Quality Management

EIGHT

Before you read this chapter, think about the quality management plan on your project. If you do not have a quality management plan, or if you do not manage quality now, this could be a difficult topic for you on the exam. This chapter will help you understand quality and its role in the project management process.

Some people argue that project managers do not have time to spend managing quality, and many organizations do not require their project managers to have quality management plans. But think about the impact of managing quality on your projects. A lack of attention to quality results in rework or defects. The more rework you have to do, the more time and money you are wasting, and the less likely you are to meet the project schedule and cost baselines. With a focus on quality, you can spend time preventing—rather than dealing with—problems. You can actually save time on the project that you would have otherwise spent on rework and problem-solving.

Projects and organizations determine their approach to quality management. For some, that may mean simply responding to customer complaints about the quality of deliverables. Others inspect their deliverables for quality before they reach the customer. More informed organizations not only inspect their deliverables, but also evaluate and adjust their quality management processes in an effort to identify the causes of defects. An even better approach includes these quality management and process improvements, as well as planning quality into projects. Ideally, an organization embraces all these efforts as part of a total commitment to providing the required level of quality. This chapter will improve your understanding of the efforts required to address quality at the most effective level.

QUICKTEST

- Quality management process
- Definition of quality
- Gold plating
- Prevention over inspection
- Continuous improvement
- Just in time (JIT)
- Responsibility for quality
- Interviews
- Brainstorming
- Benchmarking
- Cost-benefit analysis
- Impact of poor quality
- Cost of quality
- Costs of conformance and nonconformance
- Marginal analysis
- Logical data models
- Flowcharts
- Test and inspection planning
- Checklists
- Quality metrics
- Quality management plan
- Cause-and-effect diagrams
- Histograms
- Pareto diagrams
- Scatter diagrams
- Document analysis
- Alternatives analysis
- Design of experiments
- Process analysis
- Root cause analysis
- Failure analysis
- Multicriteria decision analysis
- Affinity diagrams
- Audits
- Design for X
- Problem-solving
- Test and evaluation documents
- Quality reports
- Mutual exclusivity
- Probability
- Normal distribution
- Statistical independence
- Standard deviation
- 3 or 6 sigma
- Checksheets
- Statistical sampling
- Questionnaires and surveys
- Performance reviews
- Inspection
- Control charts
  - Assignable cause/ special cause variation
  - Control limits
  - Mean
  - Specification limits
  - Out of control
  - Rule of seven

Quality Management EIGHT

INITIATING

- Select project manager
- Determine company culture and existing systems
- Collect processes, procedures, and historical information
- Divide large projects into phases or smaller projects
- Understand business case and benefits management plan
- Uncover initial requirements, assumptions, risks, constraints, and existing agreements
- Assess project and product feasibility within the given constraints
- Create measurable objectives and success criteria
- Develop project charter
- Identify stakeholders and determine their expectations, interest, influence, and impact
- Request changes
- Develop assumption log
- Develop stakeholder register

PLANNING

(This is the only process group with a set order.)

- **Determine development approach, life cycle, and how you will plan for each knowledge area**
- Define and prioritize requirements
- Create project scope statement
- Assess what to purchase and create procurement documents
- Determine planning team
- Create WBS and WBS dictionary
- Create activity list
- Create network diagram
- Estimate resource requirements
- Estimate activity durations and costs
- Determine critical path
- Develop schedule
- Develop budget
- **Determine quality standards, processes, and metrics**
- **Determine team charter and all roles and responsibilities**
- Plan communications and stakeholder engagement
- Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
- **Go back—iterations**
- Finalize procurement strategy and documents
- Create change and configuration management plans
- **Finalize all management plans**
- **Develop realistic and sufficient project management plan and baselines**
- Gain formal approval of the plan
- Hold kickoff meeting
- Request changes

EXECUTING

- Execute work according to the project management plan
- Produce product deliverables (product scope)
- Gather work performance data
- **Request changes**
- Implement only approved changes
- **Continuously improve; perform progressive elaboration**
- **Follow processes**
- **Determine whether quality plan and processes are correct and effective**
- **Perform quality audits and issue quality report**
- Acquire final team and physical resources
- Manage people
- Evaluate team and individual performance; provide training
- Hold team-building activities
- Give recognition and rewards
- **Use issue logs**
- Facilitate conflict resolution
- Release resources as work is completed
- Send and receive information, and solicit feedback
- Report on project performance
- Facilitate stakeholder engagement and manage expectations
- Hold meetings
- Evaluate sellers; negotiate and contract with sellers
- **Use and share project knowledge**
- Execute contingency plans
- **Update project management plan and project documents**

MONITORING & CONTROLLING

- **Take action to monitor and control the project**
- Measure performance against performance measurement baseline
- **Measure performance against other metrics in the project management plan**
- **Analyze and evaluate data and performance**
- **Determine if variances warrant a corrective action or other change request(s)**
- **Influence factors that cause change**
- **Request changes**
- Perform integrated change control
- Approve or reject changes
- **Update project management plan and project documents**
- Inform stakeholders of all change request results
- Monitor stakeholder engagement
- Confirm configuration compliance
- Create forecasts
- Gain customer's acceptance of interim deliverables
- **Perform quality control**
- Perform risk reviews, reassessments, and audits
- Manage reserves
- Manage, evaluate, and close procurements
- Evaluate use of physical resources

CLOSING

- Confirm work is done to requirements
- Complete final procurement closure
- Gain final acceptance of product
- Complete financial closure
- Hand off completed product
- Solicit customer's feedback about the project
- Complete final performance reporting
- Index and archive records
- Gather final lessons learned and update knowledge bases

Rita's Process Chart™
Quality Management
Where are we in the project management process?

If asked, "Is it better to plan in quality or to inspect to find quality problems?" almost everyone will answer correctly that it is better to plan in quality. However, that is not how most of the quality-related questions are presented on the exam. Instead, exam questions focus on situations to see if you know what to do. For example:

> *The project manager finds that one of his team members has created their own process for installing hardware. What should the project manager do?*

Beginning project managers might choose a response that relates to thanking the team member for the effort. More experienced project managers might select a choice that relates to finding out if the process was a good one. The best project managers select the choice that relates to investigating the quality management plan to determine if a standard process should have been followed.

People without quality management experience generally have a hard time with such questions. Fortunately, not all the quality questions on the exam are that difficult. Expect to see exam questions that refer to different project environments (for example, the project manager works for a manufacturer of tables). This does not mean you have to learn about all industries. The exam may highlight manufacturing because quality is an important factor in that industry, and manufacturing examples tend to be understandable to all. Focus on the situation that is being described. Also expect questions about the process of quality management and how quality relates to the project constraints, as defined in this book.

Imagine a project to build a stadium. The concrete part of the work is two-thirds done when the buyer arrives one day and tests the strength of the concrete. The buyer finds that the concrete does not meet the clearly stated quality requirements for strength in the contract. You can imagine the problems when the buyer says, "Rip out the concrete; it is not acceptable." Whose fault is this? Why did this occur?

Could we say it is the buyer's fault for not testing the concrete sooner? You might argue that case, but isn't the real fault with the seller for not testing the quality throughout the project? Where was their quality plan? They should have noted the requirement and determined when and how they would confirm they had met it. Lack of attention to quality in this scenario needlessly added considerable risk to the project, which resulted in a tremendous amount of rework and additional expense.

Here is something else to consider. Have any of your customers ever said one of your deliverables was not acceptable, even though they had not provided you with a definition of what was acceptable? It is important to know—in advance—what acceptable quality is and how it will be measured on the project. You can then determine what you will do to make sure the project meets those requirements. It is the project manager's responsibility to make sure that quality is defined in the plan. If you do not take these steps, you will have unclear acceptance criteria, such as "the customer likes it." Performing the quality management process well helps you avoid many issues later in the project.

The following should help you understand how each part of quality management fits into the overall project management process:

The Quality Management Process	Done During
Plan Quality Management	Planning process group
Manage Quality	Executing process group
Control Quality	Monitoring and controlling process group

Before we start discussing these three processes in detail, let's look at some basic quality management concepts that you should understand for the exam.

Definition of Quality

What is quality? Know the short definition for the exam. Quality is defined as the degree to which the project fulfills requirements. Memorize this phrase; it may help you with up to four questions on the exam.

Now here is a story about quality. A student in one of RMC's classes looked out the window during class and noticed someone painting the limestone of an old building white. The student said, "That is not quality!" Let's think about the student's statement for a moment. Why would such painting not be "quality"? If the painting contract required the painter to use a certain kind of paint and follow painting standards, and he was doing so, the work met the quality requirements. The issue the student really had was that the wonderful old stone was being painted instead of cleaned. In other words, this was a disagreement with the requirements, not the quality of the work.

Let's review the definition of quality again: the degree to which the project fulfills requirements. In a plan-driven, or predictive, environment, can you achieve quality if you do not have all the stated and unstated requirements defined in the project scope statement and requirements documentation? Of course not. This makes the requirements-gathering effort (from scope management), the requirements documentation, and the project scope statement very important to the quality management effort. In a change-driven, or adaptive, environment, we capture quality requirements and acceptance criteria in user stories. As user stories are prioritized, quality efforts will be planned in detail for releases and iterations.

You may see situational questions on the exam that use the term "grade" in discussing quality. Whereas quality is the degree to which a project (or deliverable) fulfills requirements, grade refers to a general category or classification of a deliverable or resource that indicates common function, but varying technical specifications. For example, a low grade of concrete that supports limited weight might be sufficient for a project's needs and could be of acceptable quality if it meets the established quality requirements, such as having zero defects. Likewise, a high grade of concrete intended to sustain more weight could be of unacceptable quality if it is mixed or poured to low standards, or otherwise fails to meet the established quality metrics.

Definition of Quality Management

Quality management includes creating and following organizational policies and procedures and tailoring them to ensure the project also meets the needs of the customer. We could also say it means ensuring a project is completed in compliance with the project requirements. Quality management includes the processes of Plan Quality Management, Manage Quality, and Control Quality.

Quality-Related PMI-isms

Quality-related questions can be confusing because many of the topics on the exam are not covered in the *PMBOK® Guide*. The exam may test your understanding of the need to satisfy project requirements, as opposed to giving the customer extras. It is important to apply this approach to quality management in order to answer exam questions correctly. Know the following PMI-isms related to quality:

- Quality means meeting requirements, not adding extras.
- The project manager must determine the metrics to be used to measure quality before the project work begins.
- The project manager must define quality management processes for the project and put into place a plan for continually improving them.
- The project manager should recommend improvements to the performing organization's standards, policies, and processes. Such recommendations are expected and welcomed by management.

- Quality should be checked before an activity or work package is completed.
- The project manager must ensure that authorized approaches and processes are followed.
- Quality should be considered whenever there is a change to any of the project constraints.
- The project manager must ensure that the quality standards and processes on the project are adequate to meet quality requirements.
- Some quality activities may be performed by a quality department.

Quality Management in the Real World

Many people getting ready for this exam have limited quality management experience, so they struggle with envisioning how quality management efforts fit into managing a project in the real world. The following scenario, along with the diagram in figure 8.1, will help clarify these concepts:

1. The customer determines their requirements.
2. The project team clarifies those requirements.
3. The project team defines what work will be done to meet those requirements (project scope).
4. The project manager determines the existing standards, policies, and procedures that might be available for the project. The quality department might assist in identifying the relevant standards.
5. The project manager creates other standards and processes that may be needed.
6. The project manager develops the quality management plan, encompassing relevant standards and processes.
7. The project manager integrates quality with other knowledge area plans to get an approved project management plan.
8. The team begins executing the project management plan.
   - 8a. The team or the quality department evaluates the quality of project deliverables against planned metrics and standards. (Control Quality)
   - 8b. The team or the quality department audits the project work periodically as part of the executing process, looking for indications that the standards, policies, plans, and procedures are not being followed or need to be changed. (Manage Quality)
   - 8c. Results are analyzed.
9. Deliverables are verified.
10. Lessons learned are documented and shared.
11. Change requests, including corrective and preventive action and defect repair, are sent to integrated change control.
12. Change requests, including corrective and preventive action and defect repair, are approved or rejected in integrated change control.
13. The team adjusts plans as needed to accommodate approved or rejected changes and returns to step 7 until project deliverables are complete and verified.
14. New organizational process assets, including lessons learned, are shared with the organization.
15. Verified deliverables are accepted by the customer, the project is completed, quality targets are reached, and the customer is happy.

