Chapter 7
Project Cost Management
(PMBOK Guide)

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Table of Content
Introduction

• Process involved in estimating, budgeting and controlling costs to complete the project with the approved budget
• Estimate costs
• Determine budget
• Control costs
Project Cost Management Overview

7.1 Estimate Costs
- Inputs
  1. Scope baseline
  2. Project schedule
  3. Human resource plan
  4. Risk register
  5. Enterprise environmental factors
  6. Organizational process assets
- Tools & Techniques
  1. Expert judgment
  2. Analogous estimating
  3. Parametric estimating
  4. Bottom-up estimating
  5. Three-point estimates
  6. Reserve analysis
  7. Cost of quality
  8. Project management estimating software
  9. Vendor bid analysis
- Outputs
  1. Activity cost estimates
  2. Basis of estimates
  3. Project document updates

7.2 Determine Budget
- Inputs
  1. Activity cost estimates
  2. Basis of estimates
  3. Scope baseline
  4. Project schedule
  5. Resource calendars
  6. Contracts
  7. Organizational process assets
- Tools & Techniques
  1. Cost aggregation
  2. Reserve analysis
  3. Expert judgment
  4. Historical relationships
  5. Funding limit reconciliation
- Outputs
  1. Cost performance baseline
  2. Project funding requirements
  3. Project document updates

7.3 Control Costs
- Inputs
  1. Project management plan
  2. Project funding requirements
  3. Work performance information
  4. Organizational process assets
- Tools & Techniques
  1. Earned value management
  2. Forecasting
  3. To-complete performance index (TCPI)
  4. Performance reviews
  5. Variance analysis
  6. Project management software
- Outputs
  1. Work performance measurements
  2. Budget forecasts
  3. Organizational process assets updates
  4. Change requests
  5. Project management plan updates
  6. Project document updates
Cost Management Plan (1/2)

- Either formal or informal, highly detailed or broadly framed can establish:
  - Level of accuracy (rounding of data, $100, $1000) based on the scope and may include an amount for contingencies
  - Units of measure (staff hours, staff days, weeks or lump sum) for each recourses
  - Organizational procedures links (the WBS component used for the project cost accounting is called the Control Account (CA), has a unique code or account numbers linked directly to organization’s accounting system
  - Control thresholds (variance thresholds for monitoring cost performance, agreed upon before any action is taken, expressed as percentage)
Cost Management Plan (2/2)

– Rules of performance measurement
  • Define WBS points where control accounts will be performed
  • Establish the earned value measurement techniques (weighted milestone, fixed formula, percent complete, ...)
  • Specify the earned value management computation equations for determining the projected Estimate at Completion (EAC) forecasts and other tracking methodologies

– Reporting format (format and frequency of cost reports)
– Process description

• Should consider:
  – stakeholder requirements (cost of an item when decision is made, order is placed, item is delivered, actual cost is incurred or recorded for project accounting)
  – Effect of project decisions on the subsequent recurring cost of using, maintaining, and supporting the product, service
7.1 Estimate Costs

- The process of developing an approximation of the monetary resources needed to complete project activities
- Identification and consideration of costing alternatives
- Cost trade-offs and risks, make versus buy, lease, sharing the resources
- Expressed in units of some currency, staff hours, staff days
- Iterative process, accuracy increases as time goes by, Rough Order of Magnitude (ROM) [±50%] at the beginning, narrow down to ±10%
- Include labour, materials, equipment, services, facilities, inflation, contingency costs
Inputs, Tools & Techniques, Outputs

**Inputs**
- 1. Scope baseline
- 2. Project schedule
- 3. Human resource plan
- 4. Risk register
- 5. Enterprise environmental factors
- 6. Organizational process assets

**Tools & Techniques**
- 1. Expert judgment
- 2. Analogous estimating
- 3. Parametric estimating
- 4. Bottom-up estimating
- 5. Three-point estimates
- 6. Reserve analysis
- 7. Cost of quality
- 8. Project management estimating software
- 9. Vendor bid analysis

