Module Four: Project Cost, Quality, and Procurement Management

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4.01 Learning Outcomes

Module Four: Project Cost, Quality, and Procurement Management

Cost management, quality management, and procurement management are essential for the effective administration of projects. Costs must be regulated, quality must be monitored, and suppliers must be directed and governed to help projects meet their objectives. Decisive actions and sound oversight in each of these three aspects is critical in ensuring successful project results.

Learning Objectives

After completing this module, you should be able to:

1. Compare and contrast methods for estimating costs
2. Assess the project budgeting process in terms of aligning with business strategies
3. Assess a cost estimate for a project that aligns to an organization's goals

4.03 Project Cost Management

Project Cost Management

Cost Management Planning

Planning for project cost management should happen very early in the project so that management efforts can have the maximum effect on the project costs. As with other project management processes, cost management planning can be done

manually or can be completed automatically using computer software; in fact, most organizations will use some combination of manual and automatic processes.

Cost management plans should provide basic guidance on how precise and accurate estimates should be, how earned value management techniques should be used to gauge performance, how the finances and cost of the project will be reported, and how the remaining cost management work should occur. These plans might also identify the units of measure to be used and dictate the variance from the cost baseline that can be tolerated before action needs to be taken to correct or prevent further variance.

To assist in the cost management plan's creation, practitioners will draw on the scope baseline, schedule baseline, and project charter to provide details and summaries of project cost-related information. Expert judgment from knowledgeable project members and subject matter experts can be used to provide insight into the project environment as well as historical context to aid in project decision-making. Planning meetings and analytical techniques will help to enhance exploration and collaboration and will ensure that details concerning project costs are thoroughly studied and evaluated before decisions are made.

Cost Estimation

Cost estimates should take into account all of the charges and expenses required to produce the project's deliverables or results. Such costs include labor and services, materials, information technology, facilities, and equipment. The project management team should also plan for uncertainties such as inflation and changing costs (like fluctuating currency exchange rates) that can't be predicted. Risks and indirect costs should be planned for as well and can be either included in activity costs or accounted for at a higher level outside of the project management team's scope of responsibility. Practitioners will need to not only consider the cost of finishing the project, but must also balance the costs that will occur when maintaining and supporting the project result—cutting resources from quality assurance might require more resources to be routed to customer support or repair costs down the road.

In the beginning of a project, cost estimates may allow for a larger margin of error. As more becomes known about the project, estimates should become more and more accurate. Because the activity estimates are a best guess about the cost of completing the project's work, details supporting how the project team arrived at the estimates should be included with the activity estimate as supporting documentation.

Finally, the confidence levels for the estimated cost and the range of possibility for actual costs are also important to document when creating cost estimates. Organizations may have their own methods for determining range and confidence level so project participants should consult company policies before choosing a method for the project.

Cost Estimating Methods

Cost estimates can be completed in a number of ways. Common cost estimating techniques are described in the table below:

Estimating Methods	
Analogous estimating	Analogous estimating refers to the use of historical information and knowledge from experienced practitioners as the basis for estimating future activities. Analogous estimating uses a value from a previous, similar activity to estimate the same parameter for a future activity. For example, if a manufacturing activity in a previous project cost $5000 to complete, this cost can be used to estimate a similar manufacturing activity in a new, upcoming project. *Advantages and Disadvantages of Using This Technique* Analogous estimating: • Can be used when a project is very similar to one already completed • May be completed quickly • Can be used when little is known about an upcoming project • May provide fairly accurate estimates (if the two project compared are truly similar) • Requires that team members have the necessary expertise to compare and complete project activities • May result in inaccurate estimates if projects that are compared only *appear* to be similar • Provides only rough estimates that may need to be adjusted as more information is obtained

Bottom-up estimating	Bottom-up estimating compiles costs at the lowest levels of a project and aggregates those costs upward to estimate a total cost for the project; as costs aggregate, they include all lower level costs and encompass all aspects of the project. *Advantages and Disadvantages of Using This Technique* Bottom-up estimating: • Provides more-accurate estimates than other estimating methods because it calls upon the expertise and knowledge of the people closest to the work in developing the cost estimates (which ensures a more-accurate appraisal of cost) • Provides an estimate for each individual task or activity, so if plans change, new estimates can be easily produced (because data for estimating already exists) • Can be costly and take longer to complete than other techniques • Requires that workers stop their "daily work" to provide estimates • May result in inaccurate estimates if individuals "pad" their estimates (which will be compounded as estimates are compiled and totaled) • Can be time-consuming if a lot of tasks or activities are involved
Parametric estimating	Parametric estimating uses a statistical relationship between historical data and other variables (e.g., square footage in construction, lines of code in software development) to calculate an estimate for activity parameters. To complete parametric estimates, participants simply multiply the planned quantity of work to be performed by the historical cost per unit. For example, if the productivity cost is $1000 per labor hour, and the quantity of work is 1,000 installations, the costs will equal $1,000 x 1,000 installations or $1,000,000. *Advantages and Disadvantages of Using This Technique* Parametric estimating: • Can be used when a project has aspects that are similar to other projects, and information exists to capture past experience and convert it into statistical data • Can be scaled to estimate projects of different sizes • Provides estimates that are less subjective than other techniques (because estimates are based on collected data) • May provide inaccurate estimates if the data used is inappropriate or no longer applicable
Three-point estimating	Three-point estimating averages three estimates that represent the optimistic, most likely, and pessimistic scenarios. This technique is applied to improve the accuracy of cost estimates when the underlying decomposed tasks or their cost components are uncertain. *Advantages and Disadvantages of Using This Technique* Three-point estimating: • Can be refined by adding weight to individual scenarios • May provide inaccurate estimates if the assumptions that scenarios are based upon are incorrect or inaccurate • May provide inaccurate estimates if any one (or more) of the individual scenarios used are skewed • Can be time-consuming and confusing (especially if different people define "optimistic," "most likely," and "pessimistic" differently)

Avoiding Unethical Practices

It is important for project participants to ensure that unethical estimation practices do not creep into the projects they are working on.

