Quantitative Risk Analysis

4. Quantitative Risk Analysis

- Quantitative risk analysis analyzes numerically the effect a project risk has on a project objective.
- The process generally follows qualitative analysis and utilizes techniques such as Monte Carlo simulation and decision analysis to:
  - Determine the probability of achieving a specific project objective.
  - Identify risks requiring the most attention by quantifying their relative contribution to project risk.
  - Identify realistic and achievable cost, schedule or scope targets.
  - Quantify project outcomes and their probabilities.
  - Guides project management decisions under conditions of uncertainty such as determination of size of contingency.

4.1 Inputs to Quantitative Risk Analysis

- **Organizational & Environmental Process Assets**
  Information from past projects, studies of similar projects, risk databases.
- **Project Scope Statement**
- **Risk Management Plan**
  Major elements from the plan needed include roles & responsibilities, budgets and schedule for risk management activities, risk categories, definitions of probability & impact, and the stakeholders' tolerances.
- **Risk Register**
  List of risks, relative ranking of risks, and risks grouped by category.
- **Project Management Plan**
  - **Project Schedule Plan**
  - **Project Cost Plan**

4.2 Tools and Techniques for Quantitative Risk Analysis

1. Data Gathering & Representation Techniques.

- **Interviewing:** Interviewing techniques are used to ***quantify the probability and impact of risks*** on project objectives. Information needed depends on the type of probability distributions that will be used (Need distribution parameters).
  - **For example**, if triangular distributions are used, information would be gathered on the optimistic, pessimistic, and the most likely scenarios. If normal distribution is used information on the mean & standard deviation would be needed,
  - **Documenting** the rationale of the risk ranges is an important component of the risk interview because it indicates reliability of data.
- **Expert Judgment:** Subject matter experts are useful to validate data. They can come from the organization or from outside.

3-point Estimates for use in triangular distribution

Range of Project Cost Estimates

WBS Element	Low	Most Likely	High
Design	4	6	10
Build	16	20	35
Test	11	15	23
Total Project		41	

The risk interview determines the three-point estimates for each WBS element for triangular or other asymmetrical distributions. In this example, the likelihood of completing the project at or below the traditional estimate of $41 is relatively small as shown in the simulation results (Figure 11-13).

Figure 11-10. Range of Project Cost Estimates Collected During the Risk Interview

4.2 Tools and Techniques for Quantitative Risk Analysis

2. Quantitative Risk Analysis & Modeling Techniques

- **Sensitivity analysis.**
  - Used to determine *which risks have the most potential impact* on the project.
  - Sensitivity analysis examines the extent to which variation of a project element affects a project objective when all other uncertain elements are held at their baseline values.
- **Expected monetary value analysis.**
  - The method considers the probability of each possible outcome and determines the average value of all outcomes

4.2 Tools and Techniques for Quantitative Risk Analysis

- **Decision tree analysis**
  - A decision analysis can be structured as a decision tree. The decision tree is a diagram that describes a decision under consideration and the implications of choosing one or another of the available alternatives.
  - It incorporates probabilities of risks and the costs or rewards of each logical path of events and future decisions.
  - Solving the decision tree gives the expected value of each decision. The decision-maker can select the decision yielding the highest expected value when all the uncertain implications, costs, rewards and subsequent decisions are quantified.