**Outputs**
- 1. Activity cost estimates
- 2. Basis of estimates
- 3. Project document updates
Data Flow Diagram

5.3 Create WBS

6.5 Develop Schedule

9.1 Develop Human Resource Plan

11.2 Identify Risks

Enterprise/Organization

Project Cost Management

7.1 Estimate Costs

- Project document updates
- Activity cost estimates
- Basis of estimates

7.2 Determine Budget

- Scope baseline
- Project schedule
- Human resource plan
- Risk register
- Organizational process assets
- Enterprise environmental factors

Project Documents

12.1 Plan Procurements

11.2 Identify Risks
Inputs

• Scope baseline
  – Scope statement (only direct or indirect costs as well?, contractual or legal implications: HSE, security, performance, insurance, copyright, licences, permits)
  – Work breakdown structure
  – WBS dictionary (identification of the deliverables and their descriptions)
Inputs

• Project schedule (type and quantity of resources, amount of their time -> schedule activity)
• Human resource plan (project staffing plan, personal rates, rewards, recognitions)
• Risk register (risk mitigation costs -> delays, and near-term costs!)
• Enterprise environmental factors
  – Market condition
  – Published commercial information
• Organizational process assets
  – Cost estimating policies
  – Templates
  – Historical information
  – Lesson learned
Tools and Techniques

• Expert judgment
  – Labour rates, material costs, inflation, risk factors, ..., historical information)

• Analogous estimating
  – Scope, cost budget, duration, size, scale, weight, complexity
  – Good when limited info is available, early phase of project
  – Less costly, less time consuming, less accurate

• Parametric estimating

• Bottom-up estimating

• Three-point estimates (most likely, optimistic, pessimistic)

• Reserve analysis (contingency allowances for uncertainty)

• Cost of Quality (COQ)

• PM estimating software

• Vendor bid analysis
Outputs

• Activity cost estimates
  – Summary or detail
  – Labour, materials, equipment, services, facilities, IT, inflation, contingency reserve

• Basis of estimates
  – Documentation of the basis of the estimate
  – Documentation of assumption made
  – Documentation of known constraints
  – Indication of uncertainty (percentage)
  – Indication of confidence level of final estimate
7.2 Determine Budget

- The process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline
- Project budget constitute the funds authorized to execute the project
- Project cost performance is measured against the authorized budget
Inputs, Tools & Techniques, Outputs

**Inputs**
- 1. Activity cost estimates
- 2. Basis of estimates
- 3. Scope baseline
- 4. Project schedule
- 5. Resource calendars
- 6. Contracts
- 7. Organizational process assets

**Tools & Techniques**
- 1. Cost aggregation
- 2. Reserve analysis
- 3. Expert judgment
- 4. Historical relationships
- 5. Funding limit reconciliation

**Outputs**
- 1. Cost performance baseline
- 2. Project funding requirements
- 3. Project document updates
Data Flow

Project Cost Management

- 7.1 Estimate Costs
  - Activity cost estimates
  - Basis of estimates

- 7.2 Determine Budget
  - Project document updates
  - Cost performance baseline
  - Project funding requirements

- 7.3 Control Costs
  - Scope baseline
  - Project schedule

- 5.3 Create WBS
- 6.5 Develop Schedule
- 9.2 Acquire Project Team
- 12.2 Conduct Procurements
- Enterprise/Organization

- Project Documents
- 12.1 Plan Procurements
- 8.1 Plan Quality
- 4.2 Develop Project Management Plan
Inputs

• Activity cost estimates
• Basis of estimates
• Scope baseline
  – Scope estimate
  – Work breakdown structure
  – WBS dictionary
• Project schedule
• Resource calendars
• Contracts
• Organizational process assets
  – Formal/informal cost budgeting-related policies, procedures, guidelines
  – Cost budgeting tools
  – Reporting methods
Tools and Techniques