Some of the more-common unethical practices that often find their way into projects and project estimates include:

- Participants skewing estimates for personal gain
- Participants knowingly allowing biases (i.e., friendships) to affect their estimates
- Participants over-estimating their assessments, to provide cushions that will cover their inexperience, incompetence, or unwillingness to complete the work

- Participants deliberately under-estimating in the early stages of the project, then demanding additional payment, time, and/or resources to complete the agreed-upon assignments
- Participants deliberately underestimating the work, effort, and/or cost during selection/initiation, to ensure that a preferred project is approved

Project leaders and team members must remain vigilant and be proactive to guarantee that these (and other) unethical practices do not find their way into their projects. If it is determined that unethical practices have occurred, immediate action must be taken to remove these issues from the project before they can damage reputations or derail project work.

Linking Estimates to Activities

Project participants may want to create a control account to link the activities in the work breakdown structure to the cost estimates used in creating the cost baseline. The control account will use a numbering system (like the one in the chart to the right) to link specific work packages with their associated costs in the accounting system, which allows practitioners to precisely track costs in the project.

Chart of Accounts

- 7001: Marketing
- 7002: Recruiting
- 7003: Travel
  - 8045: Meals and Entertainment
  - 8072: Airline Expense
  - 8099: Tolls
- 7004: Printing and Reproduction
- 7009: Telephone
- 8003: Training
- 8016: Editing

Video Commentary

Control Accounts

Richard Maltzman

What's a control account? A control account is a work breakdown structure (or WBS) work-package-level identifier for charging time. So if a work package is "Perform Final Electrical Tests" and this has a work breakdown structure ID of "4.5.2.1.1," the control account for this activity could be, for example, "Account 45211." And really it's just a representation of the outline form that the WBS tends to behave to. And it's useful to allocate and track project expenses and to be able to look for variances by account type. A code of accounts is the system used to accommodate this whole numbering scheme.

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4.03.1 Contingency and Management Reserves

Contingency and Management Reserves

When practitioners are planning and estimating projects, they will need to establish reserves to deal with the risks associated with project work. A reserve is the amount of cost (and/or time) allocated to a project to account for risk.

Contingency reserves (also called contingency allowances) are established to deal with "known unknown risks" and accepted known risks. They may be in the form of additional time, money, or resources, and cover risk events that are not accounted for in project duration and cost estimations. Contingency reserves should include enough money and/or time to implement contingency plans (to deal with known risks), as well as a buffer for dealing with unidentified risks.

Management reserves are meant to cover unplanned/unpredictable changes in project scope and cost (sometimes called "unknown unknowns"). Management reserves are often included in the total project budget, but are generally not included in project cost baselines.

Types of Contingency Reserves

Contingency reserves can be broken down into schedule reserves (which establish time in the schedule to deal with risks) and budget reserves (which cover money). Typically contingency reserves are determined at the outset of a project, but they may be adjusted or modified during the project life cycle.

While there is not a standard formula for calculating the size of contingency reserves, the project team should take a variety of factors into account, including:

- *Risk tolerance.* How much risk will management and stakeholders accept? Organizations with low levels of risk tolerance will require larger contingency reserves.
- *Inherent risk.* How much risk is inherent in the project? Risky projects will require larger contingency reserves.
- *Complexity.* How complex is the project? Highly complex projects will require larger contingency reserves.
- *Comparable projects.* What reserve levels were used for completed projects with a similar size and scope?

Contingency Reserve Best Practices

Some best practices related to contingency reserves relate to how they are used and how they are communicated to the team. A rule of thumb is that reserves should only be used for problem solving. A project manager may be tempted, for example, to use schedule reserve to handle scope creep or other risks. This behavior will inevitably lead to greater project risk overall.

The way that reserves are communicated among the team will differ from project to project. In some cases, the reserves are known to all. In other instances, they are only discussed among the project leaders. In general, open communication is preferred. However, knowledge of reserves can lead to scope creep and Parkinson's Law ("work will expand to fill the time available for it"). One technique that can be used to prevent this phenomenon is to reward teams for any unused reserve at the conclusion of the project. The reward should be proportional to the amount of reserve that remains—the larger the untouched reserve, the larger the reward for the group.

4.04 The Performance Measurement Baseline

The Performance Measurement Baseline

One important output of cost management work is the cost baseline. As mentioned in a previous module, the cost baseline stipulates the amount of money that should be spent at every point in time through the project's life cycle.

The cost baseline shows the summation of all of the costs incurred during the course of the project, so it will always rise over the course of time. However, because the costs per period of time will be low at both the beginning and the end of the project, the curve will be concave at the beginning of the project and convex at the end, resulting in a characteristic S-curve.

The cost baseline is an integral component of the performance measurement baseline for controlling costs. The performance measurement baseline (PMB) is an approved integrated scope-schedule-cost plan for the project, against which project execution is compared to measure and manage performance. The performance measurement baseline is used in earned value management (EVM) calculations to assess project progress and to evaluate performance to-date. A project's cost performance is measured by determining the earned value and comparing it to the actual cost, while its schedule performance is a comparison of a project's earned value and its planned value.