The quality management process is represented by the shaded area of figure 8.1.

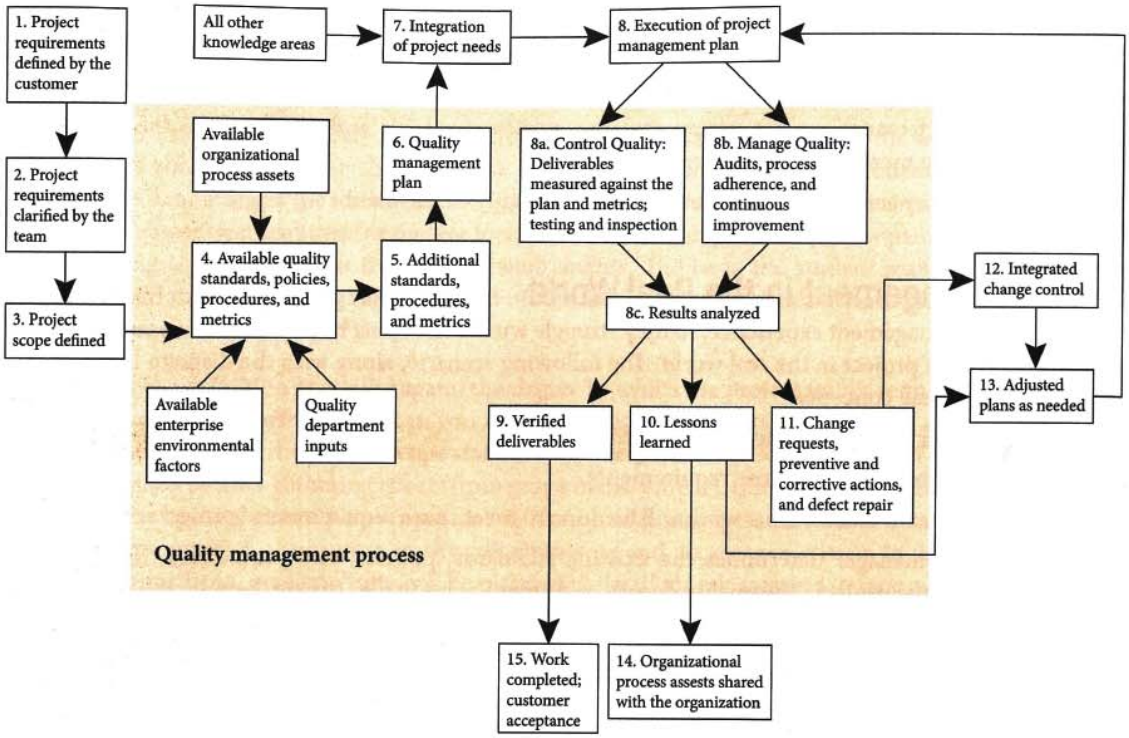

FIGURE 8.1 *Quality management*

Gold Plating[1]

Do you remember a time on a project when one of your team members delivered more than what was needed? Can you think of a time when you've had trouble keeping a project from producing the Taj Mahal when all you needed was a garage, for example?

Gold plating refers to giving the customer extras (extra functionality, higher-quality components, extra scope, or better performance). Although your company might have a policy that promotes gold plating (for example, "Meet and exceed customers' expectations."), advanced quality thinking does not recommend "exceeding" as a best practice. Gold plating is often the team's impression of what is valued by the customer, and the customer might not agree. It is also a problem because so few projects provide what the customer wanted. Since most projects have difficulty meeting the project objectives, all available effort should go into achieving those objectives, instead of into gold plating.

Sometimes gold plating is not planned, but rather arises out of a team member's efforts to do the best they can. The project might not call for the best, however, just what was asked for. Therefore, the project manager must be on the lookout for team members providing extra functionality, extra work, or higher quality than is required for the project.

Prevention over Inspection

Is it better to inspect work to find problems or to prevent them in the first place? Which takes less effort and is less costly? Remember that quality must be planned in, not inspected in! The concept of prevention over inspection was advocated by quality theorist Philip Crosby. You may see exam questions that test your understanding that failure to plan quality into a project will lead to problems later in the project.

Continuous Improvement

Continuous improvement involves continuously looking for ways to improve the quality of work, processes, and results. The terms "continuous improvement" and *"Kaizen"* are taken to mean the same thing on the exam; however, in Japan, *Kaizen*[2] means to alter *(kai)* and make better or improve *(zen)*. *Kaizen* is a general term, while continuous improvement is a quality movement. In the United States and most of Western Europe, continuous improvement focuses on major improvements. In Japan, the emphasis is on smaller improvements. Continuous improvement of project management within an organization can include analysis of how quality management is planned and utilized on projects.

Similarly, the philosophy of total quality management[3] developed by quality expert W. Edwards Deming encourages companies and their employees to focus on finding ways to continuously improve the quality of their products and their business practices at every level of the organization.

Another approach to continuous improvement is Six Sigma[4]—a methodology for achieving organizational process improvement and high levels of correctness with extremely reduced variances. Sigma is another name for standard deviation. It indicates how much variance from the mean has been established as permissible in a process. The higher the sigma, the fewer deviations (less variance) in the process. The level of quality required by an organization is usually represented by 3 or 6 sigma.

Just in Time (JIT)[5]

Many companies find that holding raw materials or other resources in inventory is not only too expensive but also unnecessary. Instead, they have their suppliers deliver resources just before they are needed, thus decreasing inventory to nearly zero. A company using JIT must achieve a high level of quality in their practices; otherwise, there will not be enough materials or equipment to meet production requirements because of waste and rework. A JIT system forces attention on quality as well as schedule.

Responsibility for Quality

The project manager has the ultimate responsibility for the quality of the product of the project, but each team member must check their work by inspecting it themselves. It is not acceptable for team members to simply complete the work and then turn it over to the project manager or their manager to be checked. Work should meet the project requirements, and testing should be done whenever appropriate before submitting the work.

According to W. Edwards Deming, 85 percent of the quality problems on a project are attributable to the management environment and the system in which the team works. Therefore, senior management is responsible for promoting an organizational approach that supports quality efforts. This often includes a quality department that determines quality management methodologies the project manager is required to follow.

Understanding the Difference between Plan Quality Management, Manage Quality, and Control Quality

One of the major challenges people have while studying this topic is understanding the difference between Plan Quality Management, Manage Quality, and Control Quality. Some of this confusion may be a result of differences between what companies call these processes and what the exam calls them. It may also be a result of the confusing nature of some of the questions in this knowledge area.

For purposes of the exam, here is a brief description of the three processes:

- **Plan Quality Management** This process focuses on defining quality for the project, the product, and project management, and planning how it will be achieved.
- **Manage Quality** Because it is an executing process, the Manage Quality process is focused on the work being done on the project. Its purpose is to ensure the team is following organizational policies, standards, and processes as planned to produce the project's deliverables. The project manager also evaluates whether the quality management plan or processes need to be improved or modified.

- **Control Quality** Control Quality, a monitoring and controlling process, includes examining the actual deliverables produced on the project to ensure they are correct and meet the planned level of quality, evaluating variances, finding the source of problems, and recommending ways to address them.

TRICKS OF THE TRADE® The following chart presents a trick for understanding the three quality management processes. Study it now to gain a clearer understanding of the focuses of each process before reading the rest of this chapter. In the detailed descriptions, you will see combinations of actions and outputs. Can you spot them? You may want to review this chart after you read the in-depth discussions of each of the processes.

Plan Quality Management	Manage Quality	Control Quality
Process Group		
Project planning	Project executing	Project monitoring and controlling
High-Level Description of What Each Process Focuses On		
• What is quality? • How will we ensure it?	• Are we following the policies, metrics, procedures, and processes as planned? • Are the procedures and processes giving us the intended results? • Will we meet the quality objectives?	• Are the results of our work meeting the standards and required metrics? • Is the variance within acceptable limits, or do we have to take action?
More Detailed Description of What Each Process Focuses On		
• Review management plans and project documents to understand quality requirements on the project. • Identify quality practices as well as internal and external standards relevant to the product, project, and project management efforts (OPAs and EEFs). • Create additional project-specific processes, standards, and metrics. • Determine the processes that will be used on the project. • Determine what work you will do to meet the standards. • Determine how you will measure to make sure you meet the standards. • Plan for process improvement.	• Use measurements from Control Quality to confirm that: – Policies and processes are being followed – Policies, metrics, and processes are still appropriate for the project – Policies and processes are effective in achieving planned quality results • Use data-representation techniques to analyze results of quality testing. • Determine the root cause of quality problems/ variances from plan. • Perform continuous improvement to increase efficiency and effectiveness. • Create test and evaluation documents for use in Control Quality.	• Inspect and measure the quality of deliverables to determine whether they meet requirements. • Use the PMIS to track deviations from planned quality. • Identify the need for quality improvements (corrective or preventive action, and defect repair). • Complete checklists and checksheets, perform tests, and evaluate results. • Graphically document results of testing and evaluation using data-representation techniques. • Verify deliverables. • Validate approved changes. • Recommend improvements to testing processes.

Plan Quality Management	Manage Quality	Control Quality
More Detailed Description of What Each Process Focuses On		
• Perform cost of quality, cost-benefit, and other analysis work to make certain the appropriate level of quality will be planned in. • Determine roles and responsibilities for achieving quality requirements and objectives. • Plan for testing and inspection to check that requirements, performance, reliability, and quality goals and objectives are achieved. • Interface the quality management plan with other management plans to balance the needs of quality with scope, cost, time, risk, resources, and customer satisfaction requirements. • Finalize a quality management plan as part of the project management plan.	• Determine if project activities comply with organizational and project policies, processes, and procedures—perform a quality audit. • Solve problems. • Produce reports. • Share good practices with others in the organization. • Submit change requests. • Update the project management plan and project documents.	• Use and update lessons learned. • Submit change requests. • Update the project management plan and project documents.

Plan Quality Management PAGE 277

Process Plan Quality Management
Process Group Planning
Knowledge Area Quality Management

The objectives of the Plan Quality Management process are to identify all relevant organizational or industry practices, standards, and requirements for the quality of the project, the product of the project, and the project management efforts, and then to plan how to meet those quality standards and requirements. The main result of this process is a quality management plan.

It is important to keep in mind that the level of quality efforts should be appropriate to the needs of the project. There is no reason to negatively impact project scope, time, or cost if higher quality is not required on the project. Quality must be balanced with the other project constraints. That sounds easy, right? Often, however, it is not. The project scope statement, WBS, and WBS dictionary (the scope baseline) help the project manager maintain the proper perspective and plan quality to the appropriate level.

On many projects and in many organizations, practices are not standardized. If this is true on your projects, take some time now to imagine what such standardized practices would be for your projects and how they might be helpful to you. For example, a construction company could choose to establish a standardized practice for installing wallpaper on home construction projects. Imagine all the wallpaper installers within that organization putting together their best ideas to make the work of installing wallpaper easier on future projects. That would be a valuable effort. As another example, the *PMBOK® Guide* is a practice standard for project management. Standardization can come from within the organization or from government or professional associations. The performing organization or the project may adopt these practices as they apply to the work of the project. As part of the Plan Quality Management process, the project manager needs to look for any such standards that will help the project avoid "reinventing the wheel," so to speak, and achieve the level of quality that is required. Some available standards include:

- **The United Nations Convention on Contracts for International Sale of Goods (CISG)**[6] The CISG is the standard that governs international sales transactions.
- **ISO 9000**[7] This family of standards was created by the International Organization for Standardization (ISO) to help ensure that organizations have quality procedures and that they follow them. Many people incorrectly believe that ISO 9000 tells you what quality should be, or describes a recommended quality system.
- **Occupational Safety and Health Administration (OSHA)** OSHA sets standards for the safety of American workers.

