put all your projects in one database
  • Prioritize the projects in the database
  • Divide projects into two or three budgets based on type of investment
  • Automate the repository
  • Apply modern portfolio theory including risk-return tools that map project risk on a curve
Case Study – Portfolio Management

• The Fiat 500e upgrade project is actually a relatively small project in connected vehicle portfolio

• Other major projects:
  • Infotainment variant support
  • Remote diagnostics
  • Model support (Chrysler, Dodge, Jeep, RAM, SRT, Fiat)
  • Platform modernization

• Draw from all to enhance cost estimation accuracy
Roadmap

• Introduction and case study overview
• Principles of cost management
• Estimating costs
• Determining the budget
• Controlling costs

• Software and tools
Cost Controlling Software

• Microsoft Project 2007
  • Assign cost to resources
  • Track actuals to forecast (EVM)

• Spreadsheets

• Using software empirically has benefits (2008 Gantry Group study)
  • Improved project timeliness by 45.2%
  • Reduced time spent on status reporting by 43%
  • Reduced time spent on labor capitalization reporting by 55% (3.6 hrs/report)
  • Decreased time to sign-off for new projects by 20.4% (8 days)
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<th>Done</th>
<th>SOX</th>
<th>Chargeable LOE (Hr)</th>
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Chapter Summary

• Project cost management is a traditionally weak area of IT projects, and project managers must work to improve their ability to deliver projects within approved budgets

• Main processes include
  • Plan cost management
  • Estimate costs
  • Determine the budget
  • Control costs