Video Commentary

Using the Performance Measurement Baseline to Measure Cost and Schedule Performance

Richard Maltzman

How can one graphic show both project cost and schedule at the same time? Well, the performance management baseline is part of the earned value management technique, which puts project accomplishment--both time and budget--in monetary units, and that sounds a little odd because you're now putting what we normally would think of as days of the week or months or hours into (if you're in the U.S.) dollars. So monetary units are the single measure for earned value management and it's a way to get an integrated view of the planned value (which is also called the PMB--performance management baseline or just the baseline) and allows you to compare actual costs and earned value against that planned value or that baseline.

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Remember that planned value, earned value, and actual cost can be defined in the following way:

Term	Definition
Planned value (PV)	The authorized budget assigned to the scheduled work. PV can be described as "the physical work that *should have been done*."
Earned value (EV)	The measure of work performed expressed in terms of the budget authorized for that work. EV is often described as "the physical work that was *actually done*."
Actual cost (AC)	The realized cost incurred for the work performed on an activity during a specific time period. Actual cost is often described as " *what was spent* to achieve the earned value."

The points on the PMB S-curve show the planned value for each point in time for the project. For every moment in the project's life cycle, a certain amount of value (an ability to meet objectives of scope at a certain amount of cost) is planned for or expected. These points, when collected and compiled together, form the S-curve that makes up the PMB; therefore, *this S-curve is the planned value for the project*.

It is important to remember that earned value is calculated with respect to the performance measurement baseline (planned value) because it has already taken into account the requirements for scope, cost, and time. That means that EV cannot be higher than PV *for an individual work package (as opposed to the EV cumulative value line, which may be above the PV line if the project is ahead of schedule)*. This is because once a project meets the objectives for that component set by the planned value, no greater value can be added to it—it's 100% complete and nothing more. On the other hand, there is no limit on actual cost. Actual cost for a work package can be much higher than the earned cost, although because overage cannot generally be recouped by the project, actual cost will ideally be lower than earned value.

Performance Indices

As discussed in a previous module, the PMB can be used to calculate a project's schedule variance and cost variance (to determine *how much* the project is ahead or behind in cost or schedule). In addition, the PMB can also be used to help calculate the schedule performance index (SPI) and the cost performance index (CPI) to help teams consider the *impact* of variance on future work or to compare variance between projects.

Like the schedule variance and cost variance calculations, the CPI and SPI calculations also use planned value (PV), earned value (EV), and actual cost (AC) to assess project progress.

Term	Definition
Cost performance index (CPI)	Earned value / Actual cost
Schedule performance index (SPI)	Earned value / Planned value

The CPI is the most commonly used cost-efficiency indicator in project cost management. CPI tells practitioners whether, over the course of the period measured, the project has been under, over, or on the budget that was planned, for the amount of earned value. A CPI value less than 1.0 indicates a cost overrun of the estimates, while a CPI greater than 1.0 indicates a cost deficit against the estimates.

Cost performance index (CPI) = EV/AC

Similarly, SPI tells project participants whether, over the course of the period measured, the project has been under, over, or on schedule for the amount of earned value. An SPI value less than 1.0 indicates the project is behind schedule, while an SPI greater than 1.0 indicates that the project is ahead of schedule.

Schedule performance index (SPI) = EV/PV

Multiplying the SPI and CPI together allows the project team to assess the degree to which a project is going exactly as planned —an index measure known as *critical ratio*. If work is on schedule, ratios will be greater than 1.0; if work progress is slower than

planned, ratios are less than 1.0.

Critical ratio = SPI * CPI

The SPI and CPI are useful for forecasting future variance from the project's budget at completion (BAC). The techniques for forecasting a project will be explained in the next assignment.

4.04.1 Exercise: Project Cost Management Crossword Puzzle

This assignment does not contain any printable content.

4.05 Forecasting

Forecasting

BAC, EAC, and ETC

A highly successful project is one that is completed within its target budget. This target budget, also known as the budget at completion (BAC), is the planned value *at the completion of the project* or the budget that the project management team hopes to finish the project within.

However, this may not always be possible. If the project management team recognizes that the project does not have the earned value that it should for the money that was spent on the project, it might need to reevaluate, and forecast a newer, more accurate estimate, using the information it has gained about the project's performance over its life cycle. This new estimate is called the estimate at completion (EAC). The estimate at completion (EAC) is used to determine the cost or amount of work needed to complete scheduled activities. The EAC may be calculated based on performance to-date, or it might be estimated bottom-up by the project team based on their own expertise and knowledge about the remaining work packages.

EAC calculations generally add the actual cost (AC) of the project to-date to an estimate to complete (ETC) the project (i.e., the estimate for completing the remaining work for a project, activity, schedule, or control account).

EAC = AC + ETC

The ETC, and therefore the EAC, can be calculated in various ways depending on the optimism of the project management team and their assumptions that the remaining work packages can be completed on budget with respect to *their* planned values. In each of the situations described below, the earned value has not met the planned value up to the point of calculation, and the EV, CPI, and SPI refer to the cumulative EV, CPI, and SPI of the completed work up to that point.

With Atypical Variances

If the variances are viewed as atypical and not expected in the future, and the project management team truly believes it can pick up the pace (managing for the completion of all *future* work packages such that their EV matches their PV), the ETC is calculated as budget at completion (BAC) minus the cumulative earned value to date (EV) (ETC = BAC-EV).

EAC = AC + (BAC - EV)

With Typical Variances and Work Completed at the Same Rate

When variances are seen as typical, and the project management team expects that future work packages will be completed at the same rate at which they have been completed up to that time in the project, earned value to date is divided by the cumulative cost performance index (ETC = BAC-EV/CPI).