Organizational process assets and enterprise environmental factors inform the project manager of relevant standards, policies, and procedures. They include lessons learned from previous projects and the performing organization's idea of the best way to accomplish work.

The project manager must plan the project so it also meets the customer's quality standards, which might be outlined in an agreement (contract) or need to be discovered as part of the Collect Requirements process. Quality requirements are documented, analyzed, and prioritized according to the requirements management plan. Examples of such standards are the acceptable number of software bugs per module, the strength of concrete, or the average time per installation. These measures of quality will help the project manager know when the project is out of control and when to request changes, including corrective actions and preventive actions designed to prevent the problem from reoccurring.

Once existing practices and standards are identified, the project manager must create any additional project-specific standards and procedures that are needed.

A project manager may create standards and procedures based on how quality is defined for each piece of work. For the exam, you should understand that this effort could also include defining processes for how project management activities should be done, and suggesting improvements to existing processes. The new practices cannot violate other relevant standards.

After the standards and procedures have been identified or created, the project manager needs to determine what work is required to meet those standards. Additional testing may need to be planned into the project, resources may need to be moved around, or the descriptions of products to be purchased may need to be changed. The project manager should also determine the specific measurements that will be made each week or each month, or for each deliverable, to ensure compliance with all standards.

Management plans and documentation that influence quality planning include the stakeholder engagement plan and stakeholder register, a list of the major project deliverables (requirements management plan), risk thresholds (risk management plan), and approval requirements (project charter). The assumption log provides insight into the level of quality that is assumed to be acceptable on the project. The requirements traceability matrix shows the origin of requirements related to quality and will be used to confirm that quality requirements, particularly external compliance requirements, have been achieved.

Plan Quality Management Tools and Techniques PAGE 281

The following are some tools and techniques used in the Plan Quality Management process. Remember that the objective of using these tools and techniques is to determine what quality requirements, procedures, and standards for the project and product should be.

Interviews, Brainstorming, and Benchmarking[8] There are numerous tools and techniques you can use to identify existing standards, processes, and metrics or to create new ones. Interviews and brainstorming can help identify appropriate ways to measure quality on the project along with the metrics or processes to be used. You may recall learning about these techniques in the Scope Management chapter.

Benchmarking was also discussed as a technique used in scope management. Here, benchmarking is used to review methodologies used by comparable projects or organizations to establish quality metrics and acceptable variance ranges, and to measure quality.

Decision-Making An important aspect of planning is determining priorities and choosing between options. In the Plan Quality Management process, key decisions might include selecting the most critical metrics or prioritizing quality requirements. Decision-making tools and techniques for planning quality include multicriteria decision analysis and prioritization matrices.

Cost-Benefit Analysis[9] Using this data analysis technique, the project manager analyzes the benefits versus the costs of quality efforts to determine the appropriate quality level and requirements for the project. As noted in the Integration Management chapter, this technique can also be used in project selection and in other planning efforts, including assessing the costs and benefits of potential risk responses.

The exam will test your knowledge about the effects of quality efforts, or the lack thereof. Note that if you have poor quality, you might also have:

- Increased costs
- Decreased profits
- Low morale
- Low customer satisfaction
- Increased risk
- Rework

Cost of Quality (COQ)[10] Evaluating the cost of quality means making sure the project is not spending too much to achieve a particular level of quality. It involves looking at what the costs of conformance and nonconformance[11] to quality will be on the project and creating an appropriate balance. This concept was popularized by the quality expert Philip Crosby. The following table provides some examples of the costs of conformance and nonconformance to quality.

Cost of Conformance	Cost of Nonconformance
Quality training	Rework of deliverables not meeting quality standards
Studies	Scrap
Measuring quality of interim deliverables	Inventory costs
Customer satisfaction surveys (and work to respond to issues raised)	Warranty costs
Efforts to ensure everyone knows the processes to use to complete their work	Lost business

The costs of conformance should be lower than the costs of nonconformance. Otherwise, why spend time improving quality? Cost of quality is planned in the Plan Quality Management process and then monitored and measured throughout the life of the project.

A term related to this concept is marginal analysis,[12] which is analysis focused on finding the point at which the benefits or revenue to be received from improving quality equals the incremental cost to achieve that quality. Sometimes added attention to something such as quality does not produce added value. When that point is reached, you should stop trying to improve quality.

Logical Data Models The logical data model can be presented using an entity relationship diagram—a method of representing and analyzing data. A logical data model contains a description of the quality needs of the project. It is used to understand the requirements, clarify business rules, and define processes. It can be used to create and refine quality plans that best meet the needs of the project.

Matrix Diagrams[13] A matrix diagram is a visual representation of the relationship between two or more sets of items. In the Plan Quality Management process, matrix diagrams can be used to sort quality requirements and identify the requirements that are most critical to the project. With this information, appropriate metrics may be planned to track and measure project progress.

A type of matrix diagram, a prioritization matrix is useful for decision analysis about quality management plan components (organizational policies, processes, and requirements) that may need to change.

An example of a matrix diagram is the probability and impact matrix shown in the Risk Management chapter of this book as a tool of qualitative risk analysis.

Mind Mapping As discussed in the Scope Management chapter, a mind map is a diagram of ideas or notes to help generate, classify, or record information. It is used here to facilitate the gathering of quality requirements and illustrate their impacts on other parts of project planning.

Flowcharts Flowcharts may also be referred to as process flows or process maps. They show how a process or system flows from beginning to end, how the elements interrelate, alternative paths the process can take, and how the process translates inputs into outputs. A common flowchart model is a SIPOC, which shows the connections between the supplier, input, process, output, and customer in a process. Flowcharts can be used in many parts of project management. In the Plan Quality Management process, flowcharts can help determine the cost of quality by mapping the expected monetary value of pursuing paths of conformance and nonconformance to quality.

Flowcharts are also useful for defining and communicating processes that will be used on the project. Also, they can be analyzed to determine how processes will be measured for conformance and effectiveness.

You can also use this tool in Plan Quality Management to visualize a process and find potential quality problems or quality control issues. Imagine that work results are passed to four departments for approval. Might this lead to quality problems? What about an unfinished fragile product in a manufacturing environment? Would the quality of the product be reduced if it needed to be passed by hand from person to person?

A generic example of a flowchart is shown in figure 8.2.

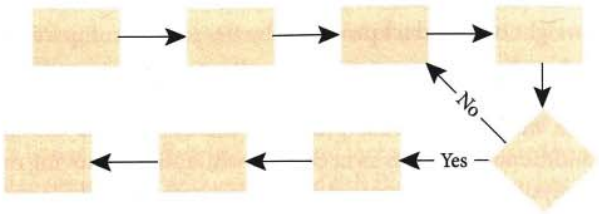

FIGURE 8.2 *Flowchart*

Test and Inspection Planning Plan Quality Management includes determining how the team will confirm that the required level of quality has been achieved in the completed project deliverables, as well as how the deliverables will be evaluated for performance and reliability. Testing methods, which vary depending upon the type of product, service, or result being created by the project, are used in the Control Quality process.

Meetings Developing management plans requires the collaboration of the project manager and team. The project manager may hold meetings specifically focused on project planning. Note that any of the tools and techniques discussed in this section may be used within those meetings as part of quality management planning.

Outputs of Plan Quality Management

PAGE 286 The Plan Quality Mangement Process results in the following outputs.

Quality Management Plan Remember that the purpose of the Plan Quality Management process is to determine what quality is and to put a plan in place to deliver that level of quality. This plan is called the quality management plan. It also includes analyzing processes to find ways to increase efficiency and prevent problems, which saves money and increases the probability that the customer will be satisfied.

Most quality management plans include the following:

- The quality practices and standards that apply to the project
- Who will be involved in managing quality, when, and what their specific duties will be
- What processes will be followed to help ensure quality
- A review of earlier decisions to make sure those decisions are correct
- The meetings that will be held regarding quality
- The reports that will address quality
- What metrics will be used to measure quality
- What parts of the project or deliverables will be measured and when

Quality Metrics Throughout this book, there is an underlying theme that the project manager must know how the project is performing compared to what was planned and be able to determine when to request changes. The only way to effectively do this is to determine metrics in advance. This means the project manager needs to think through the areas on the project that are important to measure and (in most cases) decide what range of variation is acceptable. The following are some examples of quality metrics:

- The number of changes (to help measure the quality of the project management planning process)
- The variance related to resources utilization

- The number of items that fail inspection
- The variance of the weight of a product produced by the project compared to the planned weight
- The number of bugs found in software that is being developed as part of the project

As a project manager, you must know what processes are being used on the project, analyze their effectiveness, and create additional processes as necessary, while also improving those processes as they are being used. This plan for analysis and improvement of these processes is included in the quality management plan. Improving existing processes saves time by increasing efficiency and preventing problems. It also saves money and increases the probability that the customer will be satisfied.

Project Management Plan and Project Documents Updates The Plan Quality Management process will result in additions or changes (iterations) to the project management plan and project documents. For example, quality management work may be added to the project. This work is documented in the scope baseline (WBS and WBS dictionary) as well as in the requirements traceability matrix, and may necessitate adjustments to the project activity list, schedule, budget, and resource assignments. Additional risks related to quality may be added to the risk register, and risk management efforts may be added to the project management plan.

Manage Quality PAGE 288

Process Manage Quality
Process Group Executing
Knowledge Area Quality Management

Manage Quality is performed while the project work is being done.
A group outside the project team, such as a quality department, often handles this work on a project. The efforts of this process focus on making certain that the project work, the processes followed, and the deliverables that are produced conform to the quality management plan.

Do you remember the discussion of conformance and nonconformance to quality in the "Plan Quality Management" section of this chapter? The items included in the list of costs of conformance (for example, quality training, measuring interim deliverables, and ensuring the project team understands and follows the accepted processes) refer to the work of both the Manage Quality and Control Quality processes.

Processes to ensure quality standards will be met are reviewed to make sure they are effective, and are being followed correctly. Quality audits, failure analysis, and design of experiments (described later in this chapter) may be done to see if the quality management plan with the standards, metrics, processes, and procedures may need to change. Test and evaluation documents, for use in Control Quality, are prepared as a part of Manage Quality.

This process uses the quality management plan, including quality requirements, and analyzes measurements gathered in Control Quality to answer the following questions:

- Are the quality requirements, organizational policies, and processes identified in the quality management plan giving us the results we intended?
- Based on what we know now, is the work we planned the right quality work for this project and the right work to meet customer requirements?
- Are we following the procedures and processes as planned?
- Can the processes and procedures be improved?
- How can we increase efficiency and prevent problems?

The process of managing quality also includes evaluating all aspects of the product design to confirm that the end result will meet quality requirements and identifying possible improvements to the design or the process of producing it.

The work performed in Manage Quality will uncover any processes that may be resulting in a level of quality that is not acceptable according to the quality management plan.

Manage Quality Tools and Techniques

PAGE 292 The quality management plan is created to prevent quality issues. The following tools and techniques are used to evaluate the success of our planning efforts. You will see that many of these accomplish the same thing, but in different ways. Not all of these tools and techniques will be used on every project. The choice depends on the preferences of the project manager, and organizational requirements regarding quality management, as well as the needs of a particular project.

Checklists In Manage Quality, a checklist can be used to confirm that the steps of a process have all been completed. It may also be used to analyze defects discovered in quality inspections, looking for issues within the process, and to assess whether a deliverable meets the acceptance criteria.

