Project Management Professional (PMP)

Section (7)
Project Cost Management

AHMED YOUSRY CONSULTANT

PMBOK 5th. Edition

Project Cost Management

- The processes involved in planning, estimating, budgeting, financing, funding, managing & controlling costs so that the project can be completed within the approved budget.

  - Project Cost Management processes:
    - 7.1 Plan Cost Management
    - 7.2 Estimate Costs
    - 7.3 Determine Budget
    - 7.4 Control Costs

Project Cost Management

- Project Cost Management should:
  - Consider the stakeholder requirements for **managing costs.**
  - Consider the different stakeholders will **measure project costs in different ways & at different times.**
  - Primarily concerned with **the cost of the resources needed to complete project activities.**
  - Consider the effect of project decisions on the subsequent recurring cost of using, maintaining & supporting the product, service or result of the project.

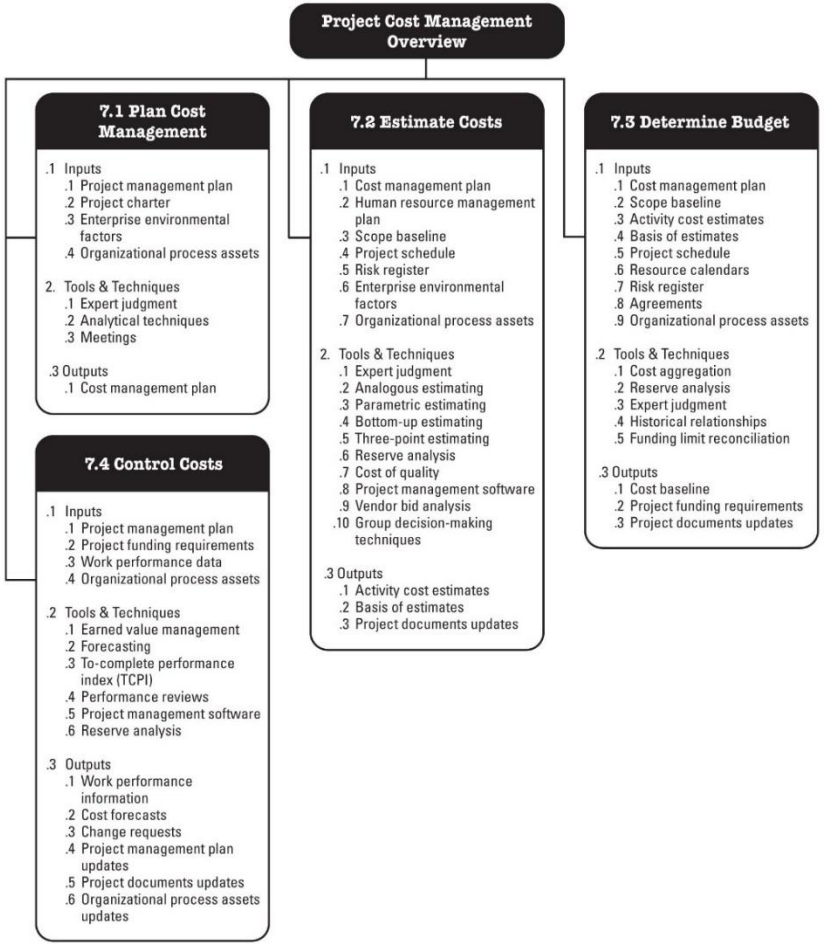

Figure 7-1. Project Cost Management Overview

7.1 Plan Cost Management

- The process that establishes the **policies, procedures & documentation** for **planning, managing, expending & controlling** project costs.

  - The key benefit of this process is
    - It provides guidance and direction on how the project costs will be managed throughout the project.

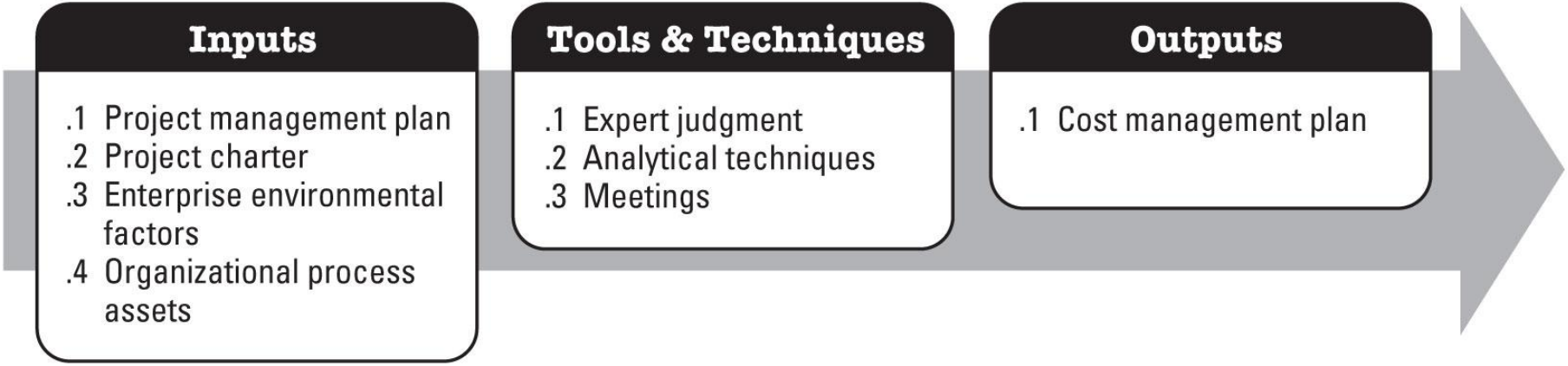

Figure 7-2. Plan Cost Management: Inputs, Tools & Techniques, and Outputs

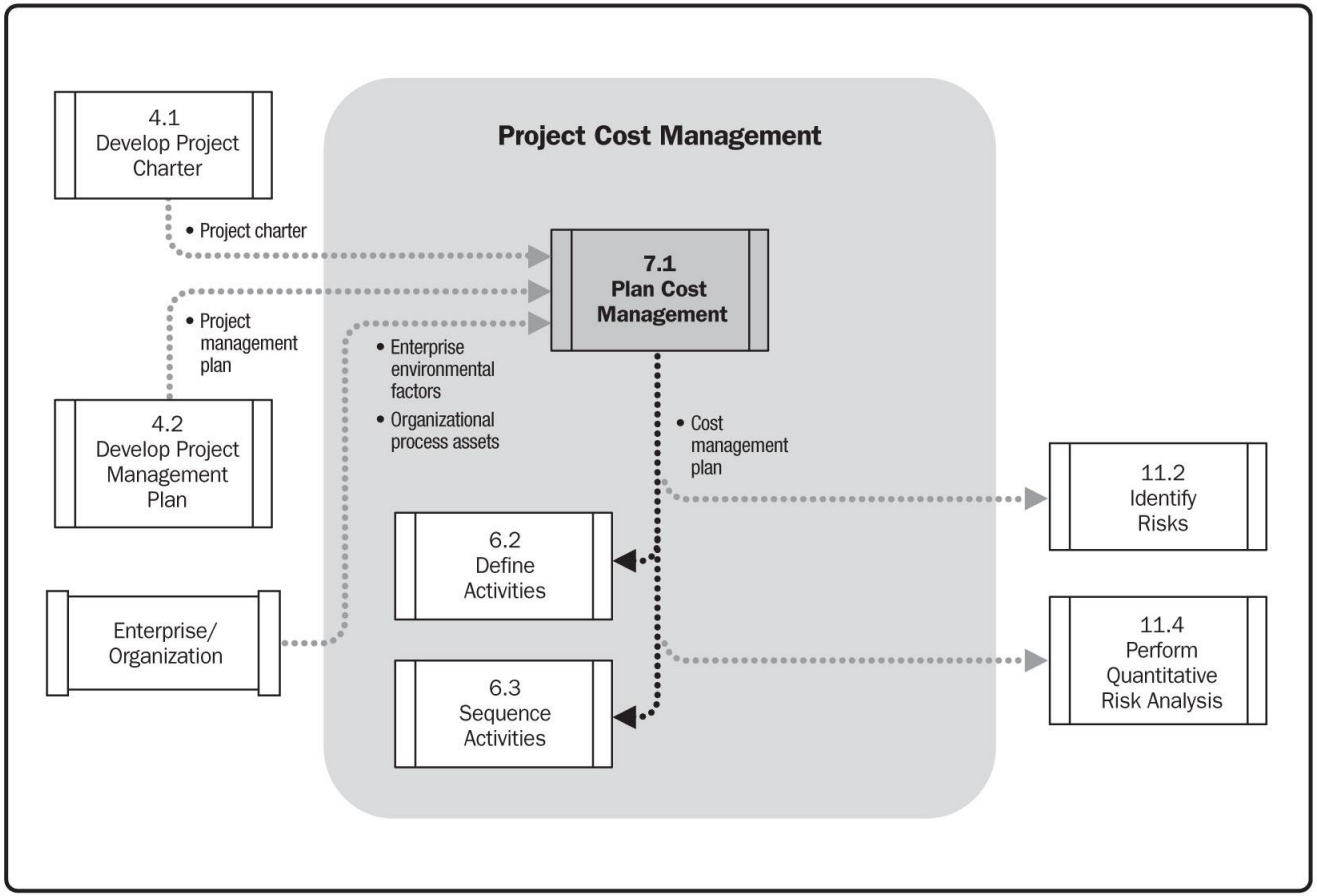

Figure 7-3. Plan Cost Management: Data Flow Diagram

7.1.1 Plan Cost Management: Inputs

- 7.1.1.1 Project Management Plan (Out: 4.2)
  - The project management plan contains information used to develop the cost management plan, which contains:
    - **Scope baseline:**
      - The scope baseline includes the project scope statement and WBS detail for cost estimation and management.
    - **Schedule baseline:**
      - The schedule baseline defines when the project costs will be incurred.
    - **Other information:**
      - Other cost-related scheduling, risk and communications decisions from the project management plan.