EAC = BAC/CPI

With Typical Variances and Work Completed at a Faster Rate

If the project management team understands that work has not been completed quickly enough to meet the requirements of an imposed schedule constraint, it can calculate the budget that will be required to increase the amount of resources to a level that will allow the work to be completed in the remaining time.

EAC = AC + [(BAC - EV) / (CPI x SPI)]

The To-complete Performance Index

When a project management team cannot change the budget at completion, and it needs to calculate the performance necessary to finish the project on budget, it can calculate the to-complete performance index (TCPI). This index represents the level of cost performance that is necessary to complete the project on budget (though whether this TCPI is realistic or not depends on the situation. The project management team may want to submit change requests to project schedule or scope if the budget is inflexible and the TCPI is not feasible at the planned cost for the activities that need to be completed.)

The to-complete performance index is a measure of the cost performance that is required to be achieved with the remaining resources to meet a specific management goal. Essentially, it is the ratio of remaining work to the funds remaining.

Again, in the calculations below, EV refers to the cumulative EV of the completed work up to the point of calculation.

When using the BAC, TCPI = (BAC - EV) / (BAC - AC)

When using the EAC, TCPI = (BAC - EV) / (EAC - AC)

4.05.1 Exercise: Forecasting

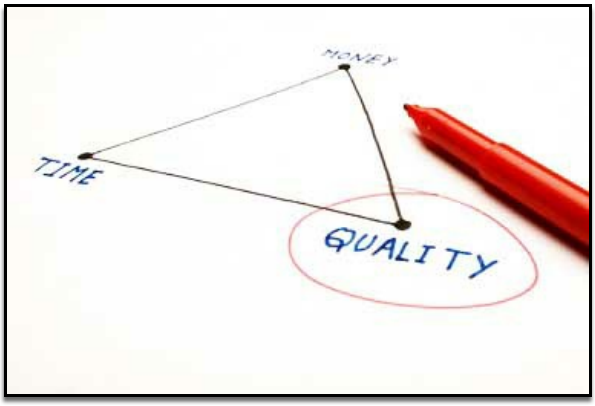
This assignment does not contain any printable content.

4.06 Project Quality Management

Project Quality Management

A project cannot be successful if its results fail to meet expectations.

When a project is designed, certain assumptions about the project's end product or service develop, and expectations about the processes used to create those results are also made. These beliefs often center on the quality of the product and processes—stakeholders expect that things will work to a certain level of excellence or expertise that they haven't confirmed to be true. To manage a project successfully, practitioners need to monitor these expectations and adjust project activities to make sure that these needs are met and that the project delivers results and value.



Projects that fail to meet requirements are a waste of time and resources. Team members may put in long hours and significant effort but if they are not aligned to meet expectations, they aren't achieving effective results. To guarantee that this doesn't happen, participants need to institute some form of quality management to ensure that the work on their projects provides high value to their stakeholders.

The quality management processes instituted should monitor both the product *and the processes used to create those products*, to guarantee a high degree or level of excellence. Failing to address the quality of processes often results in frustration for project participants who are trying to develop high-quality products with less-than-capable processes. Conversely, organizations that continuously ensure that processes are adjusted to run smoothly and efficiently help their teams create high quality products and enhance satisfaction in completing project work.

Good quality management practices verify that a project will meet the needs it was designed for, whatever those needs might be. Keeping an eye on a project's ability to meet expectations for both the product and the project will go a long way toward making work more effective and enjoyable. By consistently monitoring the ability of the project to meet expectations and satisfy stakeholders, practitioners continue to provide value and quality results on their projects, and develop processes that ingrain quality management concepts into the project environment and organizational culture.

Video Commentary

Overview of Quality Management

Fran Dwyer

From a PM perspective, if there's not an established quality set or what quality means to the particular project, and then the end results is that you're going to be looking at the quality or project from specifically a subjective nature, and you don't want to do that. You really want to be able to provide some standardization or what quality is.

By definition, quality management is establishing quality standards, controlling the quality, improving quality, and acting as a voice of quality for the customer. Normally you might hear about VOCs or voice of quality analysis being done. One of the issues in having quality standards as well, and in establishing a quality management or a formalized quality management process is you can counsel the executive team in any particular company or organization on how you're doing from a quality perspective on the project. And it's important to understand as well that quality is the differentiator many times between you and your competitor in a business. So having objective quality model that measures quality in an objective fashion throughout the life of the project determines whether or not you may be successful in the marketplace.

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4.07 Cost of Quality

Cost of Quality

All good quality management practices share several common concerns:

- the importance of understanding and managing customer expectations and requirements
- the value of *preventing* problems with a product rather than discovering them in inspection (when fixes are more costly) or during usage
- the necessity for continuous improvement of both the product and the development processes
- the responsibility of the project management team to manage for quality
- the need to consider the cost of quality throughout the life cycle of the deliverables

It is essential for practitioners to consider quality costs throughout the life of the product, to ensure that customers and end users remain satisfied with results. Failure to consider maintenance and warranty costs for project outcomes may decrease initial costs but may dramatically increase costs later as organizations work to keep customers happy.

Cost of quality can be separated into two categories—conformance costs and nonconformance costs. Prevention and appraisal costs (the costs of conformance) include costs for quality planning, quality control (QC), and quality assurance (QA) to ensure compliance with requirements (i.e., training, QC systems, etc.). Failure costs (cost of nonconformance) include costs to rework products, components, or processes that are noncompliant, costs of warranty work and waste, and the loss of reputation associated with producing unsatisfactory products.