Cause-and-Effect (Fishbone, Ishikawa, or Why-Why) Diagrams[14] A project manager can use cause-and-effect diagrams to confirm that policies and procedures are being followed and that metrics are being used correctly, and that they were adequate to produce the required level of quality in project deliverables. Figure 8.4 in the "Control Quality" section of this chapter is an example of a cause-and-effect diagram.

Histograms[15] In this process, histograms are used to analyze the type and frequency of defects in order to identify where the quality plan and processes may need improvement as the project moves forward. Figure 8.5 and figure 8.6 in the Control Quality section of this chapter are both examples of histograms.

Scatter Diagrams[16] This diagram tracks two variables to determine their relationship to the quality of the results. Figure 8.7 in the "Control Quality" section of this chapter shows three examples of scatter diagrams.

Document Analysis Document analysis involves reviewing the results of testing and other quality reports to identify ways in which the quality management plan and processes may not be supporting the production of deliverables that meet the project quality requirements.

Alternatives Analysis It is important to consider all the ways to solve an issue or problem. In Manage Quality, alternatives analysis may be used to evaluate which action would best impact the results of quality management efforts or processes. For example, would a new automated testing tool be of more benefit than redefining the testing process?

Design of experiments (DOE)[17] is a technique that can be used to analyze alternatives. Experimentation is performed to determine statistically what variables will improve quality; for example, DOE can be used to look for ways to deliver the same level of quality for less cost. DOE is a fast and accurate technique that allows you to systematically change the important factors in a process and see which combinations have an optimal impact on the project deliverables. For example, designers might use DOE to determine which combination of materials, structure, and construction will produce the highest-quality product. Performing DOE can help decrease the time and effort required to discover the optimal conditions in which to produce a quality deliverable. An alternative to DOE is to perform individual experiments for each variable in a process to assess their impacts on quality, but this can be time-consuming and can overlook interactions among variables.

Process Analysis[18] Quality management can also include process analysis. Have you ever worked on a project where some of the activities or work packages were repeated? This often happens when projects have multiple installations, such as a project to install software onto hundreds of computers. The lessons learned on the first few installations are used to improve the process for the remaining installations. Though this often happens naturally, formal process analysis should be planned in at certain points in the project (for example, after every 10 installations). Process analysis is a part of the continuous improvement effort on a project and focuses on identifying improvements that might be needed in project processes.

Root Cause Analysis Root cause analysis in Manage Quality seeks to identify the processes, procedures, and policies within the plan that may not be working or that may need adjustment. Identifying the root cause of a quality problem or defect helps the team determine how to prevent it from recurring.

Failure analysis is a specific type of root cause analysis. It analyzes failed components of deliverables or failed processes to determine what led to that failure. Corrective action or change requests are likely outcomes of this type of analysis.

Multicriteria Decision Analysis The project manager must facilitate a number of decisions regarding quality. There are several decision-making techniques that may be used. Multicriteria decision analysis is a complex method of numerically assessing options based on criteria such as time, cost, and quality. It can be used throughout a project to help the team reach agreement regarding the best way to solve a problem or improve quality. For example, in Manage Quality, the team may use this technique when considering whether to adjust the quality management plan or specific processes or procedures.

A simpler decision-making technique is a prioritization matrix. A prioritization matrix can be used to numerically assess available options, ranking them based on predetermined criteria.

Flowcharts[19] In the Plan Quality Management process, we discussed flowcharts as a tool to determine the cost of quality and identify potential quality problems. In Manage Quality, flowcharts may be used to study the steps of a process leading up to a quality defect. It is possible that this analysis would uncover confusion among the team or point out ways the process needs to be adjusted to make it more effective.

Affinity Diagrams We first saw this technique in the Collect Requirements process. In Manage Quality, affinity diagrams can help you organize and group the results of root cause analysis. For example, in Control Quality you may have determined the cause of a variance, product defect, or a deliverable not meeting requirements. You can use this information in the Manage Quality process to determine whether a change to the policies, procedure, and standards in the quality management plan would best address the root cause of the problems.

Audits Imagine a team of auditors walking into your office one day to check up on you and the project. Their job is to see if you are complying with company policies, processes, practices, and procedures as defined in the quality management plan, and to determine whether those being used are efficient and effective. This scenario represents a quality audit, and it serves as an example of how seriously companies take quality. Do not think of a quality audit as a negative event. Instead, a good quality audit will look for new lessons learned and effective practices that your project can contribute to the performing organization. The work of a project is not only to produce the product of the project; it could also be said that a project should contribute to the best practices within the organization and, therefore, make the organization better. A quality audit may identify gaps or areas in need of improvement. Making these changes will enhance your ability to meet quality objectives.

If you do not have a team of auditors from the quality department coming to see you on your projects, do you take on the responsibility of looking for opportunities to identify lessons learned and best practices on your projects? Although quality audits are usually done by the quality department, the project manager can lead this effort if the performing organization does not have such a department.

Design for X Design for X is another way of analyzing variables to evaluate both the effectiveness of the quality management plan and the team's ability to meet objectives. The X in the name Design for X can represent an attribute of quality, such as reliability, security, or serviceability. If the plan is not delivering the intended results in relation to the variable being analyzed, Design for X can help determine what changes or adjustments are needed.

Problem-Solving Think of how important this technique might be when you encounter quality problems. Gaining a good understanding of the real problem is the first step towards finding an effective and long-lasting solution. Problem-solving can be used when considering quality improvements or to determine how best to respond to deficiencies identified in quality audits.

The following are the steps used to analyze quality (and other) problems:

1. Define the real or root problem—not what is presented to you or what appears to be the problem.
2. Analyze the problem.
3. Identify solutions.
4. Pick a solution.
5. Implement a solution.
6. Review the solution, and confirm that the solution solved the problem.

Outputs of Manage Quality PAGE 296 To understand the value of the Manage Quality process, you need to know that it leads to the following outputs.

Test and Evaluation Documents Test and evaluation documents are identified or created in Manage Quality and used in Control Quality. They provide a format with which to evaluate whether quality objectives have been met. Control charts, checklists, test plans, or project documents such as a requirements traceability matrix from scope management, may also be used here. Larger organizations, or organizations that work on many similar projects, may develop templates for such testing and evaluation work.

Quality Reports These types of reports interpret and document the results of Manage Quality and Control Quality activities. They can present information in a number of formats. Information in quality reports is used to identify necessary changes to plans, policies, and processes to ensure that quality requirements will be met throughout the life of a project.

Change Requests and Project Management Plan Updates Changes and updates to components of the project management plan—including the quality management plan and the scope, schedule, or cost baselines—may result from the work of this process.

Project Documents Updates Newly discovered issues will be added to the issue log. The lessons learned register and risk register will be updated as needed.

Control Quality PAGE 298

Process Control Quality
Process Group Monitoring & Controlling
Knowledge Area Quality Management

Control Quality is the process of ensuring a certain level of quality in a deliverable, whether it be a product, service, or result. Control means measure, and that is the major function of the Control Quality process. Aspects of products, services, or results are measured to determine whether they meet the quality standards. This process helps ensure customer acceptance, as it involves confirming and documenting the achievement of agreed-upon requirements.

It is important to note that Control Quality is closely related to the previous process, Manage Quality. Many of the tools and techniques used in Control Quality—as well as the resulting measurements—are also used in Manage Quality, but with a different focus. Control addresses the quality of product. Defects are detected and corrected. Manage Quality addresses the effectiveness of quality management plans, processes, and procedures, and whether the project is on track to meet quality objectives. Quality defects are assumed to indicate issues with those plans, processes, and procedures.

Inputs to this process include the quality management plan, quality metrics (the agreed-upon measures of quality), test and evaluation documents (developed in Manage Quality to be used in this process), work performance data and deliverables (from Direct and Manage Project Work in integration management), approved change requests from integrated change control, and project documents.

Although a project manager must be involved and concerned about quality control, a quality department may complete much of this work in large companies. The department then informs the project manager about quality issues through change requests, which are accompanied by any necessary documentation and reports to detail the quality issues. The project manager must be able to read and understand quality measurement reports.

It is during Control Quality that the height of doors in a manufacturing process or the number of bugs per module will be measured. Quality control helps answer the following questions:

- Are the results of our work meeting the agreed-upon standards and thereby meeting project requirements?
- What is the actual variance from the standards?
- Is the variance from standards or processes outside of acceptable limits?
- Are people using the checklists to support meeting the metrics established for the process?
- What changes in the project should be considered?

To better understand questions relating to Control Quality, you should be familiar with the following terms.

Mutual Exclusivity The exam may reference statistical terms such as "mutual exclusivity." Two events are said to be mutually exclusive if they cannot both occur in a single trial. For example, flipping a coin once cannot result in both a head and a tail.

Probability This term refers to the likelihood that something will occur. Probability is usually expressed as a decimal or a fraction.

Normal Distribution A normal distribution is the most common probability density distribution chart. It is in the shape of a bell curve and is used to measure variations (see the example in the control chart exercise later in this chapter).

Statistical Independence Another confusing statistical term you may see on the exam is "statistical independence." This means the probability of one event occurring does not affect the probability of another event occurring. For example, the probability of rolling a six on a die is statistically independent from the probability of getting a five on the next roll.

Standard Deviation (or Sigma) As we've already discussed, one measure of a range is its standard deviation. It denotes what would be considered a statistically stable process or output. This concept is also sometimes stated as a measure of how far you are from the mean (not the median). (Remember (P – O)/6 is the beta distribution formula for standard deviation, using pessimistic and optimistic estimates, as described in the Schedule Management chapter.)

Control Quality Tools and Techniques There are many tools and techniques that may be used in this process. However, it is helpful to realize that regardless of the method used, the ultimate goal is the same: to test (verify) that each deliverable meets the metrics and requirements as stated in the plan, including the customer's acceptance criteria, and that it is ready to move to the Validate Scope process.

Checklists Information about the quality of interim deliverables can be gathered using quality checklists. A quality checklist can be a list of items to inspect, a list of steps to be performed, or a picture of the item to be inspected, with space to note any defects found.

In Control Quality, checklists are used to determine that all required features and functions are included, and that they meet acceptance criteria. Checklists may be a part of the test and evaluation documents created in Manage Quality. Checklist templates for commonly performed work, deliverables, or processes may be organizational process assets of the organization.

Checksheets A checksheet is a type of checklist that can be used to keep track of data, such as quality problems uncovered during inspections, as well as to document how often a particular defect occurs, as illustrated in figure 8.3.

Defect	Frequency
Too long	𝍸 ||
Too narrow	|||
Too wide	𝍸 |||
Too short	||

FIGURE 8.3 *Checksheet*

Statistical Sampling Let's think about the process of manufacturing doors. There would likely be some allowable variation in the height and weight of the doors being manufactured. Even so, the doors must be checked to see if they meet quality standards on the project. What if inspecting each door would cause damage or take too much time? Then you may need to take a statistically valid sample. It is best to take a sample of a population if you believe there are not many defects, or if studying the entire population would:

- Take too long
- Cost too much
- Be too destructive

The sample size and frequency of measurements are determined as part of the Plan Quality Management process, and the actual sampling is done in Control Quality. Keep in mind that statistical sampling can also be done for project management activities. For example, you may initially check the on-time status for 5 out of 50 of a group's activities. If you find issues in those 5, you can assume there will be more issues in the remaining 45 activities.

Questionnaires and Surveys Questionnaires and surveys may be used in Control Quality to gather data on details of problems or defects, or to confirm that customers or end users are satisfied with deliverables that have been deployed on the project. The results can be used to determine whether conformance to quality has been achieved.

Performance Reviews The project manager or quality department may conduct periodic performance reviews to formally assess how the project is doing in terms of following the quality management plan and meeting quality requirements. Such a review involves comparing the results of control measurements to metrics identified in the quality management plan. It may bring to light changes necessary to achieve quality requirements.