7.1.1 Plan Cost Management: Inputs

- 7.1.1.2 Project Charter (Out: 4.1)
  - The project charter provides the summary budget from which the detailed project costs are developed.
  - The project charter also defines the project approval requirements that will influence the management of the project costs.

7.1.1 Plan Cost Management: Inputs

- 7.1.1.3 Enterprise Environmental Factors (Out: 2.1.5)
  - The EEFs that influence the Plan Cost Management process include:
    - Organizational culture and structure can all influence cost management.
    - Market conditions describe what products, services & results are available in the regional and global market.
    - Currency exchange rates for project costs sourced from more than one country.
    - Published commercial information[1]
    - Project management information system, which provides alternative possibilities for managing cost.

7.1.1 Plan Cost Management: Inputs

- 7.1.1.4 Organizational Process Assets (Out: 2.1.4)
  - The OPAs that influence the Plan Cost Management process include:
    - Financial controls procedures (e.g., time reporting, required expenditure and disbursement reviews, accounting codes, and standard contract provisions).
    - Historical information and lessons learned knowledge bases.
    - Financial databases.
    - Existing formal and informal cost estimating and budgeting-related policies, procedures, and guidelines.

7.1.2 Plan Cost Management: Tools and Techniques

- 7.1.2.1 Expert Judgment
  - Expert judgment, guided by historical information, provides valuable insight about the environment and information from prior similar projects.
  - Expert judgment can also suggest whether to combine methods and how to reconcile differences between them.
  - Judgment based upon expertise in an application area, Knowledge Area, discipline, industry, etc., as appropriate for the activity being performed should be used in developing the cost management plan.

7.1.2 Plan Cost Management: Tools and Techniques

- 7.1.2.2 Analytical Techniques
  - Developing the cost management plan may involve choosing **strategic options to fund the project** such as:
    - Self-funding
    - Funding with equity
    - Funding with debt

7.1.2 Plan Cost Management: Tools and Techniques

- 7.1.2.2 Analytical Techniques (Cont.)
  - The cost management plan may also detail ways to finance project resources such as:
    - Making OR Purchasing
    - Renting OR Leasing
  - Organizational policies & procedures may influence which financial techniques are employed in these decisions. Techniques may include:
    - Payback period
    - Internal rate of return (IRR)
    - Net present value (NPV)
    - Return on investment (ROI)
    - Discounted cash flow

7.1.2 Plan Cost Management: Tools and Techniques

- 7.1.2.3 Meetings
  - Project teams may hold planning meetings to develop the cost management plan.
  - Attendees at these meetings may include:
    - The project manager
    - The project sponsor
    - Selected project team members
    - Selected stakeholders
    - Anyone with responsibility for project costs
    - Others as needed.

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan
  - **A component of the project management plan** and <u>describes how the project costs will be planned, structured, and controlled</u>.
  - The cost management processes and their associated tools & techniques are documented in the cost management plan.

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan (Cont.)
  - Example: The cost management plan can establish the following:
    1. Units of measure
    2. Level of precision
    3. Level of accuracy
    4. Organizational procedures links
    5. Control thresholds
    6. Rules of performance measurement

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan (Cont.)
  - Example: The cost management plan can establish the following:
    1. Units of measure
       - Each unit used in measurements (Defined for each resources), such as:
         - Staff hours
         - Staff days
         - Weeks for time measures
         - Meters
         - Liters
         - Tons
         - Kilometers
         - Cubic yards for quantity measures
         - Lump sum in currency form

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan (Cont.)
  - Example: The cost management plan can establish the following:

2. Level of precision
   - The degree to which activity cost estimates will be rounded up or down (e.g., US$100.49 to US$100, or US$995.59 to US$1,000) based on the scope of the activities and magnitude of the project.

3. Level of accuracy
   - The acceptable range (e.g., ±10%) used in determining realistic activity cost estimates is specified, and may include an amount for contingencies;

7.1.3 Plan Cost Management: Outputs

7.1.3.1 Cost Management Plan (Cont.)

- Example: The cost management plan can establish the following:

4. Organizational procedures links
   - The work breakdown structure (WBS) provides the framework for the cost management plan, allowing for consistency with the estimates, budgets, and control of costs.
   - The WBS component used for the project cost accounting is called the control account.
   - Each control account is assigned a unique code or account number(s) that links directly to the performing organization's accounting system.

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan (Cont.)
  - Example: The cost management plan can establish the following:
    5. Control thresholds
       - Variance thresholds for monitoring cost performance may be specified to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken.
       - Thresholds are typically expressed as percentage deviations from the baseline plan.

7.1.3 Plan Cost Management: Outputs

7.1.3.1 Cost Management Plan (Cont.)

- Example: The cost management plan can establish the following:

6. Rules of performance measurement
   - Earned value management (EVM) rules of performance measurement are set.
   - Example: The cost management plan may:
     - Define the points in the WBS at which measurement of control accounts will be performed.
     - Establish the earned value measurement techniques (e.g., weighted milestones, fixed-formula, percent complete, etc.) to be employed.
     - Specify tracking methodologies and the earned value management computation equations for calculating projected estimate at completion (EAC) forecasts to provide a validity check on the bottom-up EAC.

7.1.3 Plan Cost Management: Outputs

- 7.1.3.1 Cost Management Plan (Cont.)
  - Notes:
    - For more specific information regarding earned value management, refer to the Practice Standard for Earned Value Management – Second Edition.
    - Reporting formats
      - The formats and frequency for the various cost reports are defined.
      - Process descriptions
      - Descriptions of each of the other cost management processes are documented.
    - Additional details, include:
      - Description of strategic funding choices.
      - Procedure to account for fluctuations in currency exchange rates.
      - Procedure for project cost recording.

7.2 Estimate Costs

- The process of **developing** an approximation of the monetary resources needed to complete project activities.
  - The key benefit of this process is:
    - It determines the amount of cost required to complete project work.