Conformance Costs	Nonconformance Costs

• Prevention Cost: The cost of planning and executing a project so it is within an acceptable error range. Costs in this category include training, studies related to quality, and quality surveys of suppliers and subcontractors. • Appraisal Cost: The cost of evaluating processes and their outputs to ensure that a project is within an acceptable error range. Costs in this category include inspection and testing of projects, maintenance of test equipment, and processing and reporting inspection data. • Measurement and Test Equipment Costs: The capital cost of equipment used to perform prevention and appraisal activities.	• Internal Failure Cost: Costs incurred to correct an identified defect before the customer receives the product. Costs in this category include scrap and rework, inventory costs that are a direct result of defects, or correcting documentation. • External Failure Cost: Costs that relate to all errors not detected and not corrected before delivery to the customer. Costs in this category include warranty costs, field service personnel training expenses, product liability suits, and future business losses.
Adapted from Kathy Schwalbe, *Information Technology Project Management*.	

Quality management practices should be *designed into* a project, not *added on* as inspections steps after the project has been completed. An inspection of results after-the-fact can be very costly because completed products will need to be reworked (if possible) or scrapped (if rework will still not ensure quality). Quality improvement practices that are designed into project work will help to uncover problems before they can adversely affect the project or disappoint customers and users.

Video Commentary

Why is Cost of Quality Important?

Richard Maltzman

What's so important about the cost of quality? Cost of quality is a philosophy that basically says, "Pay me now, or pay me later." That is, if work is done properly with the proper trained resources, it prevents rework and defects which will be very expensive to the project and to the enterprise later. The costs of good quality would, therefore, be training, inspection, planning, anything you do to provide a higher quality output.

The costs of poor quality would be the defects, rework, lost business, lost reputation, lawsuits, and much more--some of which is very intangible.

The cost-of-quality philosophy says that the resources spent on good quality outweigh the threats presented by bad quality.

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4.08 Quality Assurance vs. Quality Control

Quality Assurance vs. Quality Control

Quality management involves both quality control and quality assurance but these terms can be confusing because they are often used interchangeably. There are, however, distinct differences between them, as shown in the following table:

	Quality Control	Quality Assurance
Focus	Uncover defects so they can be fixed	Prevent defects from occurring

Purpose	Assess performance and recommend corrective action	Assess capability and recommend preventive action
Level	Basic—recognize problems so they can be fixed	Advanced—understand the intricacies of the system and predict outcomes
Major Activities	Inspection and repair	Training
Change Response	Reactive—take action once the problem has occurred	Proactive—take action before the problem can occur

Quality management is not an "either-or" proposition—practitioners don't have to choose between quality assurance and quality control. Instead, they should strive to incorporate both into their quality improvement processes.

The combination of these two techniques gives participants the best possible results by managing quality on two fronts. Refining their processes (quality assurance) will ensure that fewer defects are produced and will increase confidence that the outcomes they expect to see will actually be reflected in their results. But even with the best quality assurance processes in place, defects can still occur. Incorporating quality control measures on top of the quality assurance activities will ensure that these defects don't make it to the customer and will also alert practitioners to gaps in their quality assurance processes that must be closed.

Video Commentary

Quality Assurance and Quality Control

Rich Maltzman

How do you combine quality assurance and quality control to get a robust quality management system? Well, first, let's start with what QA and QC are all about. Quality assurance is all about the process, where quality control is tied in directly with the product itself--inspection and testing of the product for example. And QC is about implementing the process that you set in QA. So, combining how you set up your process to meet customer requirements with a check as to whether or not you're meeting those requirements along with those steps that you're following is a very powerful combination.

Let's start with an example. Let's say you have a process to make a laminate product, and it's important that it's a certain thickness. So, you have a check after you've manufactured the laminate to see whether or not it's at the requirements for thickness. If a sample comes up too thin in that test, it's up to the QC folks to record that failure as well as the technical details--exactly how thin was it or how thick was it. That's very important.

QC is there to do the testing. QA is there to make sure that the process is there to catch this information to make sure that the process includes all of the voice of the customer requirements and needs. Of course, ideally, you're iterating or cycling feedback from quality control to quality assurance to improve the process so you don't need to do as much testing and inspection in the future state. This is how QA and QC work together to form a power quality management system.

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4.08.1 Exercise: Quality Control vs. Quality Assurance

This assignment does not contain any printable content.

4.09 Minicase: Quality Control vs. Quality Assurance

This assignment does not contain any printable content.

4.10 Quality Management Tools and Techniques

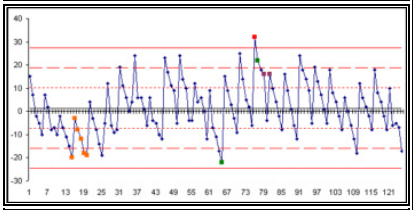
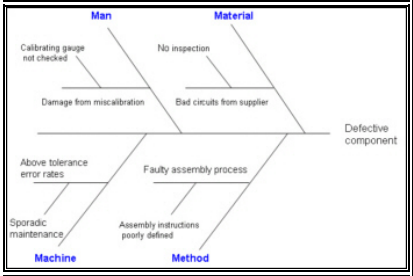
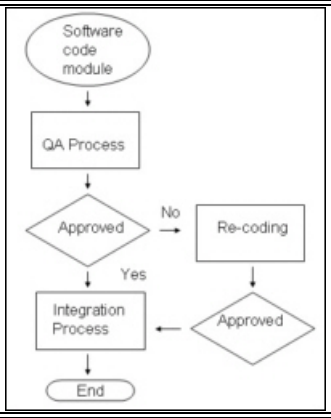
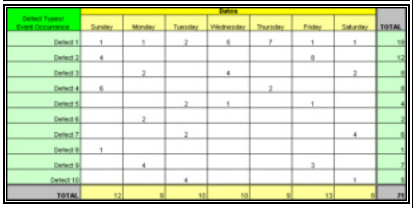
Quality Management Tools and Techniques