Root Cause Analysis Root cause analysis is used to identify the cause of quality problems, including defects, to determine how they can be remedied.

Inspection Inspections are used to verify that deliverables meet the requirements. Inspections may be referred to as audits or walkthroughs, and generally include measurement of project deliverables. Quality tools, such as checklists and control charts, may be used to capture the data. Inspections are also used to check that previously approved changes have been made correctly, and that the changes have provided the intended results (validated changes).

Control Charts[20] Much of what the exam focuses on regarding control charts is not in the *PMBOK® Guide*. But don't worry; the information in the following sections, along with the exercise that follows, will help you understand this tool, even if control charts are new to you. Once you understand control charts, it is generally easy to get questions about them right on the exam. Note that there's an example of a control chart in the exercise.

Control charts are established in Manage Quality, and the parameters such as the mean, specification limits, and control limits (all defined later in this section) are determined. Control charts are used in Control Quality to help determine if the results of a process are within acceptable limits.

To better understand the need for control charts, imagine a door manufacturer is undertaking a project to create a new production line. To make sure the production facility will create doors that meet quality

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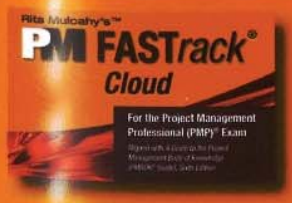

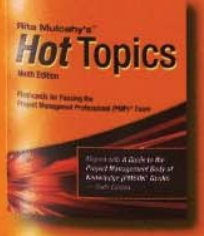

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standards, it's essential to monitor the processes and output so the new production line can become an ongoing business operation. Would each door be the same exact height? Weight? Not likely. Instead there is a range, however small, that is acceptable. Each door should be within the range of normal and acceptable limits.

During the Control Quality process, samples are taken and plotted on the chart (see the small squares shown on the control chart in the following exercise). The control chart shows whether the samples are within acceptable limits. If the data does not fall within the acceptable range, the results are considered to be "out of control," which indicates a problem that needs to be handled.

A control chart can also be used to represent and monitor data on project performance, such as cost and schedule variances.

Now that we have discussed the basic concepts of a control chart, let's look at some of the related terms you should know for the exam. You will see questions on this topic, but they should be fairly straightforward. The following can be indicated on a control chart.

Upper and Lower Control Limits[21] Control limits are often shown as two dashed lines on a control chart. These limits are the acceptable range of variation of a process or measurement's results. Control limits indicate what is stable versus unstable (out of control) in the process. Every process is expected to have some variation in its results; for example, each door manufactured will not be exactly the same size. The project manager and stakeholders determine the appropriate upper and lower control limits for quality metrics on a project. Data points within this range are generally thought of as "in control," excluding the rule of seven (described later in this section), and are an acceptable range of variation. Data points outside this range indicate the process is out of control.

The concept of control limits is also important outside of a control chart. A project manager can have control limits for many things. How about for a work package? Is one hour late in its delivery a problem? How about one day? Such control limits help the project manager know when to take action.

Mean (Average) The mean is indicated by a line in the middle of the control chart. It shows the middle of the range of acceptable variation. A normal distribution curve represents the acceptable range of variance around a mean, and it falls within the boundaries of the control limits.

Specification Limits[22] While control limits represent the performing organization's standards for quality, specification limits represent the customer's expectations—or the contractual requirements—for performance and quality on the project. Specification limits are characteristics of the measured process and are not inherent. In other words, specification limits are not calculated based on the control chart; instead, they are inputs from the customer. Therefore, they can appear either inside or outside of the control limits. To meet the customer's specification limits, the performing organization's standards for quality (control limits) must be stricter than those of the customer. Agreeing to do a project when your work does not meet the customer's quality standards adds waste and extra management to the project to sort out acceptable items. Therefore, on the exam, assume that specification limits are outside the upper and lower control limits.

Out of Control The process is out of a state of statistical control under either of two circumstances:

- A data point falls outside of the upper or lower control limit.
- There are nonrandom data points; these may be within the upper and lower control limits, such as the rule of seven (described next).

Think of "out of control" as a lack of consistency and predictability in the process or its results.

Rule of Seven[23] The rule of seven is a general rule, or heuristic. It refers to a group or series of nonrandom data points that total seven on one side of the mean. The rule of seven tells you that, although none of these points are outside of the control limits, they are not random and the process is out of control. The project manager should investigate this type of situation and find a cause.

Assignable Cause/Special Cause Variation[24] An assignable cause or special cause variation signifies that a process is out of control. If there is an assignable cause or special cause variation, it means a data point, or a series of data points, requires investigation to determine the cause of the variation. The project manager could use additional tools, such as a cause-and-effect diagram, to try to uncover the root cause of the variation.

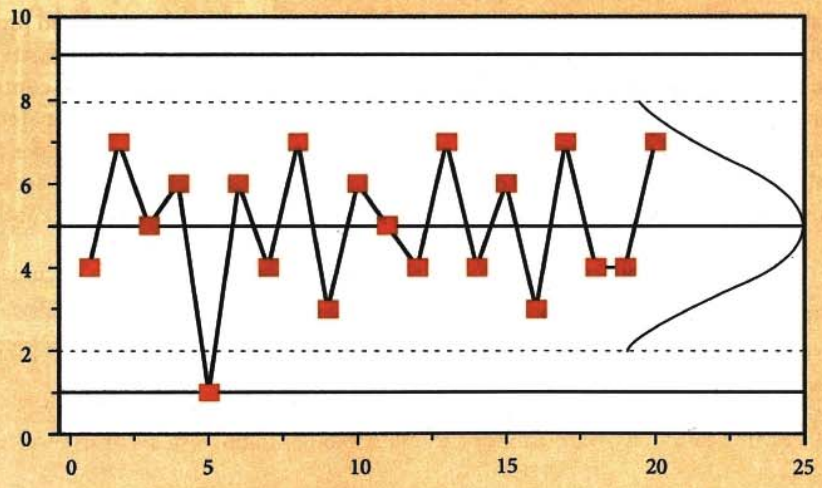
Exercise Now try this exercise. On the following charts, label the examples of each of the ten listed items by placing the item number next to its location on the chart(s). If you are unsure, take a guess, and then review the control chart discussion. The pictures represent two different control charts.

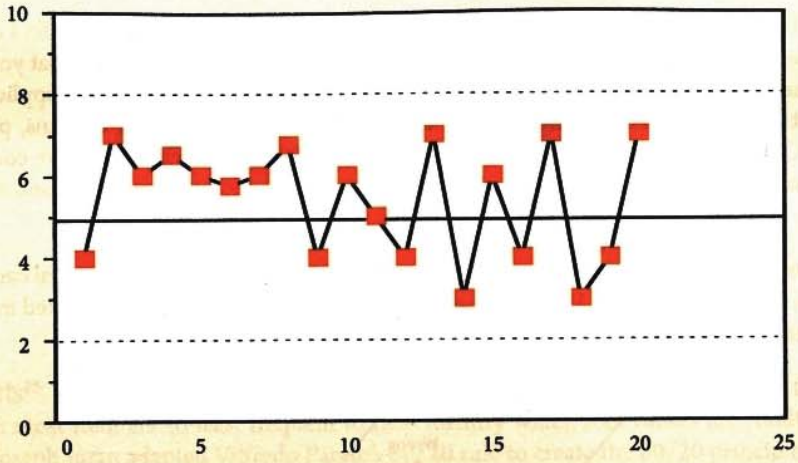
When you are able to pick out all the items on the control charts, you should be ready to answer questions about control charts on the exam.

NOTE: The questions on the exam relating to control charts may be easier to answer if you can picture a control chart in your mind. It is unlikely one will be shown to you on the exam. Instead, the exam will use the terms in situational questions, and you will need to know what they mean. (For example: "A team member tells you that one sample is outside the lower control limit. What should you do?"). This exercise is designed to help you visualize control charts and make sure you understand these tools so you can answer questions about them.

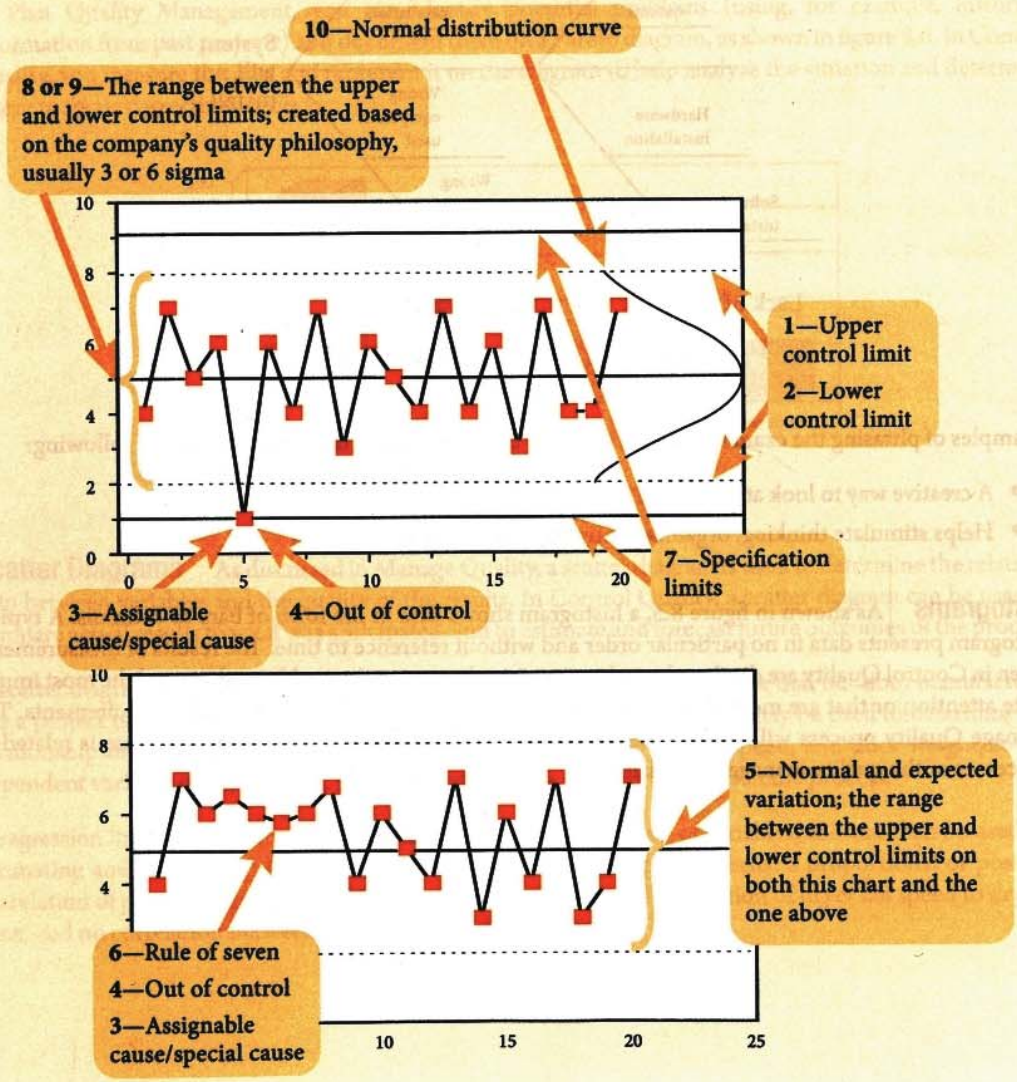
Identify the following on the charts:

1. Upper control limit
2. Lower control limit
3. Assignable cause/special cause
4. The process is out of control
5. Normal and expected variation in the process
6. Rule of seven
7. Specification limits
8. Three sigma
9. Six sigma
10. Normal distribution curve





Answer



Cause-and-Effect (Fishbone, Ishikawa, or Why-Why) Diagrams Is it better to fix a defect or get to the root cause of the defect? Think about this question for a moment. The answer is that you should do both, and a cause-and-effect diagram can help you. In Manage Quality, we discussed the application of the cause-and-effect diagram in determining the root cause of quality issues relating to plans, processes, or procedures. In Control Quality, this tool can be used to look backward at what may have contributed to quality problems on the project, as well as to analyze the impact of defects on the quality and acceptability of a deliverable.