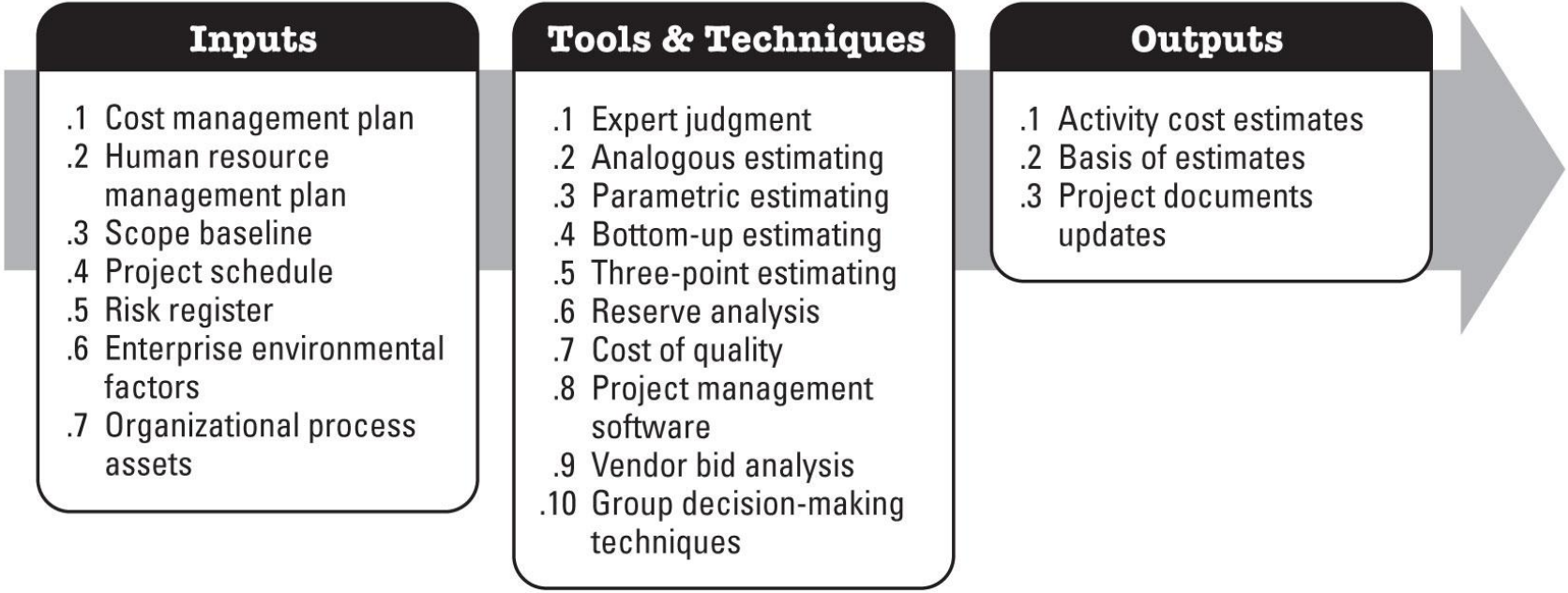

Figure 7-4. Estimate Costs: Inputs, Tools & Techniques, and Outputs

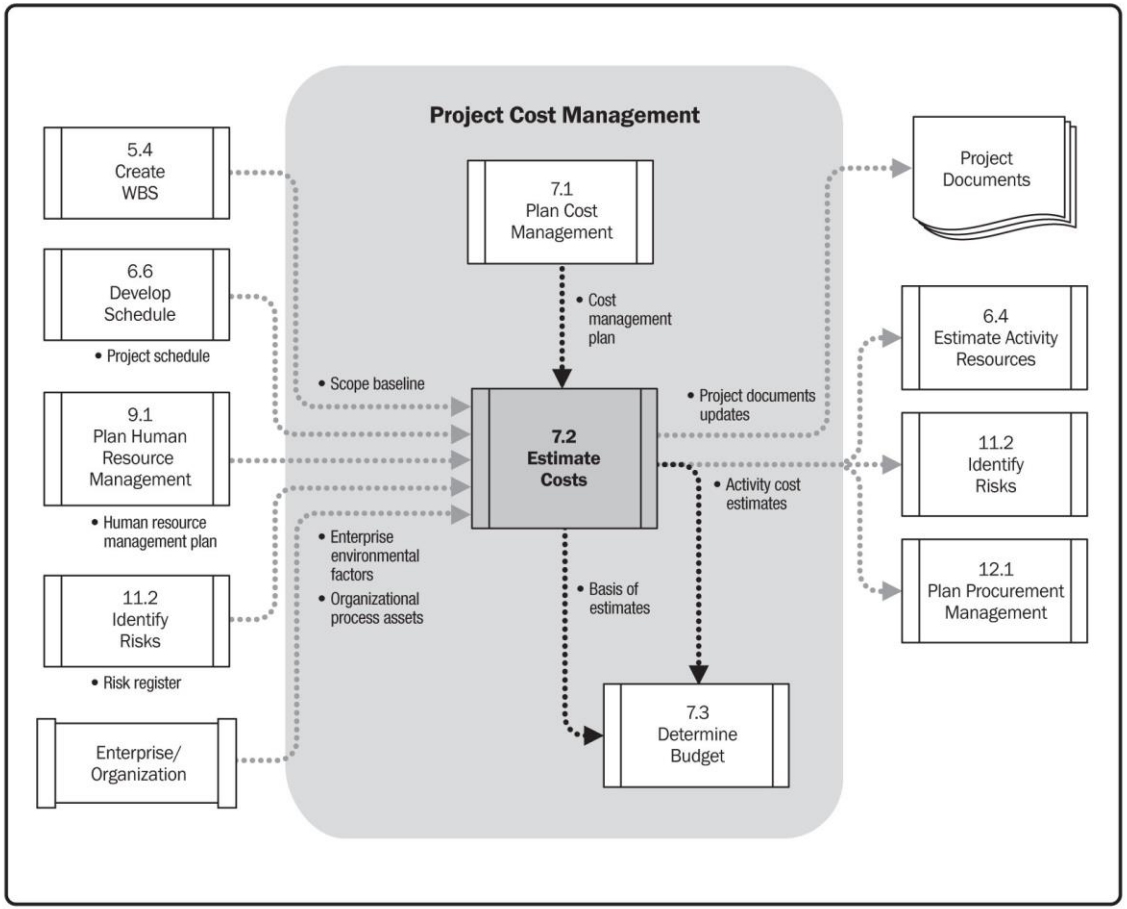

Figure 7-5. Estimate Costs Data Flow Diagram

7.2.1 Estimate Costs: Inputs

- 7.2.1.1 Cost Management Plan (Out: 7.1)
  - Defines how project costs will be managed and controlled. It includes the method used and the level of accuracy required to estimate activity cost.

- 7.2.1.2 Human Resource Management Plan (Out: 9.1)
  - Provides project staffing attributes, personnel rates, and related rewards/recognition, which are necessary components for developing the project cost estimates.

7.2.1 Estimate Costs: Inputs

- 7.2.1.3 Scope Baseline:
  - **Project scope statement**: (Out: 5.3)
    - Provides the product description, acceptance criteria, key deliverables, project boundaries, assumptions, and constraints about the project.
  - **Work breakdown structure** (WBS): (Out: 5.4)
    - Provides the relationships among all the components of the project and the project deliverables.
  - **WBS dictionary**: (Out: 5.4)
    - Provides detailed information about the deliverables and a description of the work for each component in the WBS required to produce each deliverable.

7.2.1 Estimate Costs: Inputs

- 7.2.1.4 Project Schedule (Out: 6.6)
  - The type and quantity of resources and the amount of time which those resources are applied to complete the work of the project are major factors in determining the project cost.

7.2.1 Estimate Costs: Inputs

- 7.2.1.5 Risk Register (Out: 11.2)
  - The risk register should be reviewed to consider risk response costs.
  - Risks, which can be either threats or opportunities, typically have an impact on both activity and overall project costs.

7.2.1 Estimate Costs: Inputs

- 7.2.1.6 Enterprise Environmental Factors (Out: 2.1.5)
  - The EEFs that influence the Estimate Costs process include:
    - Market conditions:
      - These conditions describe what products, services, and results are available in the market, from whom, and under what terms and conditions.
      - Regional and/or global supply and demand conditions greatly influence resource costs.
    - Published commercial information:
      - 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.

7.2.1 Estimate Costs: Inputs

- 7.2.1.7 Organizational Process Assets (Out: 2.1.4)
  - The OPAs that influence the Estimate Costs process include:
    - Cost estimating policies.
    - Cost estimating templates.
    - Historical information.
    - Lessons learned.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.1 Expert Judgment
  - Expert judgment, guided by historical information, provides valuable insight about the environment and information from prior similar projects.
  - Expert judgment can also be used to determine whether to combine methods of estimating and how to reconcile differences between them.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.2 Analogous Estimating (Similar Values)
  - Analogous cost estimating uses the similar values such as:
    - Scope, cost, budget and duration or measures of scale such as size, weight, and complexity from a previous, similar project as the basis for estimating the same parameter or measurement for a current project.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.3 Parametric Estimating
  - Parametric estimating uses a statistical relationship between relevant historical data and other variables (e.g., square footage in construction) to calculate a cost estimate for project work.
  - This technique can produce higher levels of accuracy depending upon the sophistication and underlying data built into the model.
  - Parametric cost estimates can be applied to a total project or to segments of a project, in conjunction with other estimating methods.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.4 Bottom-Up Estimating
  - Bottom-up estimating is a method of estimating a component of work. The cost of individual work packages or activities is estimated to the greatest level of specified detail.
  - The detailed cost is then summarized or "rolled up" to higher levels for subsequent reporting and tracking purposes.
  - The cost and accuracy of bottom-up cost estimating are typically influenced by the size and complexity of the individual activity or work package.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.5 Three-Point Estimating
  - The accuracy of single-point activity 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 activity cost based on analysis of the best-case scenario for the activity.
    - **Pessimistic (cP):**
      - The activity cost based on analysis of the worst-case scenario for the activity.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.5 Three-Point Estimating (Cont.)
  - 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 (from a traditional PERT analysis). $cE = (cO + 4cM + cP) / 6$
  - Cost estimates based on three points with an assumed distribution provide an expected cost and clarify the range of uncertainty around the expected cost.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.6 Reserve Analysis
  - Cost estimates may include contingency reserves (sometimes called contingency allowances) to account for cost uncertainty.

- 7.2.2.7 Cost of Quality (COQ)
  - Assumptions about costs of quality (Section 8.1.2.2) may be used to prepare the activity cost estimate.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.8 Project Management Software
  - Project management software applications, computerized spreadsheets, simulation, and statistical tools are used to assist with cost estimating.
  - Such tools can simplify the use of some cost-estimating techniques and thereby facilitate rapid consideration of cost estimate alternatives.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.9 Vendor Bid Analysis
  - Cost estimating methods may include analysis of what the project should cost, based on the **responsive bids from qualified vendors**.
  - When projects are awarded to a vendor under competitive processes, additional cost estimating work may be required of the project team to examine the price of individual deliverables and to derive a cost that supports the final total project cost.