• Cost aggregation
• Reserve analysis
• Expert judgment
  – Other units within organization
  – Consultants
  – Stakeholders, customers
  – Professional and technical association
  – Industry groups
• Historical relationships (analogous estimate, reliability: similarity of projects, parameters, scalability of model)
• Funding limit reconciliation
Outputs

• Cost performance baseline
  – Authorized time-phased Budget at Completion (BAC) used to measure, monitor and control overall cost performance (S shape curve)

• Project funding requirements

• Project document updates
  – Risk register
  – Cost estimates
  – Project schedule
Cost Baseline, Expenditures, and Funding Requirements
7.3 Control Costs

• The process of monitoring the status of the project to update the project budget and managing changes to the cost baselines
• Involves recording actual cost spent
• Approval to increase the budget through Integrated Change Control Process
7.3 Control Costs

• Includes
  – Influencing the factors that create changes to authorized cost baselines
  – Ensuring change requests are acted in a timely manner
  – Managing the actual changes
  – Ensuring the cost expenditures do not exceed the authorized funding
  – Monitoring cost to find out the variances
  – Monitoring work performance versus funds expended
  – Preventing unapproved changes in cost or resources
  – Informing appropriate stakeholders of approved changes and their costs
  – Bringing expected cost overruns within accepted limits
Inputs, Tools & Techniques, Outputs

Inputs
.1 Project management plan
.2 Project funding requirements
.3 Work performance information
.4 Organizational process assets

Tools & Techniques
.1 Earned value management
.2 Forecasting
.3 To-complete performance index
.4 Performance reviews
.5 Variance analysis
.6 Project management software

Outputs
.1 Work performance measurements
.2 Budget forecasts
.3 Organizational process assets updates
.4 Change requests
.5 Project management plan updates
.6 Project document updates
Data Flow

- 4.2 Develop Project Management Plan
  - Project management plan
  - Project management plan updates

- 4.3 Direct and Manage Project Execution
  - Work performance information
  - Organizational process assets
  - Organizational process assets updates

- 7.2 Determine Budget
  - Project funding requirements
  - Project document updates

- 7.3 Control Costs
  - Work performance measurements
  - Budget forecasts
  - Change requests

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Inputs

- **Project management plan**
  - Cost performance balance
    - To check with the actual results to see if change (corrective, preventive actions) is necessary
  - Cost management plan
    - How the project should be managed and controlled

- **Project funding requirements**

- **Work performance information**
  - Which deliverables have started, finished, how much progress
  - Costs have been authorized, incurred, and estimate for future

- **Organizational process assets**
  - Formal/informal cost control-related policies, procedures, and guidelines
  - Cost control tools
  - Monitoring and reporting methods
Tools and Techniques

• Earned Value Management (EVM)
  – Uses project scope, cost and schedule measures to assess and measure project performance and progress
  – Develop and monitors three key dimensions for each work package and control account
    • Planned value (PV)
      – Authorized budget assigned for completion of an activity or WBS component
      – Detailed authorized work + the corresponding budget
      – Total PV is called Performance Measurement Baseline (PMB)
      – Total PV for the project is called Budget at Completion (BAC)
    • Earned value (EV)
      – The value of work performed expressed in terms of approved budget
      – Authorized work that has been completed + the corresponding authorized budget
      – Is related to PV baseline (PMB)
      – EV cannot be greater than authorized PV
    • Actual cost (AC)
      – Total cost actually incurred for accomplishing work performed
      – Same definition (direct hours only, direct costs only, all costs including indirect costs) as PV and EV
      – Has no upper limit
Tools and Techniques

– Variances from approved baseline is monitored
  • Schedule variance (SV)
    – Measure of schedule performance
    – SV=EV – PV
    – SV at the end of project is zero
  • Cost variance (CV)
    – Measure of cost performance
    – CV=EV-AC
    – CV at the end of project is the difference between BAC and the actual amount spent
    – Any negative CV is often non-recoverable
Tools and Techniques

