HAROLD KERZNER | FRANK P. SALADIS

PROJECT MANAGEMENT

WORKBOOK AND PMP®/CAPM® EXAM STUDY GUIDE

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TWELFTH EDITION

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Project Management Workbook and PMP®/CAPM® Exam Study Guide

Project Management Workbook and PMP®/ CAPM® Exam Study Guide

Twelfth Edition

HAROLD KERZNER, PH.D.

FRANK P. SALADIS, PMP

WILEY

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Preface

The purpose of this workbook is to provide students of project management with meaningful exercises and homework problems that will enhance the knowledge of the subjects included in the textbook *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) by Harold Kerzner, Ph.D.

The material in the workbook is directly related to the subjects and knowledge areas associated with the Project Management Institute's Project Management Professional (PMP)® exam and the Certified Associate Project Manager (CAPM)® exam and will provide a sound framework for exam preparation.

The workbook is designed to engage the student in activities that will provide practical application of the concepts of project management as described in the textbook and in the *PMI® Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*), Sixth Edition.

Included in the workbook are topic-specific glossaries, common project terms and acronyms, knowledge area summaries, examples of typical project management mathematic formulas and equations, and key project terms, and logic problems. The workbook also includes PMP® exam study tips, situational exercises, and sample questions designed to simulate the type of questions that may be encountered on the actual PMP® exam.

We hope you will find this book enjoyable and educational.

CHAPTER ONE

Project Management Overview

Project management has been practiced for hundreds, actually thousands, of years. Long before computers and sophisticated scheduling techniques became available, the ancestors of today's professional project managers had to determine resource requirements, arrange for material and equipment, and strive to meet a schedule imposed by, in many cases, a powerful leadership entity. They knew that any construction type of undertaking or project endeavor, large or small, required a goal, a set of objectives, a plan, coordination with many functional groups, the management of resources, and the ability to manage change. Additionally, it became very clear that every project requires strong and adaptive leadership. Project managers, by nature of the position, will work with and manage teams and a variety of stakeholders, some of whom can be expected to be a real a challenge to work with. Considering this factor, project managers must continue to develop the skills necessary to balance the expectations and demands of each stakeholder while managing project deliverables. This is driving a change in the role of "project manager" to that of "project leader." Today's project managers see themselves as managing part of a business as well as managing a project.

As the world's business and financial environment has changed and evolved, organizational leaders have recognized the value of project management and the competent project manager. Project management has also become a key factor in strategic planning.

Today, project management is practiced, to some extent, in almost every organization from small businesses to Fortune 500 companies to local and state governments. Some organizations follow a very formal methodology, and many organizations have adopted a "management by projects" approach. Some organizations have established project management offices (PMOs) to assist them in developing standards for managing projects and processes and to ensure that these standards are followed. Studies have indicated that the application of project management results in significantly higher levels of performance than those of organizations that do not have a project management discipline. As the project management discipline is adapted into the culture of an organization, the benefits of project management are quickly realized. These benefits include more efficient scheduling of resources, improved and more reliable estimating, higher quality of deliverables, early identification of project risks, issues and problems,

and more effective measurement processes to assess success. In this highly competitive business environment, it is clear that a well- executed project management methodology has become a significant advantage.

Applying project management is certainly a factor in achieving organizational objectives, but it is important to understand the definition and nature of a project. Projects are defined as temporary endeavors with specific start and end dates, and they are initiated to produce a unique product or service. Project management is the application of knowledge skills, tools, and techniques to project activities to meet project objectives. Effective project management is accomplished through the integration of five major project management processes: initiation, planning, execution, monitoring and controlling, and closing. For control purposes, projects are generally divided into phases, and these processes also apply to the management of each phase of a project. As projects are authorized by a project sponsor, a project manager is assigned and becomes accountable for the success of the project through effective leadership and the application of project management techniques. The project manager will ensure coordination between functional organizations and must have the ability to apply the appropriate amount of managerial and cross-organizational support and guidance to achieve success as the project is executed.

Project management, as a discipline or profession, also subscribes to a code of ethics and professional conduct specifically focused on integrity, respect, fairness, and honesty. This includes business ethics as well as project management ethics because we now believe that we are managing our business by projects and that the project managers are actually managing part of a business.

► Glossary of Terms

Key project management terms and definitions to review and remember. The disciple of project management includes a lexicon that is widely used in most industries, and it is beneficial to learn the "language" of the professional project manager.