7.2.2 Estimate Costs: Tools and Techniques

- 7.2.2.10 Group Decision-Making Techniques
  - Team-based approaches, such as **brainstorming**, the **Delphi** or **nominal group techniques**, are useful for engaging team members to improve estimate accuracy and commitment to the emerging estimates.

7.2.3 Estimate Costs: Outputs

- 7.2.3.1 Activity Cost Estimates
  - **Quantitative assessments of the probable costs required to complete project work.** Cost estimates can be presented in summary form or in detail & estimated for all resources, This includes:
    - Direct labor
    - Materials
    - Equipment
    - Services
    - Facilities
    - Information technology
    - Special categories such as:
      - Cost of financing (including interest charges)
      - An inflation allowance
      - Exchange rates
      - A cost contingency reserve.

7.2.3 Estimate Costs: Outputs

- 7.2.3.2 Basis of Estimates
  - The amount and type of additional details supporting the cost estimate vary by application area.
  - Supporting detail for activity cost estimates may include:
    - Documentation of the basis of the estimate (i.e., how it was developed),
    - Documentation of all assumptions made,
    - Documentation of any known constraints,
    - Indication of the range of possible estimates (e.g., €10,000 (±10%) to indicate that the item is expected to cost between a range of values), and
    - Indication of the confidence level of the final estimate.

7.2.3 Estimate Costs: Outputs

- 7.2.3.3 Project Documents Updates
  - Project documents that may be updated include:
    - the risk register

7.3 Determine Budget

- The process of **aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.**
  - <u>The key benefit of this process is:</u>
    - It determines the cost baseline against which project performance can be monitored and controlled.
  - A project budget includes all the funds authorized to execute the project. The cost baseline is the approved version of the time-phased project budget, but excludes management reserves.

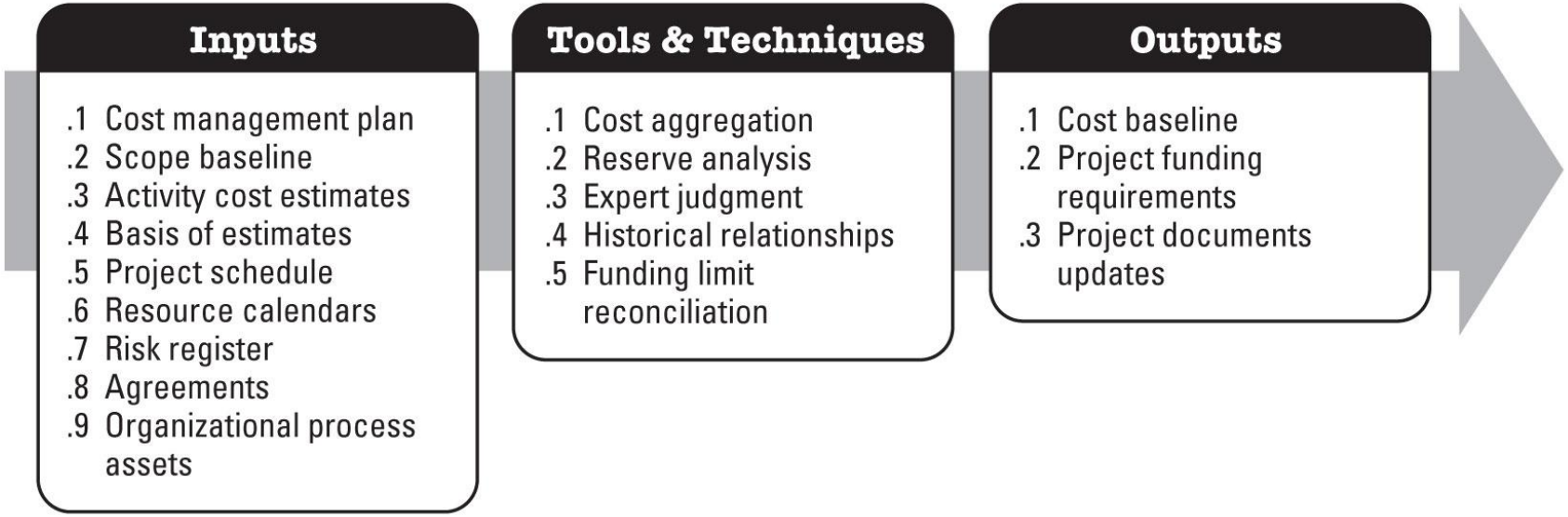

Figure 7-6. Determine Budget: Inputs, Tools & Techniques, and Outputs

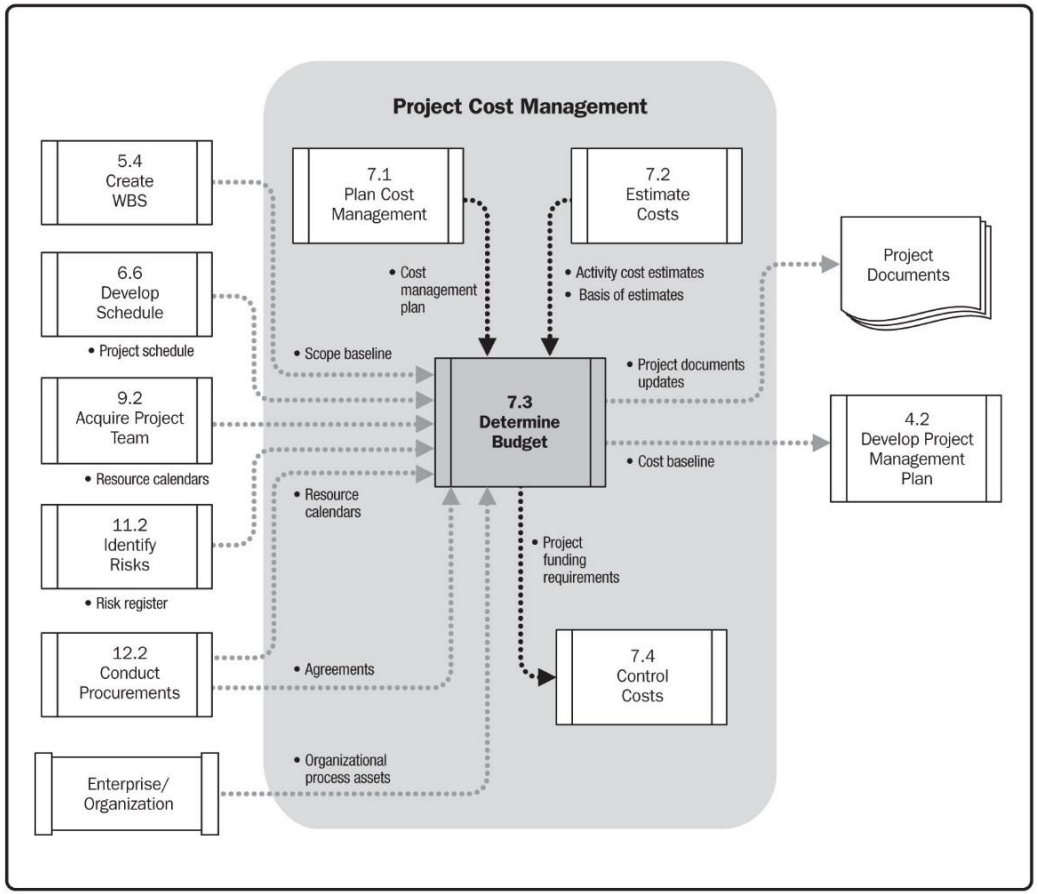

Figure 7-7. Determine Budget Data Flow Diagram

7.3.1 Determine Budget: Inputs

- 7.3.1.1 Cost Management Plan (Out: 7.1)
  - The cost management plan describes how the project costs will be managed and controlled.

- 7.3.1.2 Scope Baseline
  - Project scope statement
  - Work breakdown structure
  - WBS dictionary

7.3.1 Determine Budget: Inputs

- 7.3.1.3 Activity Cost Estimates (Out: 7.2)
  - Cost estimates for each activity within a work package are aggregated to obtain a cost estimate for each work package.

- 7.3.1.4 Basis of Estimates (Out: 7.2)
  - Supporting detail for cost estimates contained in the basis for estimates should specify any basic assumptions dealing with the inclusion or exclusion of indirect or other costs in the project budget.

7.3.1 Determine Budget: Inputs

- 7.3.1.5 Project Schedule (Out: 6.6)
  - The project schedule includes planned start and finish dates for the project's activities, milestones, work packages and control accounts.
  - This information can be used to aggregate costs to the calendar periods in which the costs are planned to be incurred.