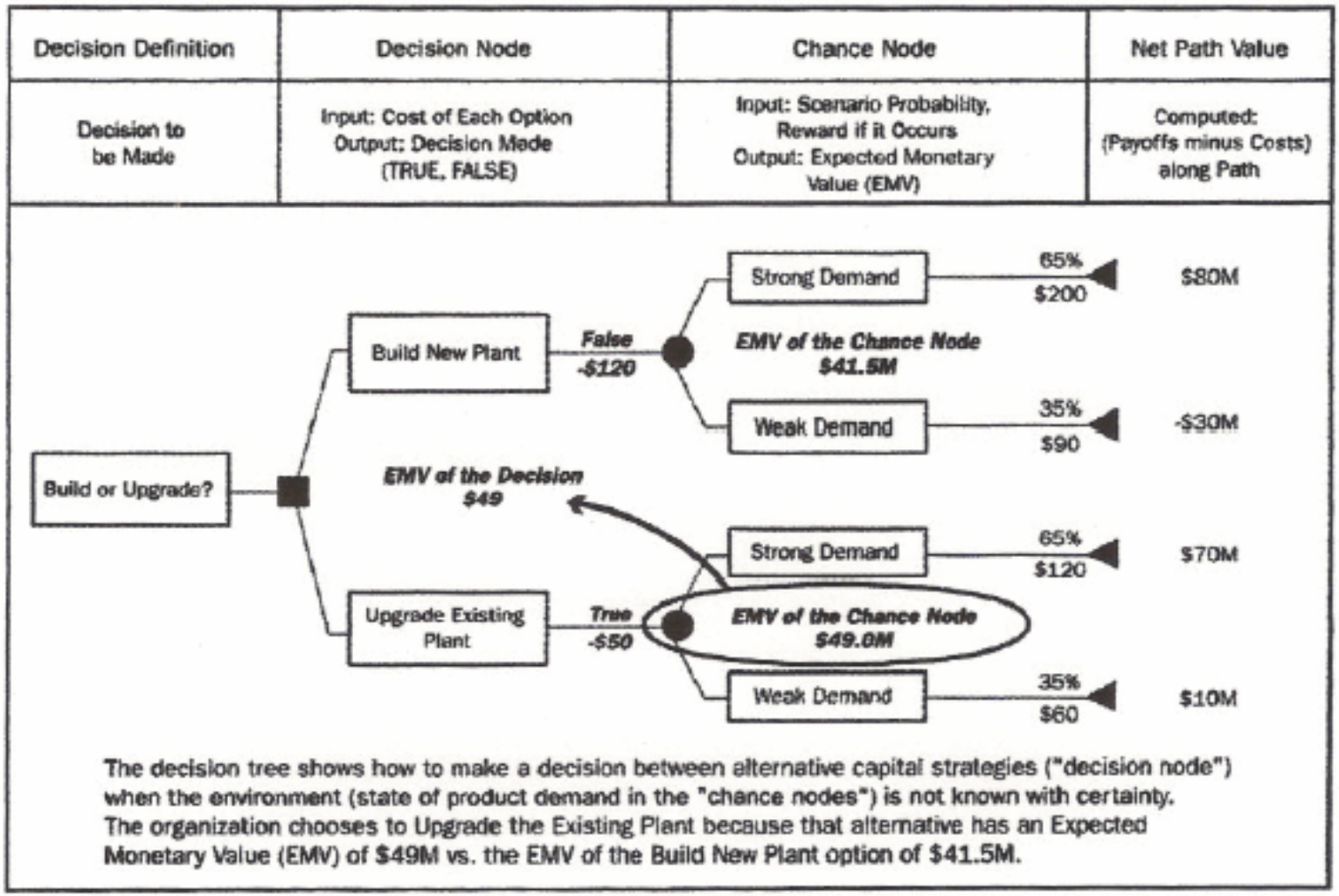

Figure 11-12. Decision Tree Diagram

4.2 Tools and Techniques for Quantitative Risk Analysis

- **Simulation.**
  - A project simulation uses a model that translates the uncertainties specified at a detailed level into their potential impact on objectives at the level of the total project.
  - Project simulations are typically performed using the Monte Carlo technique.
  - For a cost risk analysis, a simulation may use the traditional project WBS as its model. For a schedule risk analysis, the Critical Path Method (CPM) schedule is used.