Deliverable A tangible, verifiable work output. Project work will generally produce multiple deliverables that will comprise the final project deliverable. Deliverables, in some cases can be intangible such as the achievement of good will, brand recognition, and customer satisfaction.

Functional manager Generally, the manager who "owns" or supervises the resources assigned to project activities. Functional managers are considered to be the technical experts and usually provide information about resource requirements, resource capability, task duration estimates, schedule development, and cost estimates. Project managers engage the assistance of functional managers to develop the project plan and subsidiary project plans.

Non-project-driven Generally, these organizations may or may not not have a project methodology in place, are not organized around the delivery of projects, and are arranged in a functional organizational structure. Work is generally associated with

manufacturing and production lines. Projects are established as needed to improve or support functional lines and activities or organizational changes.

Program A group of related projects managed in a coordinated way to obtain benefits and control not available from managing them separately. Generally, projects in a program are interrelated.

Project A temporary endeavor undertaken to create a unique product, service, or result. A project has a specific objective, defined start and end dates, and funding limitations. Projects consume resources including human (labor), equipment and materials. A project is generally multifunctional or cross-organizational in nature. Projects generally produce one or more deliverables and deliverables can be tangible or intangible.

Project-driven organization Also known as "project based." In these organizations all work is characterized through projects. Projects are arranged as separate cost centers and the sum of all project work is associated with organizational goals and strategic objectives.

Project management Application of knowledge skills, tools, and techniques to project activities to meet project requirements. Project management involves the utilization of the five major process groups: initiation, project planning, executing, monitoring and controlling, and closing. These processes are applied to each project phase and enable the project manager to effectively integrate the 10 project management knowledge areas described in the *Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) developed by the Project Management Institute, or PMI.

Project sponsor Generally, described as the person or organization that authorizes the project and provides the financial resources required to plan, execute, and deliver the project objectives. The sponsor may be joined by other stakeholders to provide committee sponsorship and/or guidance for this project or for a portfolio of projects.

Triple constraint This term has been used for many years to describe the effects of changes to the competing project demands of time (schedule), cost (budget), and scope (specifications) usually depicted as a triangle. Specifically, the triple constraint emphasized that a change to any one side or element of the triangle will have an effect on the other elements. The triple constraint was also considered to display the key factors that define project success. The triple constraint has been modified and is now part of a list of several competing demands, including scope, time, cost, quality, risk, safety, business value, and resources. Project success is defined using several success factors, including quality, business value added, and fitness for use.

► Activities, Questions, and Exercises

Refer to Chapter One of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

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Dr. Kerzner's 16 Points to Project Management Maturity

1. Adopt a project management methodology and use it consistently.
2. Implement a philosophy that drives the company toward project management maturity and communicate it to everyone.
3. Commit to developing effective plans at the beginning of each project.
4. Minimize scope changes by committing to realistic objectives.
5. Recognize that cost and schedule management are inseparable.
6. Select the right person as the project manager.
7. Provide executives with project sponsor information, not project management information.
8. Strengthen involvement and support of line management.
9. Focus on deliverables rather than resources.
10. Cultivate effective communications, cooperation, and trust to achieve rapid project management maturity.
11. Share recognition for project success with the entire project team and line management.
12. Eliminate nonproductive meetings.
13. Focus on identifying and solving problems early, quickly, and cost effectively.
14. Measure progress periodically.
15. Use project management software as a tool, not as a substitute for effective planning or interpersonal skills.
16. Institute an all-employee training program with periodic updates based on documented lessons learned.

■ Exercise

This exercise is intended to provide you with a basis and understanding of the major goals of an enterprise-wide project management methodology and to provide a baseline for process for improvement. The 16 Points to Project Management Maturity define the steps necessary to achieve high-level and consistent project performance and business value.

Review Dr. Kerzner's 16 points and identify the specific benefits associated with each point. Identify actions that may be taken to introduce, implement, or further enhance the value of each of the listed points in an organization.

Example: Adopt a project management methodology and use it consistently.

Action: Provide management with supporting information about how project management can assist in achieving organizational objectives. Obtain best practices documentation from companies that are actively using project management processes and methodologies and provide a summary to executive management.