- 7.3.1.6 Resource Calendars (Out: 9.2, 12.2)
  - Resource calendars provide information on which resources are assigned to the project and when they are assigned. This information can be used to indicate resource costs over the duration of the project.

7.3.1 Determine Budget: Inputs

- 7.3.1.7 Risk Register (Out: 11.2)
  - The risk register should be reviewed to consider how to aggregate the risk response costs.
  - Updates to the risk register are included with project document updates described in Section 11.5.3.2.

- 7.3.1.8 Agreements (Out: 12.2)
  - Applicable agreement information and costs relating to products, services, or results that have been or will be purchased are included when determining the budget.

7.3.1 Determine Budget: Inputs

- 7.3.1.9 Organizational Process Assets (Out: 2.1.4)
  - The organizational process assets that influence the Determine Budget process include:
    - Existing formal and informal cost budgeting-related policies, procedures, and guidelines;
    - Cost budgeting tools; and
    - Reporting methods.

7.3.2 Determine Budget: Tools and Techniques

- 7.3.2.1 Cost Aggregation
  - Cost estimates are aggregated by work packages in accordance with the WBS.
  - The work package cost estimates are then aggregated for the higher component levels of the WBS.

- 7.3.2.2 Reserve Analysis
  - Budget reserve analysis can establish both the contingency reserves and the management reserves for the project.

7.3.2 Determine Budget: Tools and Techniques

- 7.3.2.3 Expert Judgment
  - Expert judgment, guided by experience in an application area, Knowledge Area, discipline, industry, or similar project, aids in determining the budget.
  - Expert judgment is available from many sources, including:
    - Other units within the performing organization
    - Consultants
    - Stakeholders, including customers
    - Professional and technical associations
    - Industry groups

7.3.2 Determine Budget: Tools and Techniques

- 7.3.2.4 Historical Relationships
  - Any historical relationships that result in parametric estimates or analogous estimates involve the use of project characteristics to develop mathematical models to predict total project costs.

7.3.2 Determine Budget: Tools and Techniques

- 7.3.2.5 Funding Limit Reconciliation
  - The expenditure of funds should be reconciled with any funding limits on the commitment of funds for the project.
  - A variance between the funding limits and the planned expenditures will sometimes necessitate the rescheduling of work to level out the rate of expenditures.
  - This is accomplished by placing imposed date constraints for work into the project schedule.

7.3.3 Determine Budget: Outputs

- 7.3.3.1 Cost Baseline
  - The approved version of the time-phased project budget, excluding any management reserves, which can only be changed through formal change control procedures and is used as a basis for comparison to actual results.

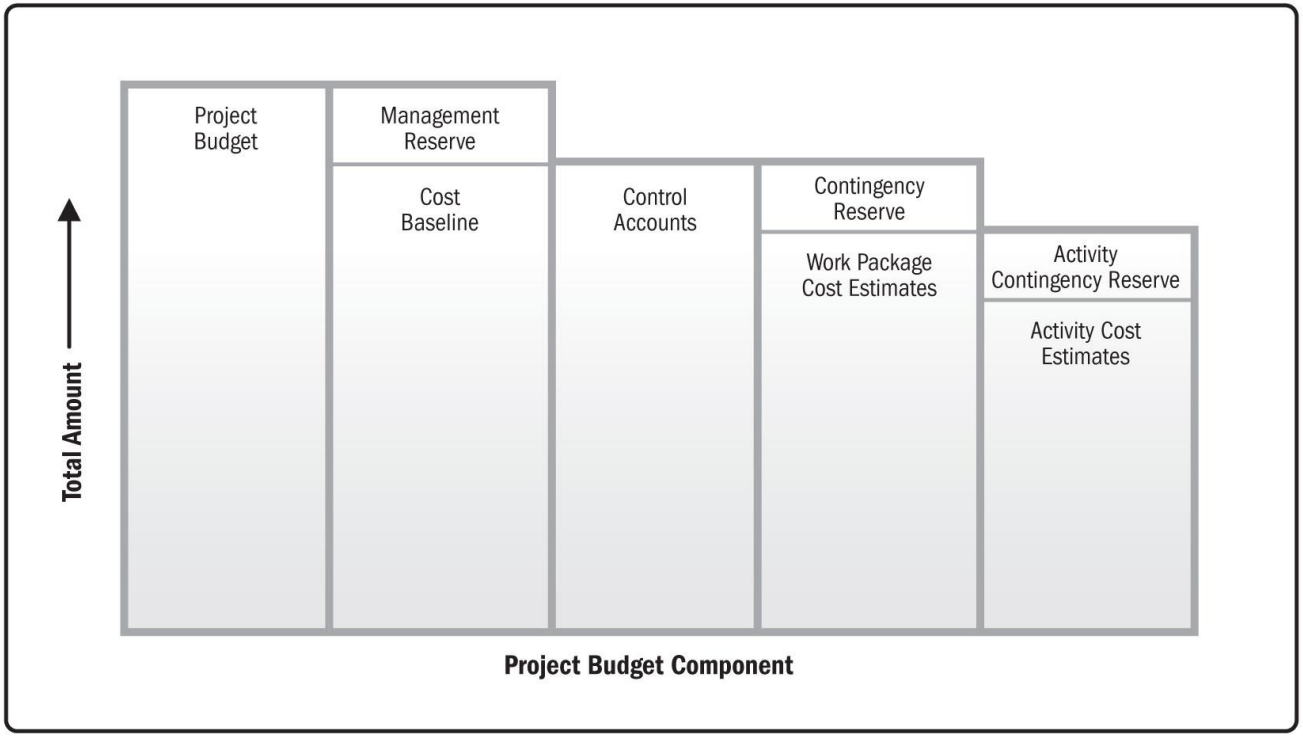

Figure 7-8. Project Budget Components

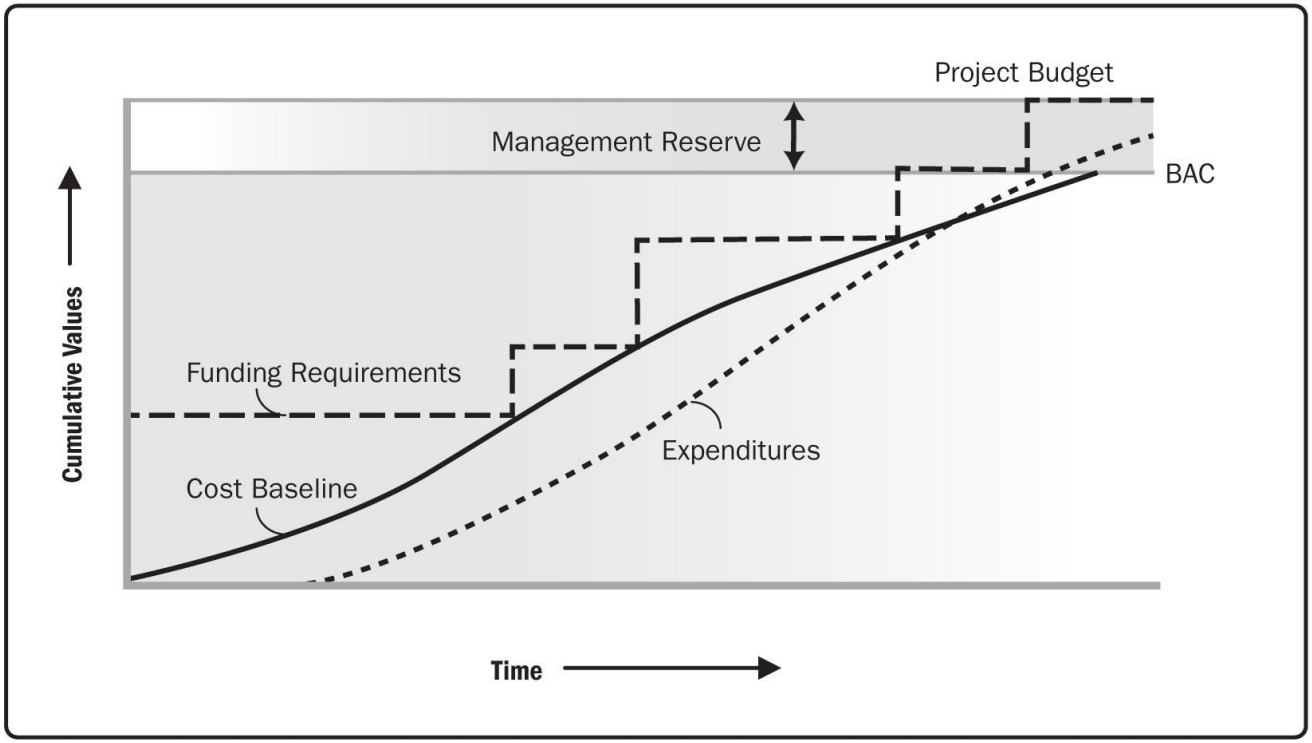

Figure 7-9. Cost Baseline, Expenditures, and Funding Requirements

7.3.3 Determine Budget: Outputs

- 7.3.3.2 Project Funding Requirements
  - Total funding requirements and periodic funding requirements (e.g., quarterly, annually) are derived from the cost baseline.