– Schedule performance index (SPI)
  • A measure of progress achieved versus progress planned
  • SPI = EV/PV
  • Sometimes used with cost performance index (CPI)
  • SPI < 1 ---> less work completed than planned
  • SPI > 1 ---> more work completed than planned

– Cost performance index (CPI)
  • A measure of value of work completed versus the actual cost
  • CPI = EV/AC
  • CPI < 1 ---> cost overrun for work completed
  • CPI > 1 ---> cost under run for work completed
EV, PV, and Actual Costs

![Graph showing EV, PV, and Actual Costs over time]
Tools and Techniques

• Forecasting
  — Budget at Completion (BAC)
  — Estimate at Completion (EAC)
    • Generated, updated, reissued based on work performance
    • Based on actual costs incurred + an estimate to complete (ETC) the remaining work
    • Most common EAC forecasting is manual bottom-up summation
    • Burden: doing EAC takes energy. EAC=AC+ (bottom-up ETC )
Tools and Techniques

– Statistical EAC based on EVM method
  • EAC forecast for ETC work performed at the budgeted rate. EAC=AC+BAC-EV
  • EAC forecasted for ETC work performed at the present CPI. EAC=BAC/(cumulative CPI)
  • EAC forecast for ET work considering both SPI and CPI factors. Variation of this method weigh the CPI and SPI differently (80/20, 50/50, ...). EAC= AC +[(BAC-EV)/(cumulative CPI x cumulative SPI)]

• To-Complete Performance Index (TCPI), the calculated projection of cost performance that must be achieved on the remaining work to meet a specific goal such as BAC or EAC. TCPI based on BAC=(BAC-EV)/(BAC-AC)
TCPI

Status Date

TCPI (BAC)

Baseline Plan

TCPI (EAC)

Cumulative CPI

Formula:

\[
\frac{\text{Work Remaining (BAC-EV)}}{\text{Funds Remaining (BAC-AC) or (EAC-AC)}} = \text{TCPI}
\]
Tools and Techniques

– If cumulative CPI falls below the baseline plan, all future work of the project will need to immediately be performed in the range of the TCPI (BAC) to stay within the authorized BAC.

– Reaching the goal depends on risks, schedule, technical performance, ...

– If not, EAC is computed and once approved, it is the new goal

– TCPI based on $EAC=(BAC-EV)/(EAC-AC)$
Tools and Techniques

• Performance reviews
  – Compare cost performance over time, schedule activities or work packages overrunning and under running the budget, and the estimated funds needed to complete work in progress
  – In EVM:
    • Variance analysis: compares actual project (cost or schedule) performance to planned or expected performance
    • Trend analysis: examines project performance over time to determine if performance is improving or deteriorating. Graphical comparison of BAC versus EAC and completion dates
    • Earned value performance: compares the baseline plan to actual schedule and cost performance
Tools and Techniques

• Variance analysis
  – Cost performance measurements (CV, CPI) are used to assess the magnitude of variation to the original cost baseline
  – Cause and degree of variance WRT the cost performance baseline? --> corrective/preventive action?
  – High acceptable variance range at start, lower as the project gets closer to complete

• Project Management software
  – Monitoring PV, EV, and AC
Outputs

• Work performance measurements
  – Calculated CV, SV, CPI, and SPI values for WBS components, work packages and control accounts are documented and communicated to stakeholders

• Budget forecasts
  – Calculated EAC value or bottom-up EAC value is documented and communicated to stakeholders

• Organizational Process Assets updates
  – Cause of variance
  – Corrective actions chosen and the reasons
  – Other types of lessons learned from project cost control

• Change requests (through the Perform Integrated Change Control Process)

• Project management plan updates
  – Cost performance baseline (scope, activity resources, cost estimates. Sometimes new cost baseline should be prepared as cost variance is severe)
  – Cost management plan

• Project document plan
  – Cost estimates
  – Basis of estimates