1. Implement a philosophy that drives the company toward project management maturity and communicate it to everyone.

   Action: _____

   _____

   _____

   _____

2. Commit to developing effective plans at the beginning of each project.

   Action: _____

   _____

   _____

   _____

3. Minimize scope changes by committing to realistic objectives.

   Action: _____

   _____

   _____

   _____

4. Recognize that cost and schedule management are inseparable.

   Action: _____

   _____

   _____

   _____

5. Select the right person as the project manager.

   Action: _____

   _____

   _____

   _____

6. Provide executives with project sponsor information, not project management information.

   Action: _____

   _____

   _____

   _____

7. Strengthen involvement and support of the line management.

   Action: _____

8. Focus on deliverables rather than resources.

   Action: _____

9. Cultivate effective communications, cooperation, and trust to achieve rapid project management maturity.

   Action: _____

10. Share recognition for project success with the entire project team and line management.

    Action: _____

11. Eliminate nonproductive meetings.

    Action: _____

12. Focus on identifying and solving problems early, quickly, and cost effectively.

    Action: _____

13. Measure progress periodically.

Action: _____

_____

_____

_____

14. Use project management software as a tool, not as a substitute for effective planning or interpersonal skills.

Action: _____

_____

_____

_____

15. Institute an all-employee training program with periodic updates based on documented lessons learned.

Action: _____

_____

_____

_____

■ Questions

1. The potential benefits from effective project management are:

_____

_____

_____

_____

_____

2. Describe how the use of a project management methodology may benefit an organization, impact organizational success, and assist in the achievement of strategic objectives.

_____

_____

_____

_____

3. List the factors that are commonly known as competing demands.

4. What factors may be considered to effectively and reliably indicate successful completion of a project?

1.

2.

3.

4.

5.

6.

7.

8.

5. In many organizations the organizational structure itself may create internal communications barriers, management gaps, functional gaps, and operational islands. These gaps and barriers may result in conflicts, inefficiencies, and lower productivity. Describe some of the causes of these gaps and how the gaps can be effectively minimized.

6. Define the term *stakeholder* and provide examples of the stakeholders associated with projects you are engaged in.

7. Describe the purpose or meaning of the term "project management."

8. The five major project management process groups are:

9. Describe at least three factors that might influence a customer's perception of project success.

10. Explain why establishing a good daily working relationship with functional managers and/or line managers is important to project success and is a critical responsibility of the project manager.

11. Explain the term *integration* as it relates to project management and describe the major roles and responsibilities of the project manager during project planning and execution.

12. Define the typical roles of the functional manager and describe at least three challenges that a functional manager may encounter in an organization that engages in the management of multiple projects.

13. How can a project manager ensure that he or she establishes and maintains an effective and collaborative relationship with the project sponsor or project executive?

_____

_____

_____

_____

14. Causes and effects. Although all projects are unique, there are many common issues that are experienced by project managers and teams. Referring to the list of causes and effects, match two causes (only two) to each effect and explain why the two were chosen.

Causes

a. Top management does not recognize the activity as a project
b. Too many projects going on at the same time
c. Impossible schedule commitments
d. No functional input into the planning phase
e. No one person responsible for the total project
f. Poor control of design changes
g. Poor control of customer changes
h. Poor understanding of the project manager's job
i. Wrong person assigned as project manager
j. No integrated planning and control
k. Company resources are overcommitted
l. Unrealistic planning and scheduling
m. No project cost accounting ability
n. Conflicting project priorities
o. Poorly organized project office

Effect	Explanation
1. Late completion of activities Cause #1: _____ Cause #2: _____	
2. Cost overruns Cause #1: _____ Cause #2: _____	

(*Continued*)

Effect	Explanation
3. Substandard performance Cause #1: _____ Cause #2: _____	
4. High turnover in project staff Cause #1: _____ Cause #2: _____	
5. High turnover in functional staff Cause #1: _____ Cause #2: _____	
6. Two functional departments performing the same activities on one project Cause #1: _____ Cause #2: _____	

15. In addition to the roles of integrator and coordinator, describe other roles and responsibilities the project manager is expected to perform:

_____

_____

_____

_____

_____

_____

16. Project managers are often challenged to influence functional managers who may have multiple projects to deal with and may be forced to compete with other project managers in the same organization for resources. Explain how the project manager can improve relationships with functional managers and influence them to provide the necessary resources to achieve the project manager's objectives.

_____

_____

_____

_____

17. The relationship between the project manager and the project sponsor or executive is a critical factor and can mean the difference between project success and failure. What actions can be taken by the project manager to ensure that a strong and supportive relationship exists between the project manager and the project sponsor?