- 7.3.3.3 Project Documents Updates
  - Project documents that may be updated include:
    - Risk register
    - Activity cost estimates
    - Project schedule

7.4 Control Costs

- The process of **monitoring** the status of the project to update the project costs and managing changes to the cost baseline.

  - The key benefit of this process is:
    - It provides the means to recognize variance from the plan in order to take corrective action and minimize risk.

7.4 Control Costs

- Project cost control includes:
  - Influencing the factors that create changes to the authorized cost baseline.
  - Ensuring that all change requests are acted on in a timely manner.
  - Ensuring that cost expenditures do not exceed the authorized funding by period, by WBS component, by activity, and in total for the project.
  - Monitoring cost performance to isolate and understand variances from the approved cost baseline.

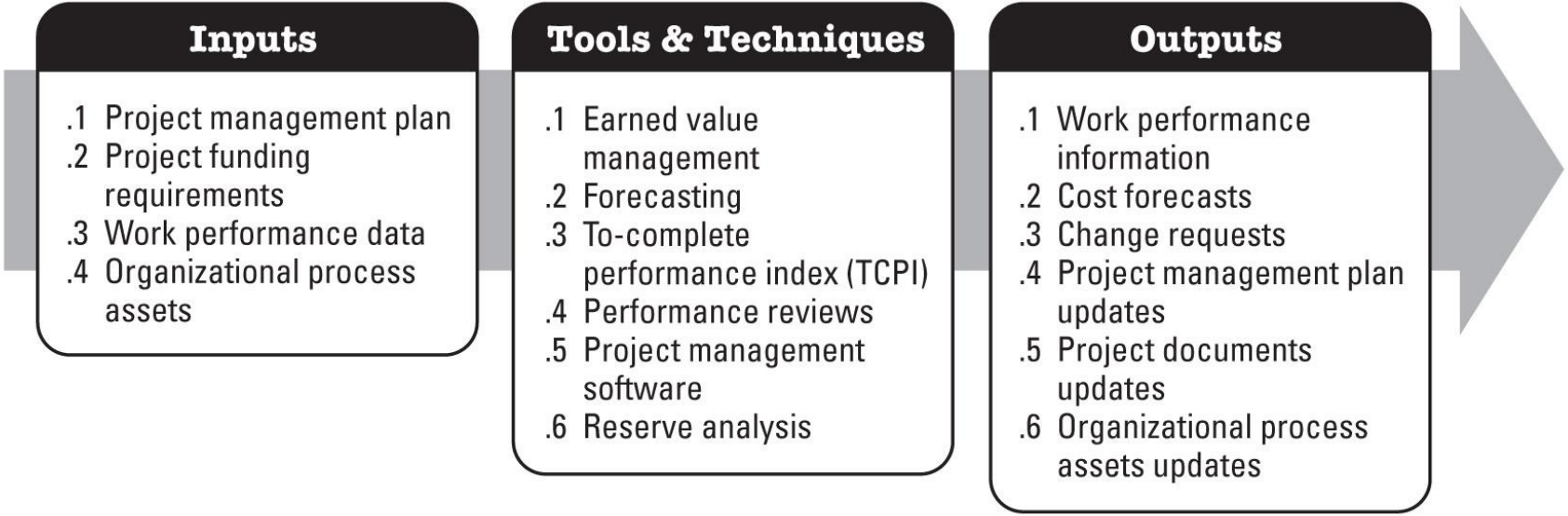

Figure 7-10. Control Costs: Inputs, Tools & Techniques, and Outputs

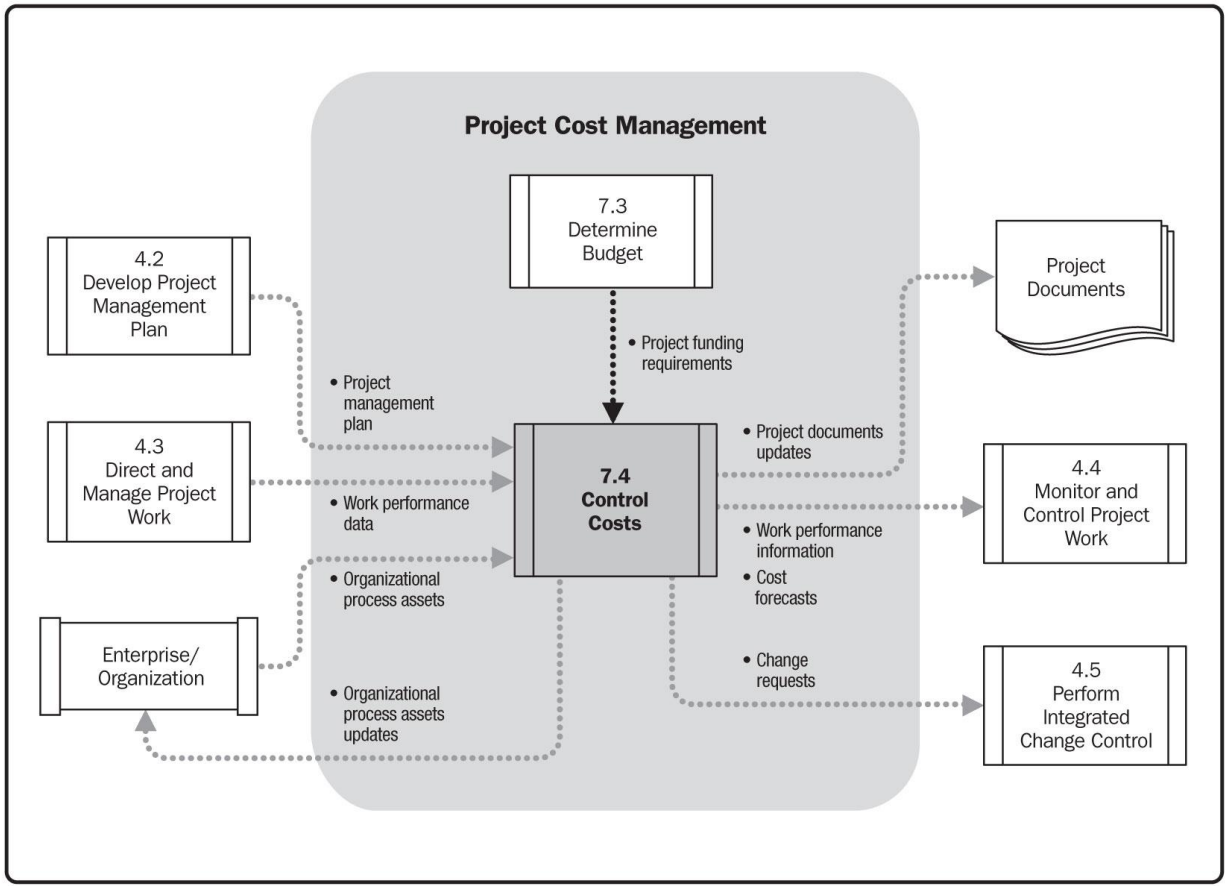

Figure 7-11. Control Costs Data Flow Diagram

7.4.1 Control Costs: Inputs

- 7.4.1.1 Project Management Plan (Out: 4.2)
  - The project management plan contains the following information that is used to control cost:
    - Cost baseline
      - The cost baseline is compared with actual results to determine if a change, corrective action, or preventive action is necessary.
    - Cost management plan
    - The cost management plan describes how the project costs will be managed and controlled (Section 7.1.3.1).

7.4.1 Control Costs: Inputs

- 7.4.1.2 Project Funding Requirements (Out: 7.3)
  - The project funding requirements include projected expenditures plus anticipated liabilities.

- 7.4.1.3 Work Performance Data (Out: 4.3)
  - Work performance data includes information about project progress, such as which activities have started, their progress, and which deliverables have finished.
  - Information also includes costs that have been authorized and incurred.

7.4.1 Control Costs: Inputs

- 7.4.1.4 Organizational Process Assets (Out: 2.1.4)
  - The organizational process assets that can influence the Control Costs process include:
    - Existing formal and informal cost control-related policies, procedures, and guidelines
    - Cost control tools
    - Monitoring and reporting methods to be used

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.1 Earned Value Management (EVM)
  - A methodology that combines scope, schedule, and resource measurements to assess project performance and progress.
  - EVM develops & monitors 3 key dimensions for each work package and control account:
    - Planned value
    - Earned value
    - Actual cost
    - Schedule variance
    - Cost variance
    - Schedule performance index
    - Cost performance index

7.4.2 Control Costs: Tools and Techniques

- Planned value (PV)
  - Planned value (PV) is the authorized budget assigned to scheduled work.
  - It is the authorized budget planned for the work to be accomplished for an activity or work breakdown structure component, not including management reserve.
  - This budget is allocated by phase over the life of the project, but at a given moment, planned value defines the physical work that should have been accomplished.
  - The total of the PV is sometimes referred to as the performance measurement baseline (PMB).
  - The total planned value for the project is also known as budget at completion (BAC).