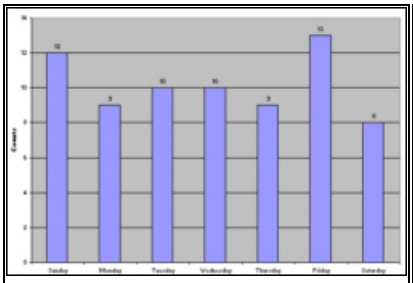
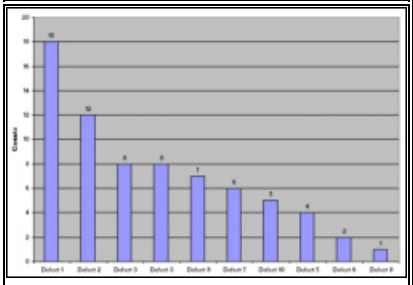
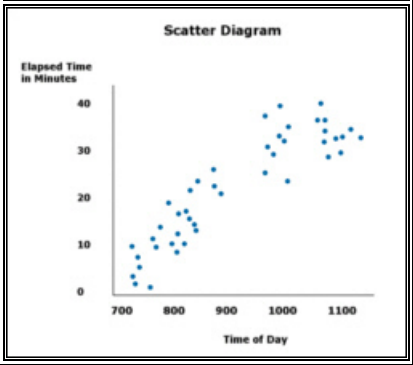
Ishikawa's Seven Basic Tools of Quality

Kaoru Ishikawa, a Japanese university professor, described seven tools that teams can use to manage quality issues in their organizations.

The tools are simple, graphic representations of data that help teams address problems and uncover the factors that contribute to those problems. The tools were designed to be simple to learn and easy to understand so that an average worker with little or no advanced training could use them effectively.

Ishikawa's seven tools are described in the table below.

Tool	Description	Example
Run chart/control chart	A graphic display of data that illustrates the results of a process over time	
Cause-and-effect diagram	A diagram used to show the factors that cause and contribute to an overall effect	
Flowchart	A graphic display of the logic and flow of processes for problem analysis and process improvement	
Check sheet	A structured, prepared form for collecting and analyzing data	

Histogram	A bar graph of the distribution of variables	
Pareto diagram	A histogram used to identify and prioritize the factors that cause quality problems	
Scatter diagram	A diagram that helps to show if there is a relationship between two variables	

Ishikawa claimed that these seven tools can be used to solve 90%–95% of the quality-related problems organizations see. The tools can be used independently or in combination to quickly uncover issues and to develop ideas to regulate quality problems. In many cases, the outputs of one tool become the input to another tool to allow practitioners to dig deeper into problems and develop more-effective solutions.

The "New" Tools

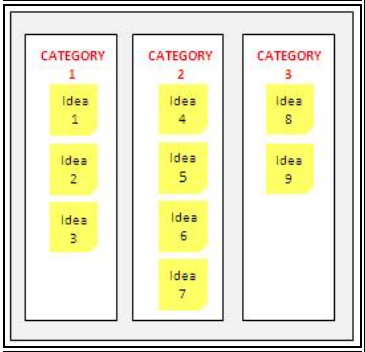
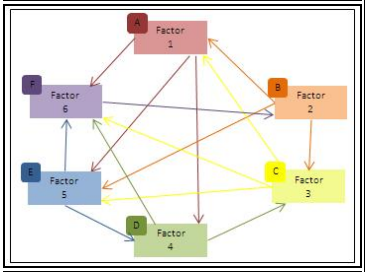
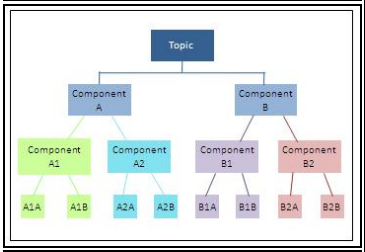
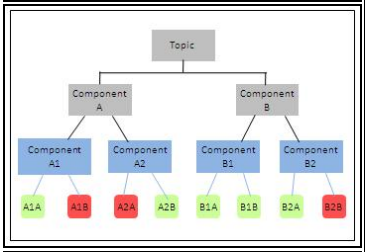
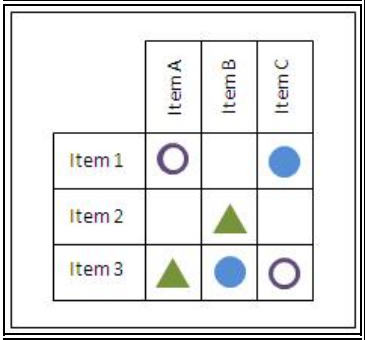
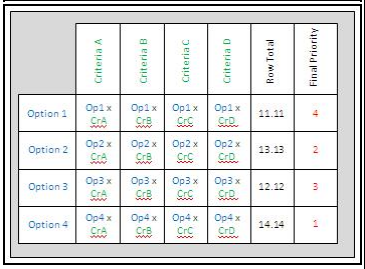
Ishikawa's tools are great for working with numerical data but people still needed a way to work with words and ideas that could not be easily quantified. They needed a way to analyze, organize, and interpret qualitative or "abstract" data to help them solve the complex problems that the Ishikawa tools weren't designed to solve. As a result, they created seven "new" tools to help explore areas where numerical data didn't exist.

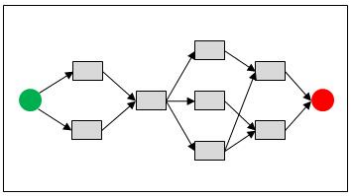
These seven tools—the affinity diagram, the interrelationship digraph (or relations diagram), the tree diagram, the matrix diagram, the prioritization matrix, the process decision program chart, and the network diagram—are interactive, team-based tools that help groups analyze verbal data and make better decisions on projects.