18. According to the *PMBOK® Guide*—Sixth Edition, a project is defined as:

19. List the three components of the PMI® Talent Triangle.

20. In any organization that accepts and utilizes a project management methodology, the project manager is often faced with several obstacles that must be overcome to achieve the desired performance and business benefits. Describe at least three of these obstacles and provide suggestions for overcoming them.

21. The project manager is responsible for coordinating and integrating activities across multiple, functional lines. The integration activities performed by the project manager include:

22. What is the ultimate role of the project sponsor?

Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The information in Chapter One Is most closely related to the following topics in the *PMBOK® Guide,* Sixth Edition: Introduction, Foundation Elements, Organizational Strategies, Role of the Project Manager, Project Life Cycle, Project Integration Management

An important item to remember is the Project Management Framework, as described in the *PMBOK® Guide*—Sixth Edition, which defines a total of 49 project processes that describe the activities generally found throughout a project's life cycle. These processes are organized into 10 knowledge areas and comprise the five process groups: Initiating, Planning, Executing, Monitoring, and Closing.

The 10 knowledge areas of project management are *Integration Management, Scope Management, Time Management, Cost Management, Risk Management, Human Resources Management, Quality Management, Procurement Management, Communication Management,* and *Stakeholder Management.* These knowledge areas and the sub-processes associated with them are connected through the "system" of project management and are all *integrated, interrelated,* and *interdependent.* There are no independent components of a project and changes to the elements of one knowledge area, such as Scope Management, as described in the *PMBOK® Guide,* may, in some way, impact any of the other knowledge areas. Each knowledge area and its detailed sub-processes are part of the total system of project management.

Important Terms to Remember

Change Control Board A team or group designated or empowered to review and determine the value of a change and to approve or deny change requests.

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Close project Utilizing the project management methodology, Project Management Information System (PMIS), and the expert judgment of the functional managers to complete the project and perform all final administrative procedures. The processes required to obtain formal acceptance and completion of project files for reference as historical information.

Configuration management Process that will ensure that configuration changes (changes to features, functions, dimensions, physical characteristics) are managed and approved to prevent or reduce the risks of additional cost and scope changes, or other impacts to the project.

Constraints and assumptions Constraints are the limitations the project manager and team must operate within. Examples: predetermined schedule and budget, limited resources. Assumptions in the project management context are items that, for planning purposes can be believed to be true, real, or certain. Assumptions are not grounded in fact and should be verified.

Enterprise environmental factors Internal and external factors may influence the project outcome and must be considered by the project manager and team during project planning and implementation such as the organizational culture, industry standards, resource availability and capability, risk tolerance, and political environment.

Historical records Data and information gathered during project planning and execution and recorded for legal purposes, references, and lessons learned.

Integrated change control The 10 knowledge areas are managed in an integrated manner with an understanding that a change in one area can impact any or all of the other knowledge areas. Example: A change in the scope of a project may impact the schedule and budget. A change in quality requirements may impact the budget and the human resource requirements. It is recommended that the project team consider the impact of the change before implementing the change by using a predefined change control process. A change control process generally has three major objectives: Obtain approval for the change, determine if change has occurred through comparison of the baseline with actual results, and determine when and how to introduce the change to minimize the impact on ongoing operations.

Monitor and control project work Agreed upon processes for managing work performance, managing change requests, utilization of earned value techniques, identifying corrective and preventive actions.

Organizational process assets Standard policies and procedures established by an organization and expected to be followed such as safety procedures, quality assurance reviews, and project health checks. Process assets may also include available planning templates, financial controls, change control procedures, and risk management processes.

Organizational strategies How an organization will achieve its goals and objectives. A formal project management process may be an organizational strategy. Consider how your project impacts or supports your organization's objectives. Make sure you can link your project to the organizational goals.

Preliminary project scope statement This document describes the project and the desired objectives at a very high level. The preliminary scope statement includes the definition of the project, the products and services to be delivered, major milestones, and acceptance criteria. A final project scope statement is developed during the *PMBOK Guide*® "define scope" process.

Progressive elaboration The process of moving forward incrementally and adding more detail to the project plan.

Project charter The initial project document that authorizes the project and the use of resources. Assignment of the project manager and level of decision-making authority of the project manager is also included in a project charter.