7.4.2 Control Costs: Tools and Techniques

- Earned value: (EV)
  - A measure of work performed expressed in terms of the budget authorized for that work.
  - It is the budget associated with the authorized work that has been completed.
  - The EV being measured needs to be related to the PMB, and the EV measured cannot be greater than the authorized PV budget for a component.
  - The EV is often used to calculate the percent complete of a project.
  - Progress measurement criteria should be established for each WBS component to measure work in progress.
  - Project managers monitor EV, both incrementally to determine current status and cumulatively to determine the long-term performance trends.

7.4.2 Control Costs: Tools and Techniques

- Actual cost: (AC)
  - Actual cost (AC) is the realized cost incurred for the work performed on an activity during a specific time period.
  - It is the total cost incurred in accomplishing the work that the EV measured.
  - The AC needs to correspond in definition to what was budgeted in the PV and measured in the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs).
  - The AC will have no upper limit; whatever is spent to achieve the EV will be measured.

7.4.2 Control Costs: Tools and Techniques

- Schedule variance (SV): (SV = EV – PV)
  - A measure of schedule performance expressed as the difference between the earned value and the planned value.
  - It is the amount by which the project is ahead or behind the planned delivery date, at a given point in time.
  - It is a measure of schedule performance on a project. It is equal to the earned value (EV) minus the planned value (PV).
  - The EVM schedule variance is a useful metric in that it can indicate when a project is falling behind or is ahead of its baseline schedule.
  - The EVM schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned.
  - SV used in conjunction with critical path methodology (CPM)

7.4.2 Control Costs: Tools and Techniques

- Cost variance (CV): (CV= EV − AC)
  - The amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and the actual cost.
  - It is a measure of cost performance on a project. It is equal to (EV) minus (AC).
  - The CV at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent.
  - The CV is particularly critical because it indicates the relationship of physical performance to the costs spent.
  - Negative CV is often difficult for the project to recover.
  - The SV and CV values can be converted to efficiency indicators to reflect the cost & schedule performance for comparison.
  - The variances are useful for determining project status.

7.4.2 Control Costs: Tools and Techniques

- Schedule performance index (SPI): (SPI = EV/PV)
  - A measure of schedule efficiency expressed as the ratio of earned value to planned value.
  - It measures how efficiently the project team is using its time. It is sometimes used in conjunction with the cost performance index (CPI) to forecast the final project completion estimates.
    - The SPI is equal to the ratio of the EV to the PV.
    - SPI value less than 1.0 indicates less work was completed than planned
    - SPI greater than 1.0 indicates that more work was completed than planned
  - Since the SPI measures all project work, the performance on the critical path also needs to be analyzed to determine whether the project will finish ahead of or behind its planned finish date.

7.4.2 Control Costs: Tools and Techniques

- Cost performance index (CPI): (CPI = EV/AC)
  - A measure of the cost efficiency of budgeted resources, expressed as a ratio of earned value to actual cost.
  - It is considered the most critical EVM metric and measures the cost efficiency for the work completed.
    - The CPI is equal to the ratio of the EV to the AC.
    - A CPI value of less than 1.0 indicates a cost overrun for work completed.
    - A CPI value greater than 1.0 indicates a cost underrun of performance
    - The indices are useful for determining project status and providing a basis for estimating project cost and schedule outcome.
  - The three parameters of PV, EV & AC can be monitored & reported on both a period-by-period basis and on a cumulative basis.

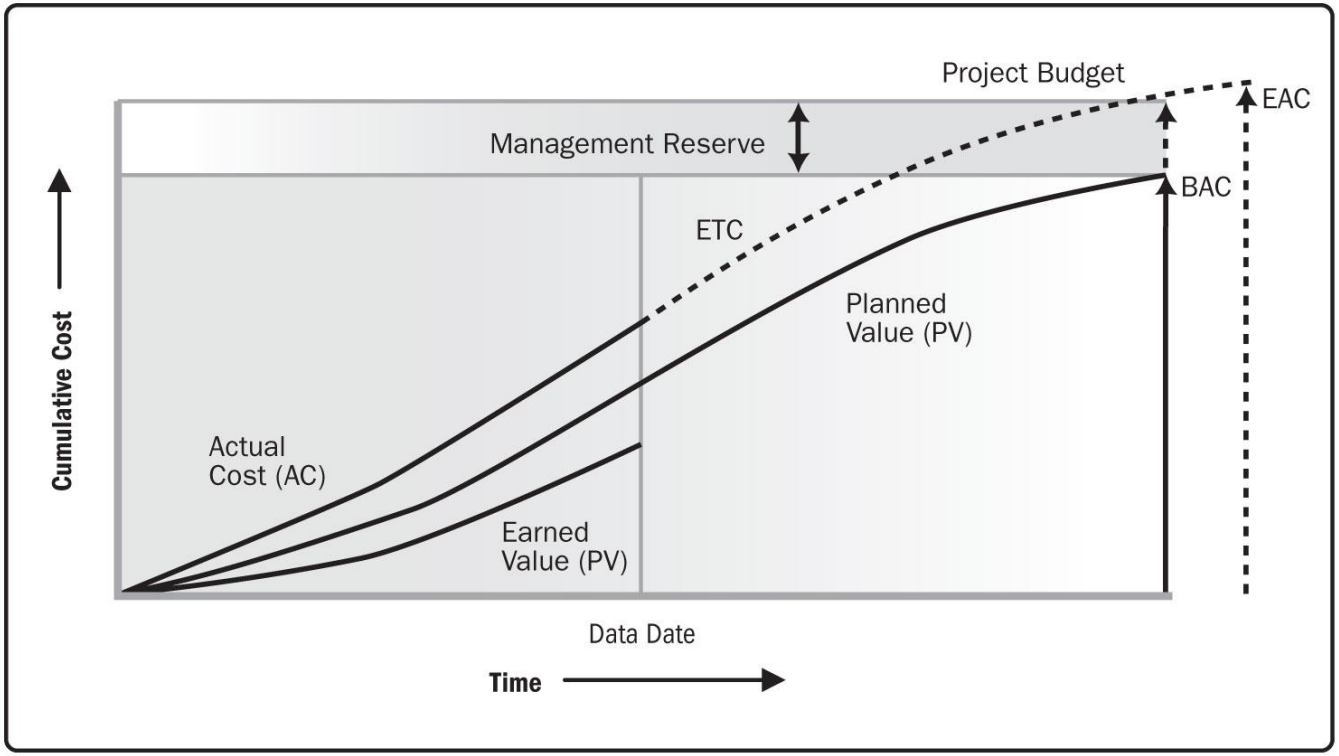

Figure 7-12. Earned Value, Planned Value, and Actual Costs

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.2 Forecasting
  - As the project progresses
    - the project team may develop a forecast for the estimate at completion (EAC) that may differ from the budget at completion (BAC) based on the project performance.

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.2 Forecasting
  - While EVM data quickly provide many statistical EACs, only three of the more common methods are described as follows:
    - EAC forecast for ETC work performed at the budgeted rate:
      - Equation: EAC = AC + (BAC – EV)
    - EAC forecast for ETC work performed at the present CPI:
      - Equation: EAC = BAC / CPI
    - EAC forecast for ETC work considering both SPI and CPI factors:
      - Equation: EAC = AC + [(BAC – EV) / (CPI × SPI)]

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.3 To-Complete Performance Index (TCPI)
  - A measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.