Figure 8.4 shows the defect "system will not install" on the right and then lists the potential causes, such as hardware issues, software issues, etc. Various subcauses of each potential cause are also listed in an effort to find the root cause of the defect.

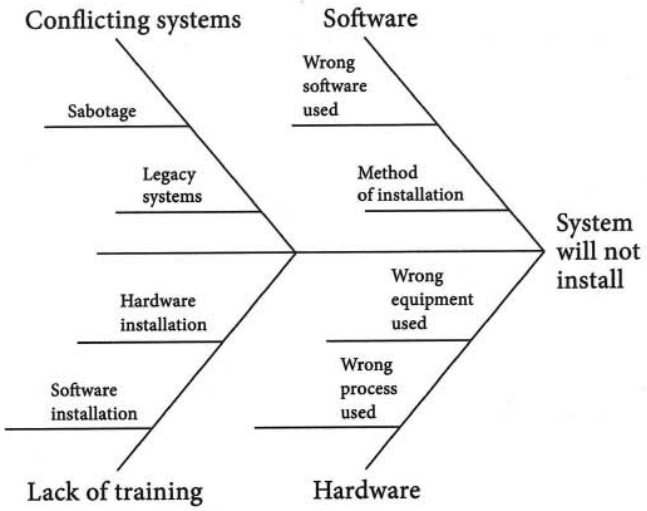


FIGURE 8.4 *Cause-and-effect diagram*

Examples of phrasing the exam may use to describe cause-and-effect diagrams include the following:

- A creative way to look at the causes of a problem
- Helps stimulate thinking, organize thoughts, and generate discussion

Histograms As shown in figure 8.5, a histogram shows data in the form of bars or columns. A typical histogram presents data in no particular order and without reference to time. The results of measurements taken in Control Quality are displayed on a histogram to determine the problems that need the most immediate attention or that are most likely to prevent the project from achieving its quality requirements. The Manage Quality process will analyze these problems and defects to determine if the cause is related to processes or the quality management plan.

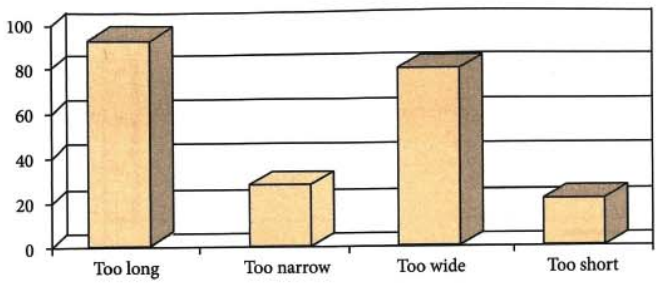


FIGURE 8.5 *Histogram*

Pareto Charts[25] A Pareto diagram or Pareto chart is a commonly used type of histogram that arranges the results from most frequent to least frequent to help identify which root causes are resulting in the most problems. Joseph Juran adapted Vilfredo Pareto's 80/20 rule to create the 80/20 principle (also known as the Pareto Principle), which states that 80 percent of problems are due to 20 percent of the root causes. Addressing the root cause of the most frequent problems makes the greatest impact on quality.

In Plan Quality Management, you can identify potential problems (using, for example, historical information from past projects) and document them on a Pareto diagram, as shown in figure 8.6. In Control Quality, you measure the data and represent it on the diagram to help analyze the situation and determine where to focus corrective action.

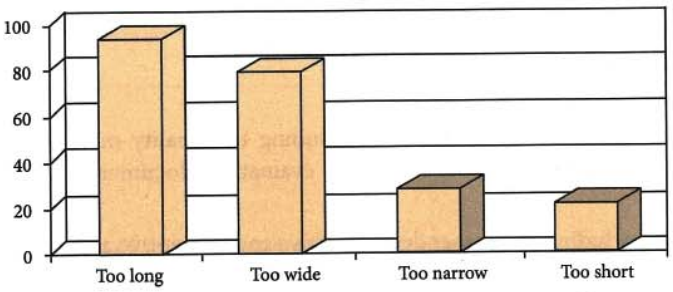


FIGURE 8.6 *Pareto diagram*

Scatter Diagrams As discussed in Manage Quality, a scatter diagram is used to determine the relationship between variables and the quality of the results. In Control Quality, a scatter diagram can be used to compare actual results to what was anticipated, and to estimate and forecast future outcomes of the process.

A scatter diagram tracks two variables to determine their relationship. Imagine that our door manufacturer has a project to develop a new painted door product line. Scatter diagrams may be used to determine the relationship of independent variables, such as paint quantity, dryer fan speed, and door weight, to the dependent variable of drying time, or to correlate defects to other variables in the process.

A regression line (or trend line) is calculated to show the correlation of variables, and can then be used for estimating and forecasting. Figure 8.7 depicts the possible resulting patterns: a proportional or positive correlation of paint quantity to drying time, an inverse or negative correlation of dryer fan speed to drying time, and no correlation between door weight and drying time.

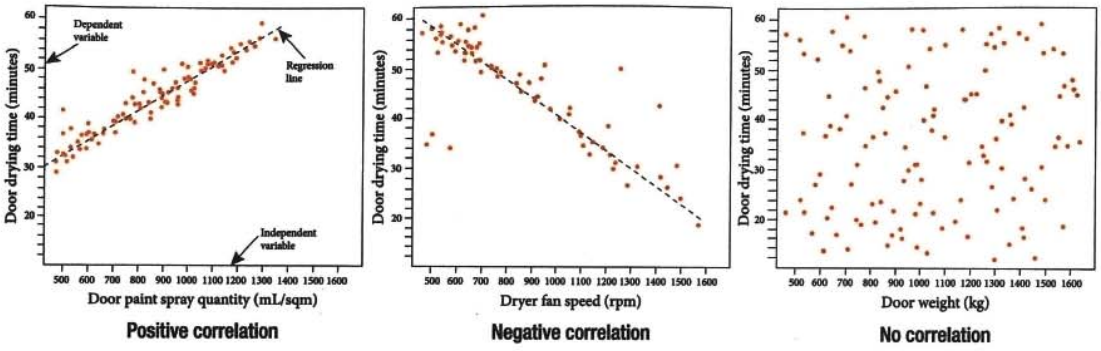


FIGURE 8.7 *Scatter diagrams*

Meetings Lessons learned or retrospectives are meetings conducted as part of Control Quality to assess what was done right and what could have been done differently to make the project more successful.

Approved change request reviews are meetings in which the team evaluates whether approved change requests have been completed, and whether they have returned the results intended.

Outputs of Control Quality

PAGE 305 When you have completed the Control Quality process, you will have the following outputs:

- Measurements
- Validated changes
- Work performance information
- Updates to the project management plan (including the quality management plan) and project documents (including the issue log, test and evaluation documents, risk register, and lessons learned register)
- Change requests, including recommended corrective and preventive actions and defect repair
- Verified deliverables

Putting It All Together

Do you think you understand quality management now? If not, don't worry; we are not finished with this chapter yet. The following exercises will help you review the information you have learned. Take this opportunity to solidify your understanding of what quality management is and how it fits into the overall project management process.

Exercise List the specific actions required to ensure quality on the project.

Answer There are a lot of possible answers. Did you come up with these?

- Review the project management plan, particularly the project baselines, and relevant project documents as they relate to quality on the project.
- Make sure you know and understand the customer's definition of quality.
- Identify the desired levels of performance in the product and components of the product.
- Identify at what level you should control the project (for example, the work package, activity, or a more detailed level).
- Identify any quality standards and processes that are applicable to the project.
- Identify the required level of quality for project management activities.
- Determine the quality standards and processes to use, when, and on what parts of the project.
- Set standards to reach the level of desired performance for activities and the project.
- Set metrics to measure quality from the customer's and the organization's perspective.
- Decide what you will do to make sure the processes are followed and the standards are met.
- Determine how you will improve the processes on the project.
- Test the validity of assumptions before they result in problems.
- Make sure team members understand what "quality" means for their work.
- Review problems, errors, and complaints to determine what can be done to prevent them from reoccurring on the project.

- Have the team follow planned efforts to evaluate the project to look for quality improvements.
- Inspect work as it is being done, not after.
- Perform quality reviews.
- Measure performance against standards.
- Hold meetings, issue reports, measure, and perform calculations to evaluate variances.
- Reassess the quality standards.
- Evaluate the effectiveness of the quality control system.
- Manage quality with the same effort as time, cost, or scope.
- Request changes, including corrective and preventive actions and defect repairs.
- Update organizational process assets with information and data learned from process improvement and control efforts.
- Include quality issues in lessons learned.
- Feed lessons learned back into the project.

Understanding the Tools and Techniques Used in Quality Management

As you have read through this chapter, have you found yourself asking questions like, "Now, when are all these tools and techniques used?" or "What are the differences between the three parts of the quality management process again?" People tend to struggle with these concepts. The following exercises will help.

Exercise Take a moment to research in this book the different tools and techniques that are created or used in each of the quality management processes. Then complete the following table, indicating the process in which each tool is used. Remember that some tools and techniques are used in more than one quality management process. Think about the ways they are used for different purposes in each process.

Tool	Used in Plan Quality Management	Used in Manage Quality	Used in Control Quality
Affinity diagrams			
Alternatives analysis			
Benchmarking			
Brainstorming			
Cause-and-effect diagrams			
Checklists			
Checksheets			
Control charts			
Cost of quality			
Cost-benefit analysis			
Design for X			
Document analysis			
Flowcharts			

Tool	Used in Plan Quality Management	Used in Manage Quality	Used in Control Quality
Histograms			
Inspection			
Interviews			
Logical data model			
Matrix diagrams			
Meetings			
Mind mapping			
Multicriteria decision analysis			
Performance reviews			
Problem-solving			
Process analysis			
Questionnaires and surveys			
Root cause analysis			
Scatter diagrams			
Statistical sampling			
Test and inspection planning			
Testing/product evaluations			

Answer

Tool	Used in Plan Quality Management	Used in Manage Quality	Used in Control Quality
Affinity diagrams		X	
Alternatives analysis		X	
Benchmarking	X		
Brainstorming	X		
Cause-and-effect diagrams		X	X
Checklists		X	X
Checksheets			X
Control charts			X
Cost of quality	X		
Cost-benefit analysis	X		
Design for X		X	
Document analysis		X	
Flowcharts	X	X	
Histograms		X	X

Tool	Used in Plan Quality Management	Used in Manage Quality	Used in Control Quality
Inspection			X
Interviews	X		
Logical data model	X		
Matrix diagrams	X	X	
Meetings	X		X
Mind mapping	X		
Multicriteria decision analysis	X	X	
Performance reviews			X
Problem-solving		X	
Process analysis		X	
Questionnaires and surveys			X
Root cause analysis		X	X
Scatter diagrams		X	X
Statistical sampling			X
Test and inspection planning	X		
Testing/product evaluations			X

TRICKS OF THE TRADE Here is a trick: If the situation is looking forward in time, it is most likely a planning function. If it is looking back in time at project results, it is most likely part of quality control. If it is looking back in time at processes and procedures, it is most likely part of managing quality.

Exercise Now take what you have learned and see if you can apply it in a different way. This exercise should help prepare you for questions on the exam, regardless of how they are written.