Project management information system Any system or group of systems working together to gather, store, and distribute information about your project. Examples: time-reporting system, accounting system, project software.

Project management plan All of the actions necessary to integrate and coordinate the entire project effort, including any subsidiary plans that have been established by the project team. The project plan guides the team during project execution and is expected to change as the project is progressively elaborated.

Project plan The approved document that provides the baseline for executing and managing the project.

SMART objectives Well-defined objectives are considered to be Specific, Measurable, Attainable, Realistic, Time bound.

Stakeholders People and/or organizations directly involved in or impacted by the project. Consider who the key stakeholders are and also other stakeholders who may view your project as a threat or an obstacle to their projects or personal objectives. Determine who the negative stakeholders are and what risks they may introduce to the successful completion of your project. Develop strategies for dealing with your project stakeholders.

Subsidiary plans Plans created to support the higher-level project management plan. An example of a subsidiary plan is the Change Control Plan—the control processes in place to manage other knowledge areas such as scope change control, schedule change control, cost change control, and so on. The total or *Integrated Project Management plan* may include several subsidiary plans depending on the complexity of the project. Other examples of subsidiary plans: Human Resources Plan, Quality Plan, Safety Plan.

Integrated planning includes many processes, so be prepared to answer questions that may include several different processes related to a project situation. Become familiar with all process groups, and make sure you are familiar with the inputs, tools, techniques, and outputs of each process described in the *PMBOK® Guide.*

PMI emphasizes the importance of planning. Proper planning requires effective communication among the team and sound leadership from the project manager. The result of effective and comprehensive planning is a project team that is more

completely informed and has a strong understanding of the larger, integrated purpose and objectives of the project.

Additional tips and practice items for the PMP® exam are included in each chapter of the text book and in Chapter 22 this workbook, "PMP® and CAPM® Exam Review."

▶ Answers to Questions and Exercises

■ Exercise

1. Identify and communicate the benefits of project management.
2. Establish a project kickoff process and project-planning methodology.
3. Set objectives clearly using SMART criteria.
4. Establish a performance measurement system using earned value management.
5. Establish guidelines and criteria for selection of a project manager. Emphasize soft skills as well as managerial skills.
6. Establish expectations with executives at project start-up.
7. Communicate project sponsor support and executive support to the team. Understand line manager priorities. Create a positive working relationship.
8. Prepare and communicate acceptance criteria. Communicate the scope statement.
9. Obtain sponsor and executive support, establish clear objectives, and develop a communications plan.
10. Reward and recognize project teams and develop team-building activities.
11. Create meeting guidelines. Meet only when necessary. Define the meeting purpose, create an agenda, and manage time effectively.
12. Develop a risk management plan and a process for managing issues.
13. Use earned value management and establish success metrics. Conduct reviews after each project phase.
14. Identify a software application that will be accepted and used by project managers. Provide the appropriate training.
15. Establish a project management office, require documentation of lessons learned, and ensure that management support is visible.

■ Questions

1. Clear identification of functional responsibilities to ensure that all activities are accounted for, regardless of personnel turnover.
   - Minimizing the need for continuous reporting
   - Identification of time limits for scheduling

- Identification of a methodology for trade-off analysis
- Measurement of accomplishment against plans
- Early identification of problems so that corrective action may follow
- Improved estimating capability for future planning
- Knowing when objectives cannot be met or will be exceeded

2. Controls changes, provides consistent approach, improves quality, reduces risk, and improves estimating ability.
3. Cost, schedule, scope, quality, risk, resources.
4. Customer satisfaction
   employee satisfaction
   minimal changes to the scope of work
   minimal conflicts among team members and organization units
   add-on business
   no disruption of operations
   executive management recognition of the project team
   fully operational and accepted product or service deliverables
5. Functional units may develop their own culture, management hierarchy may affect the ability to communicate, protection of area of responsibility (turfism), competition among managers, different priorities, unclear organizational objectives, failure to communicate strategic goals, inappropriate organizational structure, organizational culture, business unit culture.
6. Anyone directly involved in the project or in some way affected either positively or negatively as a result of the project. Stakeholders generally include the project manager, project team, project sponsor, suppliers, end users, the customer, and many others.
7. The application of knowledge, skills, and tools necessary to achieve the project's requirements.
8. Initiating, planning, executing, monitoring and controlling, closing.
9. Quality, availability of the project manager, timeliness of status reporting, reliability of the product or service deliverable, safety, minimum or mutually agreed upon scope changes, no impact or interruption to the work flow of the organization. Also considered may be aesthetic appearance or aesthetic value of the deliverable, achievement of objectives, achievement of benefits expected, achievement of the value expected, and also possibly ease of use.
10. The project manager depends on the functional managers to provide the appropriate resources and to ensure that the work is performed correctly. A good relationship will minimize conflict and increase the likelihood of functional manager willingness to work on future projects with the project manager.
11. All project components and planning processes are interrelated. The project manager must coordinate and integrate project activities across organizational boundaries. The project manager ensures that functional units communicate effectively.