Used separately or in combination, these tools help teams:

- Identify problems
- Generate ideas
- Develop plans

- Implement solutions

Tool	Description	Example
Affinity diagram	A tool that sorts data or ideas into categories for further investigation	
Interrelationship digraph	A circular diagram that shows the cause-and-effect relationships among contributors	
Tree diagram	A hierarchical tool that breaks a topic down into its components	
Process decision program chart	A tree diagram that illustrates options for preventing or solving problems	
Matrix diagram	A table or chart that shows the strength of relationships between items or sets of items	
Prioritization matrix	A table or chart that helps a team prioritize multiple options, based on how well these options satisfy preselected criteria	

Network diagram	A scheduling diagram that shows the relationships among project activities	

The collaborative nature of these tools encourages participation and buy-in to project plans and uses the team's collective knowledge to solve problems and improve work. The graphic expression of these tools allows a significant amount of information to be seen without forcing interested parties to wade through complicated tables and spreadsheets. And the tools can be linked together or used in conjunction with the Ishikawa tools to dig deeper into problems and gain a better understanding of project work.

4.11 Project Procurement Management

Project Procurement Management

Project procurement management includes the processes for purchasing or acquiring products or services from outside of the project team. It assumes that formal agreements or contracts are at stake in the processes, but procurement activities can also apply to intradivisional procurements (without formal agreements) that may be necessary to complete a project.

Procurement management includes information that helps the project management team decide:

- whether to make or buy project materials
- how project agreements will be written and administrated
- what criteria to use to help the team choose between suppliers and then manage the chosen suppliers
- how to adapt organizational assets to current needs for statements of work and contracts
- how to incorporate necessary lead times into the schedule when procurements require time to buy or produce
- when and how insurance or other risk-mitigating tools and techniques will be used
- how to use prequalified sellers, if there are any

Procurement documents include all of the documents used in bid and proposal activities, which include the buyer's invitation for bid, invitation for negotiation, tender notice, request for information, request for quotation, request for proposal, and invitation for seller's initial response. The types and formats of procurement documents used will vary depending on the organization and environmental factors (such as governmental or industry standards). These documents should contain enough information so that the performing organizations know what is expected of them. On the other hand, allowing room for the performing organization to provide their input on the best way to meet project requirements can also benefit the project.

Procurement documents should also include a procurement statement of work (SOW), which describes the procurement item in sufficient detail to allow prospective sellers to determine if they are capable of providing the products, services, or results needed. The procurement SOW is developed from the project scope baseline and defines only that portion of the project scope that is to be planned for in the related contract. The statement of work provides requirements for the project's specifications, performance, schedule, and quality to the performing organization. As with all project management documents, the SOW can be as detailed or as general, as formal or informal as will suit the project and meet the requirements of an organization.

Selecting Sources

Project practitioners may also want to develop some source selection criteria to help in choosing which vendors or suppliers to work with. Although decisions will vary from project to project, some common source selection criteria for proposals are listed below.

Source selection criteria	
Understanding of need	The extent to which the seller's proposal addresses the requirements of the statement of work
Business size and type	How well the seller matches any stated preferences for the type of business that the buyer would like to work with. For example, a buyer may only want to choose a business that employs union workers

Management approach	The extent to which the buyer believes that the seller will be able to manage the project adequately
Life cycle cost	The overall cost of the vendor's work after the expected operating cost of the product is factored in
Technical approach and capability	The extent to which the buyer is confident that the seller's proposed approaches to creating the deliverable will actually satisfy SOW requirements
Financial capacity	The extent to which the seller is capable of gathering the resources necessary to complete the contracted work with the financial resources it has
Production capacity and interest	The vendor's intent and proof of a production ability to meet project requirements
Intellectual property or proprietary rights	The specifics of whether the buyer or seller will own the intellectual property or proprietary rights of the products created to satisfy the SOW
References	The extent to which the seller can back up its proposed work with the recommendations of satisfied customers
Risk	The amount of risk that is embedded in the SOW, whether the risk is assigned to the buyer or seller, and how the seller mitigates the risk
Warranty	The seller's warranty for the final product and the time period of that warranty
Past performance of sellers	The organization's past experiences (good or bad) with selected sellers

Video Commentary

Product Procurement Management: Roles and Responsibilities

Richard Maltzman

Project procurement management roles and responsibilities in project teams. Your role in relation to procurement management is going to vary very widely depending on your organization and its policies, as well as the specific project on which you're working.

For example, a giant project with its own contract clauses devoted to purchasing may put you more in charge as the project practitioner. Ideally, the project practitioner has at least some say early on in contract negotiation with power up-to and including being able to turn down a contract based on project characteristics such as too much schedule risk.

Some organizations even assign a "project expert" to assess projects from the project practitioner's perspective. You're lucky if you have this in your organization.

On the other end of the spectrum, some companies throw projects over the wall to the practitioner and say, "Here, go manage this." Good luck if this is your situation.

In any case, my coaching is to take advantage of experienced procurement and contract managers who have that particular expertise. And don't forget the power of contract clauses to protect your project from specific threats.

Rich Maltzman, PMP®, is the Learning and Professional Advancement Leader at a major telecom supplier.A contributor to the *PMBOK® Guide*, 4th Edition, he has co-authored PMP® Exam study guides. He is co-founder at EarthPM, LLC, and along with co-founder David Shirley, PMP®, has authored the book, *Green Project Management: Planet, Projects, Profits, and People*, published in September 2010. He received a BSEE from the University of Massachusetts in Amherst and has a graduate degree in industrial engineering from Purdue University.