	Situation	What Tool/ Technique Is Being Referred To?	What Part of the Quality Management Process Are You In?
1	Looking at the project practices of comparable projects		
2	Measuring 4 of the doors produced, rather than all 400		
3	Evaluating the factors that influence particular variables in a product or process		
4	Analyzing a chart of problems to find the most frequent one(s) to determine whether processes need to be improved		

	Situation	What Tool/ Technique Is Being Referred To?	What Part of the Quality Management Process Are You In?
5	Comparing the expense of quality efforts to the return on that investment		
6	Determining what will be an acceptable range of performance		
7	Comparing what was done to what was documented in the plans		
8	Graphically representing a process to determine where a process that is achieving low-quality results might need adjustment		
9	Taking measurements and comparing them to the upper and lower thresholds of acceptable variance		
10	Collecting data about defects discovered during inspection		
11	Analyzing a graphic displaying issues that might have caused a defect, to determine whether the proper process was followed		
12	Showing data in the form of bars to measure and plot how frequently a problem occurred		
13	Collecting many data points to look at the pattern of relationships or correlation between two variables		
14	Using a bar chart to show how many problems occurred for each cause and arranging them according to the frequency at which the problems occurred		
15	Creating a list of items to be checked during inspections		
16	Reviewing a graphic displaying issues or potential issues that might have led to a defect or problem		
17	Examining a work product to make sure it meets standards		

Answer Remember that the tools and techniques can be described in many ways on the exam. Get used to the idea that the exam will ask questions indirectly, and be able to differentiate between the tools or techniques and their uses.

	Situation	What Tool/ Technique Is Being Referred To?	What Part of the Quality Management Process Are You In?
1	Looking at the project practices of comparable projects	Benchmarking	Plan Quality Management
2	Measuring 4 of the doors produced, rather than all 400	Statistical sampling	Control Quality
3	Evaluating the factors that influence particular variables in a product or process	Design of experiments (part of process analysis)	Manage Quality
4	Analyzing a chart of problems to find the most frequent one(s) to determine whether processes need to be improved	Histograms	Manage Quality
5	Comparing the expense of quality efforts to the return on that investment	Cost-benefit analysis	Plan Quality Management
6	Determining what will be an acceptable range of performance	Control charts	Manage Quality
7	Comparing what was done to what was documented in the plans	Checklists	Control Quality
8	Graphically representing a process to determine where a process that is achieving low-quality results might need adjustment	Flowcharts	Manage Quality
9	Taking measurements and comparing them to the upper and lower thresholds of acceptable variance	Control charts	Control Quality
10	Collecting data about defects discovered during inspection	Checksheets	Control Quality
11	Analyzing a graphic displaying issues that might have caused a defect to determine whether the proper process was followed	Cause-and-effect diagrams	Manage Quality
12	Showing data in the form of bars to measure and plot how frequently a problem occurred	Histograms	Control Quality
13	Collecting many data points to look at the pattern of relationships or correlation between two variables	Scatter diagrams	Control Quality
14	Using a bar chart to show how many problems occurred for each cause and arranging them according to the frequency at which the problems occurred	Histograms (Pareto diagram)	Control Quality
15	Creating a list of items to be checked during inspections	Checklists	Manage Quality

	Situation	What Tool/ Technique Is Being Referred To?	What Part of the Quality Management Process Are You In?
16	Reviewing a graphic displaying issues or potential issues that might have led to a defect or problem	Cause-and-effect diagrams	Control Quality
17	Examining a work product to make sure it meets standards	Inspection	Control Quality

TRICKS OF THE TRADE

Understanding the Differences between the Three Parts of the Quality Management Process Are you still unsure about the difference between Plan Quality Management, Manage Quality, and Control Quality? Think through what you have learned in this chapter, and see if you can recreate the chart shown earlier by filling in the following table.

Plan Quality Management	Manage Quality	Control Quality
Process Group		
High-Level Description of What Each Process Focuses On		
More Detailed Description of What Each Process Focuses On		

Plan Quality Management	Manage Quality	Control Quality

When you are finished, check your answers against the chart on pages 326-327. Having a clear understanding of what happens in each process will make it easier for you to answer quality-related questions on the exam. You will still have to read the questions carefully to determine which quality management process is being described.

Practice Exam

1. When a product or service completely meets a customer's requirements:
   A. Quality is achieved.
   B. The cost of quality is high.
   C. The cost of quality is low.
   D. The customer pays the minimum price.

2. To what does the following definition refer? "A type of analysis focused on finding the point at which the benefits or revenue to be received from improving quality equals the incremental cost to achieve that quality."
   A. Quality control analysis
   B. Marginal analysis
   C. Standard quality analysis
   D. Conformance analysis

3. Who is ultimately responsible for quality management on the project?
   A. The project engineer
   B. The project manager
   C. The quality manager
   D. The team member

4. A project has faced major difficulties in the quality of its deliverables. Management now states that quality is the most important project constraint. If another problem with quality were to occur, what would be the best thing for the project manager to do?
   A. Fix the problem as soon as possible.
   B. Allow the schedule to slip by cutting cost.
   C. Allow cost to increase by fixing the root cause of the problem.
   D. Allow risk to increase by cutting cost.

5. A manager notices that a project manager is holding a meeting with some of the team and some stakeholders to discuss the quality of the project. The project schedule has been compressed, and the CPI is 1.1. The team has worked hard on the project and has been rewarded according to the reward system the project manager put in place. Overall, there is a strong sense of team. The manager suggests that the project manager does not have enough time to hold meetings about quality when the schedule is so compressed. Which of the following best describes why the manager is wrong?
   A. Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk.
   B. Improved quality leads to increased productivity, decreased cost effectiveness, and increased cost risk.
   C. Improved quality leads to increased productivity, increased cost effectiveness, and increased cost risk.
   D. Improved quality leads to increased productivity, decreased cost effectiveness, and decreased cost risk.

6. Quality is:
   A. Meeting and exceeding the customer's expectations
   B. Adding extras to make the customer happy
   C. The degree to which the project meets requirements
   D. Conformance to management's objectives

7. All the following are tools and techniques of Control Quality except:
   A. Inspection
   B. Cost of quality
   C. Histogram
   D. Cause-and-effect diagram

8. A project manager is experiencing a great deal of frustration because a lot of rework has been required. It seems as though the team has significant differences of opinion related to interpretation of the requirements. The project manager is trying to determine what changes need to be made to meet the quality requirements and reduce future rework. He seeks the advice of his manager, who asks if he has created a histogram. Histograms help the project manager:
   A. Focus on the most critical issues to improve quality.
   B. Focus on stimulating thinking.
   C. Analyze the cause of a quality problem.
   D. Determine if a process is out of control.

9. A control chart helps the project manager:
   A. Focus on the most critical issues to improve quality.
   B. Focus on stimulating thinking.
   C. Analyze the cause of a quality problem.
   D. Determine if a process is functioning within established metrics.

10. Testing the entire population would:
    A. Take too long
    B. Provide more information than wanted
    C. Be mutually exclusive
    D. Show many defects

11. Cost has been determined to be the highest priority constraint on a project to design and produce a new tool that will be used in restaurant kitchens. The project team has included random sampling of these tools in their quality plan. Although cost is a key factor, the product must also meet high quality standards. All the following are examples of the cost of nonconformance except:
    A. Rework
    B. Quality training
    C. Scrap
    D. Warranty costs

12. Standard deviation is a measure of:
    A. How far the estimate is from the highest estimate
    B. How far the measurement is from the mean
    C. How correct the sample is
    D. How much time remains in the project

13. All the following result from quality audits except:
    A. Determination of whether project activities comply with organizational policies
    B. Improved processes to increase productivity
    C. Creation of quality metrics
    D. Confirmation of the implementation of approved change requests

14. A control chart shows seven data points in a row on one side of the mean. What should the project manager do?
    A. Perform a design of experiments.
    B. Adjust the chart to reflect the new mean.
    C. Find an assignable cause.
    D. Nothing. This is the rule of seven and can be ignored.

15. You are managing a project in a just in time environment. This will require more attention because the amount of inventory in such an environment is generally:
    A. 45 percent
    B. 10 percent
    C. 12 percent
    D. 0 percent

16. There are several executing activities underway on your project. You are beginning to get concerned about the accuracy of the progress reporting your team members are doing. How could you verify whether there is a problem?
    A. Perform a quality audit.
    B. Create risk quantification reports.
    C. Perform regression analysis.
    D. Perform Monte Carlo analysis.

17. A project manager and team from a firm that designs railroad equipment are tasked to design a machine to load stone onto railroad cars. The design allows for 2 percent spillage, amounting to over two tons of spilled rock per day. In which of the following does the project manager document this for the project?
    A. Quality management plan
    B. Quality policy
    C. Control charts
    D. Quality audit documentation

18. During a team meeting, the team adds a specific area of extra work to the project because they have determined it would benefit the customer. What is wrong in this situation?
    A. The team is not following the project management plan.
    B. These efforts shouldn't be done in meetings.
    C. Nothing. This is how to meet and exceed customer expectations.
    D. Nothing. The project manager is in control of the situation.

19. The project team has created a plan for how they will implement the quality policy, addressing responsibilities, procedures, and other details. If this plan changes during the project, which of the following plans will also change?
    A. Quality assurance plan
    B. Quality management plan
    C. Project management plan
    D. Quality control plan

20. You are a project manager for a major information systems project. Someone from the quality department comes to see you about beginning a quality audit of your project. The team, already under pressure to complete the project as soon as possible, objects to the audit. You should explain to the team that the purpose of a quality audit is:
    A. To check whether measurements of project deliverables are within specification limits
    B. To check if the customer is following the quality process
    C. To identify inefficient and ineffective policies
    D. To check the accuracy of costs submitted by the team

21. You are in the middle of a major facility construction project. The structural steel is already in place, and the heating conduits are being put into place when a senior manager informs you that he is worried the project will not meet the quality standards. What should you do in this situation?
    A. Assure senior management that during the Plan Quality Management process, it was determined that the project would meet the quality standards.
    B. Analogously estimate future results.
    C. Involve the quality team.
    D. Check the results from the last quality management plan.

22. You are asked to select tools and techniques to supplement existing quality control activities. Which of the following would not be appropriate for this purpose?
    A. Performance reviews
    B. Statistical sampling
    C. Pareto diagrams
    D. Focus groups

23. The new software installation project is in progress. The project manager is working with the quality department to improve stakeholders' confidence that the project will satisfy the quality standards. Which of the following must they have before they start this process?
    A. Quality problems
    B. Quality improvement
    C. Quality control measurements
    D. Rework

24. A project manager has just taken over the project from another project manager during project executing. The previous project manager created a project budget, determined communications requirements, and went on to the complete work packages task. What should the new project manager do next?
    A. Coordinate completion of work packages.
    B. Identify quality standards.
    C. Begin the Identify Risks process.
    D. Validate scope.

25. An experienced project manager is working with a team chartered to build a bridge near the Arctic Circle. In addition to the usual concerns of safety and longevity, the team must also take into account the extreme weather conditions and their potential impact on the bridge. The sponsor meets with the project manager regarding her progress on this work. The sponsor is pleased to learn that the project manager is planning to conduct a design of experiments as part of quality planning. Design of experiments:
    A. Identifies which variables will have the most influence on a quality outcome
    B. Helps to identify the root cause of quality problems
    C. Determines what a quality outcome is
    D. Determines methods to be used for research and development

26. At the end of the project, the project manager reports that the project has added four unexpected areas of functionality and three areas of performance. The customer has expressed satisfaction with the project. What does this mean in terms of the success of the project?
    A. The project was an unqualified success.
    B. The project was unsuccessful because it was gold plated.
    C. The project was unsuccessful because the customer being happy means they would have paid more for the work.
    D. The project was successful because the team had a chance to learn new areas of functionality and the customer was satisfied.

27. During project executing, a project team member informs the project manager that a work package has not met the quality metric, and that she believes it is not possible to meet it. The project manager meets with all concerned parties to analyze the situation. Which part of the quality management process is the project manager involved in?
    A. Manage Quality
    B. Perform Integrated Change Control
    C. Control Quality
    D. Plan Quality Management

28. The project manager notices that the project activities being completed by one department are all taking slightly longer than planned. To date, none of the activities in the work packages have been on the critical path. The project manager is bothered by the problem, since four of the next five critical path activities are being completed by this department.