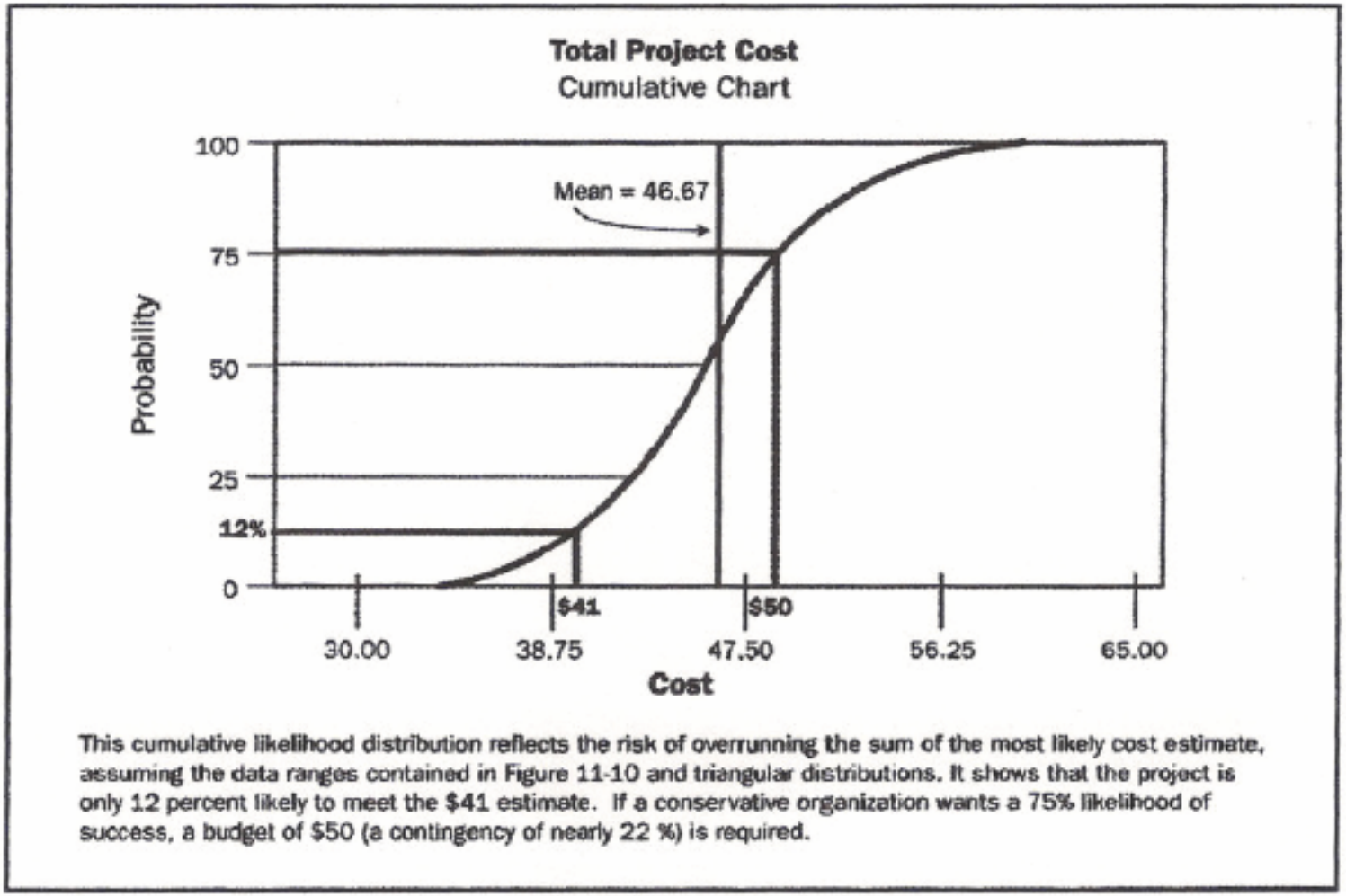

Figure 11-13 Cost Risk Simulation Results

4.3 Outputs from Quantitative Risk Analysis

1. **Risk Register Updates**
   Risk register is updated to reflect results from the quantitative risk analysis. Information added include:
   - **Probabilistic analysis of the project.**
     - **Forecasts of potential project schedule and cost results listing the possible completion dates or project duration and costs with their associated confidence levels (usually as a cumulative distribution see Figure 11-13.)**
     - **Analysis results are used in conjunction with the stakeholders' tolerances to estimate cost and time contingencies.**

4.3 Outputs from Quantitative Risk Analysis

- **Probability of achieving the project cost and time objectives.**
  The probability of achieving the project objectives under the current plan can be estimated using quantitative risk analysis results. In Figure 11-13, probability of project cost being within 41 is about 12%.
- **Prioritized list of quantified risks.**
  This list of risks includes those posing the greatest threat or presenting the greatest opportunity to the project together with a measure of their impacts.
- **Trends in quantitative risk analysis results.**
  As the analysis is repeated, a trend of results may become apparent. Trends may be useful for developing risk responses.