4.11.1 Exercise: Source Selection Criteria Seven Strikes Game

This assignment does not contain any printable content.

4.12 Contract Types and Negotiation

Contract Types and Negotiation

Contract Types

One of the most important aspects of procurement management is determining what type of agreement or contract to use to guide procurement activities.

Most contracts can be classified as one of three basic types—fixed-price contracts, cost-reimbursable contracts, or time and material contracts.

Fixed-price Contracts

> These contracts are ideal for well-defined products where costs don't often change. A firm-fixed-price contract (FFP) sets a cost, and the seller is legally obligated to perform the work for that cost. FFP contracts are generally preferred by buying organizations because any risks associated with cost fluctuations are most often absorbed by the seller. Fixed-price contracts do allow some room for 1) increasing the sale price by allowing incentive payments (for fixed price incentive fee contracts [FPIF]) or 2) increasing the sale price by allowing price adjustments for inflation or increasing or decreasing cost of commodities (for fixed price with economic price adjustment contracts [FP-EPA]).

Cost-reimbursable Contracts

> In these arrangements, payment is made to the seller for the seller's actual costs plus a fee for seller profit. These types of contracts are valuable when requirements for scope or other objectives will be progressively elaborated through the course of the project. Cost plus fixed fee contracts (CPFF) reimburse the seller only for the allowable actual cost of performing the work. A cost plus incentive fee contract (CPIF) allows for incentive pay based on arrangements set out in the SOW or other project documentation. And a cost plus award fee contract (CPAF) requires that award pay be granted to the seller, with the amount of this pay determined by the buyer based on its subjective evaluation of the seller's performance.

Time and Material Contracts (T&M)

> This type is a hybrid contract that has the openness of the cost-reimbursable arrangement, but includes some fixed-price type arrangements as well. The full value and the exact quantity of items to be delivered are not defined by the buyer at the time of the contract award, but elements of fixed-price type arrangements (such as unit-rates for a specific resource category) can be used.

Contract Negotiation

Contract negotiation, in a nutshell, describes the process of a buyer and seller agreeing to terms before signing a contract or agreement. The idea is simple; its execution is not. Regardless of the industry or contract type, the reality is that contract negotiation is an art that involves diplomacy, subtlety, and many other skills.

Project practitioners, and specifically project managers, may be called upon to negotiate many parts of a project, including the project's scope, price, terms, and schedule. They may need to discuss initial contract negotiations with vendors and they may need to address any change negotiations during planning and design or execution.

As the specifics of the contract are discussed, it is important for practitioners to remember that these negotiations will set the tone for the working relationships on the project. A "take no prisoners" approach to negotiation may emphasize short-term gains at the cost of long-term success. Alternatively, a project participant's negotiation skills can develop mutual respect between the buyer and seller, improve communication, and create a lasting rapport.

The research shows that project contracts that have been effectively negotiated lead to fewer disputes, claims, and lawsuits.

When negotiating a contract, consider some of the key issues listed below.

Preparation	• Establish the scope to be negotiated. • Determine what success looks like. • Ensure that the person you are negotiating with has the proper authority to negotiate. • Try to anticipate how the other party might react. • Brainstorm "what if" scenarios and develop creative solutions. • Rehearse discussions or role-play the negotiation with a coworker to prepare for negotiations.
Conducting Negotiations	• Develop rapport with the other party before entering the negotiations in earnest. • Focus on the scope of the project and potential issues. • Establish your own credibility. • Listen to the other party. • Understand the other party's needs and concerns. • Keep a tally of concessions. • Seek reciprocal concessions. • Close negotiations successfully on a positive note.

There are a host of negotiating techniques that can be used to help ensure a positive result for negotiations. Explore some of the common (good and bad) tactics employed in negotiation ("take it or leave it," "good cop/bad cop," "the nibble," "emotional outbursts") and be prepared to deal with them if they arise.

Video Commentary

Which Contract Type is Better?

Richard Maltzman

How do you decide which contract type makes the most sense in your project situation? This becomes part of the initial negotiation when a project is conceived. As a customer, so if you're on the buying end, be very wary of cost-reimbursable contracts, which have no motivation for the seller to reduce costs. Remember, there are some contracts where the best decision is just to walk away. If you're interested in a particular example, where the U.S. government was the customer, you can check out the virtual case file project of the U.S. FBI (Federal Bureau of Investigation) in which a cost-reimbursable contract ended up costing the American taxpayers a huge sum of money and we received no benefit. This is because the seller (the contractor) was able to point to the contract and say, "Well, we're getting paid for the services rendered up to this point and we don't have to deliver anything."

On the other side you have a fixed-fee contract where the risk is all with the seller and the seller is obligated to provide the services for that fixed fee whether the price of their materials and services go up or down. You, as a customer, have the certainty of getting a certain deliverable for a certain fixed fee and you have that guaranteed.

Rich Maltzman, PMP®, is the Learning and Professional Advancement Leader at a major telecom supplier.A contributor to the *PMBOK® Guide*, 4th Edition, he has co-authored PMP® Exam study guides. He is co-founder at EarthPM, LLC, and along with co-founder David Shirley, PMP®, has authored the book, *Green Project Management: Planet, Projects, Profits, and People*, published in September 2010. He received a BSEE from the University of Massachusetts in Amherst and has a graduate degree in industrial engineering from Purdue University.

4.13.1 Exercise: Contract Types

This assignment does not contain any printable content.

4.13 Discussion Board

This assignment does not contain any printable content.

Module Feedback

This assignment does not contain any printable content.