    After making three calls, the project manager is finally able to talk with the department manager to determine what is going on. The conversation is slow because both speak different native languages, and they are trying to converse in French, a shared language. To make communication easier, the project manager frequently asks the department manager to repeat back what has been said.

    The department manager communicates that his staff is following a company policy that requires two levels of testing. During the conversation, the department manager also makes a comment that leads the project manager to believe the policy may include excessive work. This is the fourth time the project manager has heard such a comment. What is the best thing to do?
    A. Create a better communications management plan that requires one universal language on the project and have translators readily available on a moment's notice.
    B. Contact someone else in the department who speaks the project manager's native language better to confirm the department manager's opinion.
    C. Find out if the upcoming activities should be reestimated.
    D. Work on increasing the effectiveness of the performing organization by recommending continuous improvement of the policy in question.

29. As the project manager, you are preparing your quality management plan. You are looking for a tool that can demonstrate the relationship between events and their resulting effects. You want to use this tool to depict the events that cause a negative effect on quality. Which of the following is the best choice for accomplishing your objective?
    A. Scatter diagram
    B. Pareto diagram
    C. Why-why diagram
    D. Control chart

30. Which of the following explains why quality should be planned in and not inspected in?
    A. It reduces quality and is less expensive.
    B. It improves quality and is more expensive.
    C. It reduces quality and is more expensive.
    D. It improves quality and is less expensive.

31. Work on a project is ongoing when the project manager overhears two workers arguing over what a set of instructions means. The project manager investigates and discovers that the instructions for the construction of the concrete footings currently being poured were poorly translated between the different languages in use on the project. Which of the following is the best thing for the project manager to do first?
    A. Get the instructions translated by a more experienced party.
    B. Look for quality impacts of the poor translation of the instructions for the footings.
    C. Bring the issue to the attention of the team, and ask them to look for other translation problems.
    D. Inform the sponsor of the problem in the next project report.

32. While performing quality planning for the design and manufacture of a new medical device, the team has identified the need to keep variances to a minimum because the end product must be of the highest quality possible. They are researching the practices of comparable projects for ideas on how to achieve this requirement. The team is using which of the following techniques?
    A. Benchmarking
    B. Pareto analysis
    C. Design for X
    D. Cost-benefit analysis

33. Which of the following would generally lead to the least amount of quality improvement?
    A. Total quality management
    B. Quality planning
    C. Implementing an ISO 9000 standard
    D. Inspection

34. In a meeting to gain approval of the quality management plan, a stakeholder points out what he believes to be an error in the plan. He notes that the plan includes using some of the same techniques in more than one of the quality processes. Which of the following quality management techniques can be used in two of the three quality management processes?
    A. Cause-and-effect diagrams
    B. Interviews
    C. Checksheets
    D. Logical data model

Answers

1. **Answer** A
   Explanation As a general rule, one cannot say that quality (as defined in the question) is either of high or low cost. Quality provides what the customer wanted, which may not be the highest or lowest cost. When a product or service completely meets a customer's needs, quality is achieved.

2. **Answer** B
   Explanation This is the definition of marginal analysis. Know the term so you will be able to answer questions that deal with this concept. The other choices may sound good, but they are made-up terms.

3. **Answer** B
   Explanation Although each person working on the project should check their own work, the project manager ultimately has the responsibility for quality on the project as a whole.

4. **Answer** C
   Explanation If a problem with quality were to occur again, many people would opt to fix the problem as soon as possible. It is proactive, but some other project constraint(s) must change to accommodate fixing the root cause of the problem. It may not be necessary to allow the schedule to slip, because the project manager might be able to compress the schedule in other areas. Cutting cost does not necessarily cause the schedule to slip, nor would that necessarily fix the problem at hand. Allowing risk to increase by cutting cost is not the best choice, because a quality problem is most likely to create additional cost, rather than cut cost. Allowing the cost to increase by fixing the root cause of the problem addresses both the need to find the cause and the probable impact of dealing with the problem.

5. **Answer** A
   Explanation Did you notice there is a lot of data not relevant to answering the question? Expect distractors to appear in many questions on the exam. Quality efforts should produce a decrease rather than an increase in cost risk as a result of less rework. Quality efforts should also provide increased cost effectiveness due to less rework. This leaves the best answer: "Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk."

6. **Answer** C
   Explanation There can be a cost impact (as well as an impact on other project constraints) of exceeding expectations or adding extras. Quality is the degree to which the project meets requirements.

7. **Answer** B
   Explanation Inspection, histograms, and cause-and-effect diagrams are all tools that can be used in Control Quality. Cost of quality is part of Plan Quality Management, making sure the project is not spending too much to achieve a particular level of quality.

8. **Answer** A
   Explanation Cause-and-effect (or why-why) diagrams are often used to stimulate thinking and to analyze the cause of quality problems. Determining whether a process is out of control is a function of control charts. Only focusing on critical issues to improve quality relates to histograms.

9. **Answer** D
   Explanation Focusing on the most critical issues to improve quality relates to histograms. Stimulating thinking and analyzing the cause of quality problems relate to cause-and-effect diagrams. Only determining if a process is functioning within established metrics relates to control charts.

10. **Answer** A
Explanation The length of time it takes to test a whole population is one of the reasons to test a sample of the deliverables, rather than all of them. The sample size and frequency of measurements are determined as part of the Plan Quality Management process, and the actual sampling is done in Control Quality.

11. **Answer** B
Explanation Quality training is a cost of conformance to quality. All the other choices are costs of nonconformance to quality.

12. **Answer** B
Explanation Standard deviation is the measurement of a range around the mean.

13. **Answer** C
Explanation Quality metrics are an output of the Plan Quality Management process. They are an input to the Manage Quality process, the process in which quality audits take place.

14. **Answer** C
Explanation The rule of seven applies here. If you have seven data points in a row on the same side of the mean, statistically the mean has shifted, calling for action to correct the problem.

15. **Answer** D
Explanation In a just in time environment, supplies are delivered when you need them and not before. Therefore, you have little or no inventory.

16. **Answer** A
Explanation Quality audits are a necessary part of the Manage Quality process. They help you assess whether the processes are being followed correctly on the project.

17. **Answer** A
Explanation The defined level of acceptable spillage would be documented in the quality management plan. The quality policy and control charts are components of a quality management plan. Quality audit documentation is created in Manage Quality, while the work of the project is being done. The amount of acceptable spillage would have been determined in the Plan Quality Management process.

18. **Answer** A
Explanation This is an example of gold plating. The team should provide only what was included in the approved project management plan. The team does not know if their change will provide benefit to the customer. Any such changes must be evaluated in integrated change control. Instead of adding extras, the team should focus their efforts on fulfilling the requirements.

19. **Answer** C
Explanation The plan described is the quality management plan. Since the quality management plan is included in the project management plan, changing the quality management plan will also change the project management plan. The other choices are not actual plans.

20. **Answer** C
Explanation Control charts show whether measurements of project deliverables are within specification limits, and are used in the Control Quality process. The seller cannot generally control or review the customer's quality process. Checking the accuracy of costs submitted by the team is more representative of a cost audit than a quality audit, so that option cannot be the best choice. Manage Quality, of which an audit is part, focuses on processes, procedures, and standards. One purpose of a quality audit is to identify inefficient and ineffective policies.

21. **Answer** C
Explanation Assuring management that it was determined in planning that the project would meet quality standards is not productive, since it does not solve the problem. An analogous estimate looks at the past history of other projects. This would not be appropriate to determine how the current project is going. The quality management plan does not provide results. The quality team could help to determine whether the team is following the correct process to satisfy the relevant quality standards.

22. **Answer** D
Explanation Focus groups are a tool of the Collect Requirements process, and would not be useful in Control Quality. The other choices are all tools and techniques of the Control Quality process.

23. **Answer** C
Explanation Although quality problems may lead to quality improvement efforts, they are not a prerequisite for quality improvement. Quality improvement is a result of Manage Quality and Control Quality, not an input. Rework (or requested defect repair) can be an output of Control Quality. That leaves only quality control measurements, which are inputs to the Manage Quality process.

24. **Answer** B
Explanation Completion of work packages is done after project planning. Since Validate Scope is a monitoring and controlling process, that is not next. Identify Risks sounds like a good choice; however, identifying quality standards occurs before the Identify Risks process. You may have misread the question and assumed communication planning was complete, but notice it only says that communications requirements have been determined. Communications planning still needs to be completed, as do other aspects of planning. Identify quality standards is the best answer choice offered.

25. **Answer** A
Explanation Design of experiments is performed in quality planning, and uses experimentation to determine statistically what variables will improve quality. It allows the project manager to focus attention on the factors that are most important. Design of experiments is also used in Manage Quality to help decrease the time and effort required to discover the optimal conditions in which to produce a quality deliverable.

26. **Answer** B
Explanation The unexpected functionality reported by the project manager is outside the scope of the project. Adding extra functionality is the definition of gold plating. Gold plating a project wastes time and probably cost. It makes the project unsuccessful.

27. **Answer** C
Explanation Measuring is part of the Control Quality process. Perform Integrated Change Control is an integration management process. It is likely that the scenario described will result in a change request submitted to Integrated Change Control.

28. **Answer** D
Explanation Changing the communications management plan may not be needed, and it does not deal with the problem at hand—the policy that is slowing things down. Confirming the department manager's opinion with someone else in the department is not the best choice, as the project manager already has heard the opinion on many other occasions. It is already confirmed. Determining whether upcoming activities should be reestimated is just being reactive. A good project manager will find the root cause and deal with that, even if it means attempting to improve the company's policies and processes. Yes, recommending improvement of the policy is the best answer. This is continuous improvement. Because there are several activities affected by the policy, it would best serve the project to get to the root cause of the problem and solve it.

29. **Answer** C
Explanation All reports and diagrams are communications tools. This question asks you to pick the most appropriate quality tool to help communications. A why-why diagram, also called a cause-and-effect or Ishikawa diagram, is more appropriate than a Pareto diagram since you are trying to determine the causes. Once causes are known and you have data on occurrences, the data can be displayed in a Pareto diagram.

30. **Answer** D
Explanation Look for the proactive approach. When we plan for quality, we define the appropriate level of quality needed, which will improve quality overall and will likely be less expensive in the long run. NOTE: You may spend more initially on determining the right level of quality and doing the work to produce the required level of quality, but you will save through reduced rework, waste, and scrap.

31. **Answer** B
Explanation Although all these choices are correct things to do, the question asks what to do first. What is the most immediate problem? Getting the instructions translated by a more experienced party could be done, but it does not address the critical concern of the footings that have already been poured according to the poorly translated instructions. Asking the team to look for other translation issues is an excellent idea. However, it does not address the immediate problem. Informing the sponsor is also not taking action to solve the problem. Isn't it most urgent to find out whether the concrete footings meet your project requirements? Are they adequate? Only the option of looking for quality impacts of the poor translation will help you determine that.

32. **Answer** A
Explanation The team is using the benchmarking technique to review methodologies used by comparable projects or organizations to establish quality metrics and acceptable variance ranges, and to measure quality.

33. **Answer** D
Explanation Quality cannot be inspected in; you must plan for and execute a quality strategy. Increasing inspection is the only answer that is not proactive.

34. **Answer** A
Explanation Interviews are used in Plan Quality Management to identify existing standards, processes, and metrics—or to create new ones. A logical data model is also used in Plan Quality Management. Its purpose is to help the team understand the requirements, and define the appropriate quality management processes. Checksheets are used in Control Quality to track data such as the type and frequency of quality problems uncovered during inspections. Cause-and-effect diagrams are used in Manage Quality to confirm that the policies, procedures, and metrics are adequate to produce the required level of quality in project deliverables. In Control Quality, cause-and-effect diagrams can be used to uncover the root cause of a variation in the quality of deliverables.