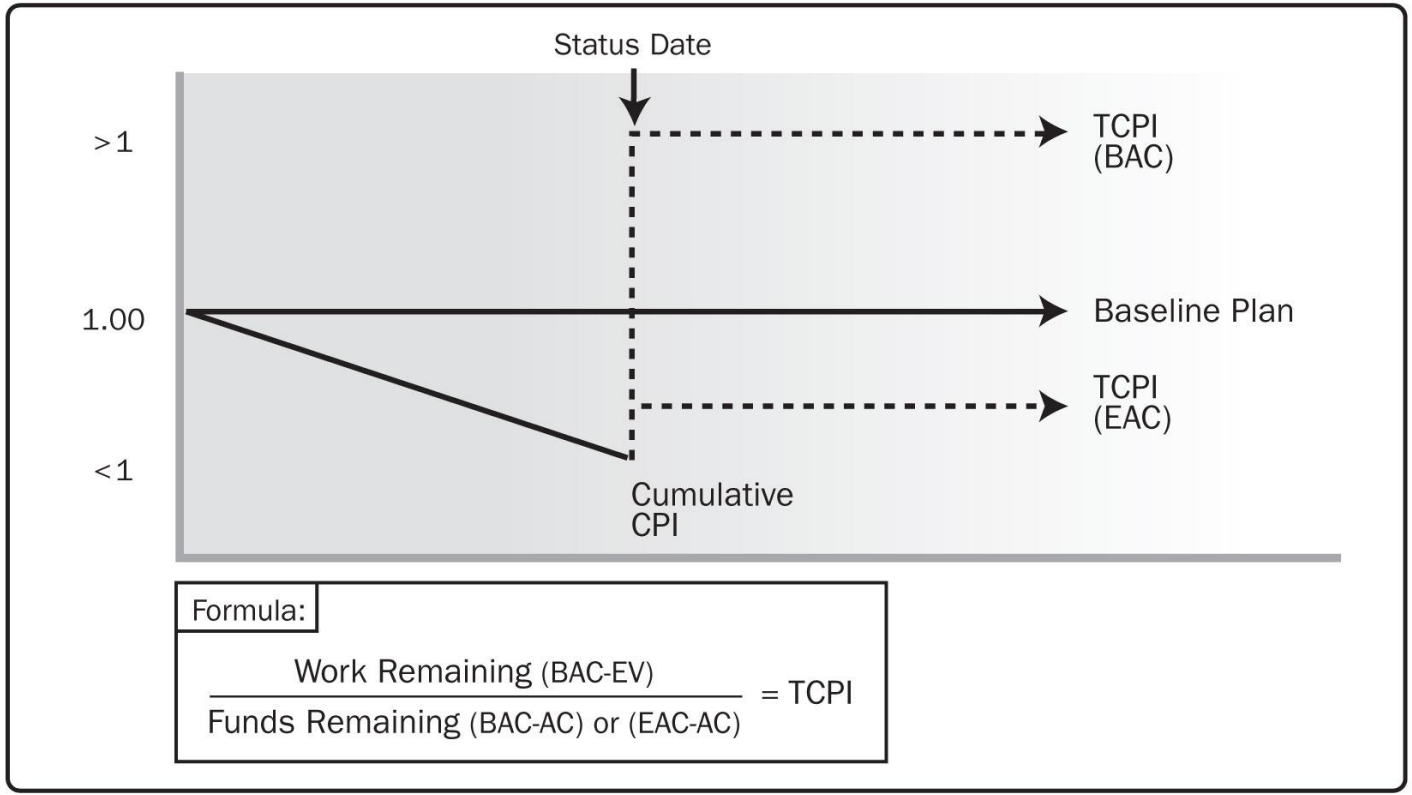

Figure 7-13. To-Complete Performance Index (TCPI)

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.4 Performance Reviews
  - Performance reviews **compare** cost performance over time, schedule activities or work packages overrunning and underrunning the budget, and estimated funds needed to complete work in progress.
  - If EVM is being used, the following information is determined:
    - Variance analysis
    - Trend analysis
    - Earned value performance

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.4 Performance Reviews
  - Variance analysis: Used in EVM
    - The explanation (cause, impact, and corrective actions)
    - Cost and schedule variances are the most frequently analyzed measurements.
    - Cost performance measurements are used to assess the magnitude of variation to the original cost baseline.
    - An important aspect of project cost control includes determining the cause and degree of variance relative to the cost baseline and deciding whether corrective or preventive action is required.
    - The percentage range of acceptable variances will tend to decrease as more work is accomplished.

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.4 Performance Reviews
  - Trend analysis:
    - Trend analysis examines project performance over time to determine if performance is improving or deteriorating.
    - Graphical analysis techniques are valuable for understanding performance to date and for comparison to future performance goals in the form of BAC versus EAC and completion dates.

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.4 Performance Reviews
  - Earned value performance:
    - Earned value performance compares the performance measurement baseline to actual schedule and cost performance.
    - If EVM is not being used, then the analysis of the cost baseline against actual costs for the work performed is used for cost performance comparisons.

Table 7-1. Earned Value Calculations Summary Table

Earned Value Analysis					
Abbreviation	**Name**	**Lexicon Definition**	**How Used**	**Equation**	**Interpretation of Result**
PV	Planned Value	The authorized budget assigned to scheduled work.	The value of the work planned to be completed to a point in time, usually the data date, or project completion.		
EV	Earned Value	The measure of work performed expressed in terms of the budget authorized for that work.	The planned value of all the work completed (earned) to a point in time, usually the data date, without reference to actual costs.	EV = sum of the planned value of completed work	
AC	Actual Cost	The realized cost incurred for the work performed on an activity during a specific time period.	The actual cost of all the work completed to a point in time, usually the data date.		
BAC	Budget at Completion	The sum of all budgets established for the work to be performed.	The value of total planned work, the project cost baseline.		
CV	Cost Variance	The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost.	The difference between the value of work completed to a point in time, usually the data date, and the actual costs to the same point in time.	CV = EV - AC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
SV	Schedule Variance	The amount by which the project is ahead or behind the planned delivery date, at a given point in time, expressed as the difference between the earned value and the planned value.	The difference between the work completed to a point in time, usually the data date, and the work planned to be completed to the same point in time.	SV = EV - PV	Positive = Ahead of Schedule Neutral = On schedule Negative = Behind Schedule
VAC	Variance at Completion	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	The estimated difference in cost at the completion of the project.	VAC = BAC – EAC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
CPI	Cost Performance Index	A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.	A CPI of 1.0 means the project is exactly on budget, that the work actually done so far is exactly the same as the cost so far. Other values show the percentage of how much costs are over or under the budgeted amount for work accomplished.	CPI = EV/AC	Greater than 1.0 = Under planned cost. Exactly 1.0 = On planned cost Less than 1.0 = Over planned cost
SPI	Schedule Performance Index	A measure of schedule efficiency expressed as the ratio of earned value to planned value.	An SPI of 1.0 means that the project is exactly on schedule, that the work actually done so far is exactly the same as the work planned to be done so far. Other values show the percentage of how much costs are over or under the budgeted amount for work planned.	SPI = EV/PV	Greater than 1.0 = Ahead of schedule Exactly 1.0 = On schedule Less than 1.0 = Behind schedule
EAC	Estimate At Completion	The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.	If the CPI is expected to be the same for the remainder of the project, EAC can be calculated using: If future work will be accomplished at the planned rate, use: If the initial plan is no longer valid, use: If both the CPI and SPI influence the remaining work, use:	EAC = BAC/CPI EAC = AC + BAC – EV EAC = AC + Bottom-up ETC EAC = AC + [(BAC – EV)/(CPI x SPI)]	
ETC	Estimate to Complete	The expected cost to finish all the remaining project work.	Assuming work is proceeding on plan, the cost of completing the remaining authorized work can be calculated using: Reestimate the remaining work from the bottom up.	ETC = EAC – AC ETC = Reestimate	
TCPI	To Complete Performance Index	A measure of the cost performance that must be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the budget available.	The efficiency that must be maintained in order to complete on plan. The efficiency that must be maintained in order to complete the current EAC.	TCPI = (BAC - EV)/(BAC - AC) TCPI = (BAC - EV)/(EAC - AC)	Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete

7.4.2 Control Costs: Tools and Techniques

- 7.4.2.5 Project Management Software
  - Used to monitor the three EVM dimensions to display graphical trends, and to forecast a range of possible final project results.

- 7.4.2.6 Reserve Analysis
  - During cost control, reserve analysis is used to monitor the status of contingency and management reserves for the project to determine if these reserves are still needed or if additional reserves need to be requested.

7.4.3 Control Costs: Outputs

- 7.4.3.1 Work Performance Information
  - The calculated CV, SV, CPI, SPI, TCPI, and VAC values for WBS components, in particular the work packages and control accounts, are documented and communicated to stakeholders.

- 7.4.3.2 Cost Forecasts
  - Either a calculated EAC value or a bottom-up EAC value is documented and communicated to stakeholders.

7.4.3 Control Costs: Outputs

- 7.4.3.3 Change Requests
  - Analysis of project performance may result in a change request to the cost baseline or other components of the project management plan.
  - Change requests may include preventive or corrective actions, and are processed for review and disposition through the Perform Integrated Change Control process.

7.4.3 Control Costs: Outputs

- 7.4.3.4 Project Management Plan Updates
  - Elements of the project management plan that may be updated include:
    - Cost baseline:
      - Changes to the cost baseline are incorporated in response to approved changes in scope, activity resources, or cost estimates.
      - In some cases, cost variances can be so severe that a revised cost baseline is needed to provide a realistic basis for performance measurement.
    - Cost management plan:
      - Changes to the cost management plan, such as changes to control thresholds or specified levels of accuracy required in managing the project's cost, are incorporated in response to feedback from relevant stakeholders.

7.4.3 Control Costs: Outputs

- 7.4.3.5 Project Documents Updates
  - Project documents that may be updated include:
    - Cost estimates.
    - Basis of estimates.

- 7.4.3.6 Organizational Process Assets Updates
  - Organizational process assets that may be updated include:
    - Causes of variances.
    - Corrective action chosen and the reasons.
    - Financial databases.

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