12. The functional manager provides the resources and technical expertise. Challenges include different priorities among project managers and projects, managing the demands of multiple project managers, limited resources, unreasonable time frames, and internal politics.
13. Establish expectations at the start of the project. Include communications requirements, escalation procedures, planning processes and methodology, and clear objectives.
14. There are many possible answers and solutions to the causes. This exercise is intended to emphasize the importance of identifying potential project problems and encourage proactive thinking and action. Any combination of causes may affect the outcome of the project.
15. The project manager is considered an integrator and coordinator for all major project activities. The project manager is held accountable for successful completion of the project. The project manager is a liaison between the project team and the project sponsor or executive steering committee. Other roles include team builder, conflict manager, coach, mentor, facilitator, leader, and motivator.
16. The project manager can develop better relationships with the functional managers through listening and understanding the priorities of the functional managers, their work environment, and issues associated with the functional manager's position.
17. Establish expectations clearly and intentionally between the project manager and the project sponsor or executive.
18. A project is a temporary endeavor undertaken to create a unique product, service, or result.
19. Technical project management, leadership, and strategic and business management skills.
20. Project complexity: Ensure that a detailed project scope statement is prepared. Organizational structure: Develop working relationships with the leaders/managers of the organizations you expect to engage in your project activities. Changing requirements: Establish a well-defined change process and ensure that it is observed. Other obstacles include changing technology, internal politics, and organizational silos.
21.
    - Integrating the activities necessary to develop a project plan
    - Integrating the activities necessary to execute the plan
    - Integrating the activities necessary to make changes to the plan
22. Provide behind-the-scenes assistance to project personnel for projects both internal to the company and external.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in this chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER TWO

Project Management Growth: Concepts and Definitions

This chapter focuses on the general evolution of project management from the 1940s through today's business environment. Formal project management has its roots in the 1940s, particularly in the area of military and complex weapons systems. These projects consumed enormous amounts of resources, and today we refer to very large implementations as "mega" projects. In the past four decades, project management has grown from a means to achieve successful completion of small, intermediate, and large complex projects or endeavors (sometimes referred to as engagements) to a key element in strategic planning. The use of powerful technology-based tools, enterprise-wide methodologies, and processes to control activities and manage people and resources have become an accepted part of business management. The project life cycle, systems thinking, and the influence of project management processes on an organization's critical success factors have had a significant impact on overall organizational performance.

Glossary of Terms

General systems management When applied to organizational structure, it is a management technique designed to cross many organizational disciplines. For example: finance, manufacturing, engineering, and marketing. Systems management refers to the need to understand how each component of a system affects the operation of the entire system.

Mature project management The implementation of a standard methodology and accompanying processes that creates a high probability of repeated successes. Maturity in this context refers to a "culture" of project management where project processes are embedded in normal business practices.

Product scope The features and functions that characterize the final project deliverable. This includes dimensions, physical characteristics, and the complexity of the product. Product scope is often displayed using a PBS, product breakdown structure.

Program A group of related projects managed in a coordinated way to obtain benefits and control that is not available from managing them individually. Programs

may include elements of related work outside the scope of the discrete projects in the program. Projects are normally the first-level subdivision of a program. Programs are associated with higher-level organizational objectives and benefits realization. Programs generally have a longer overall duration than a project and in some cases are related to the support of ongoing organizational activities.

Program management Focuses on the interdependencies between component projects at the program level to determine the optimal approach for managing them. This includes managing risks, resolving constraints, change requests, and other factors across multiple projects in the program.

Project management methodology A repetitive process, approved by executive management, and used on all projects within an organization to increase the likelihood of achieving project success, project management excellence, and maturity.

Project scope The work that must be accomplished to produce the final project deliverable and to achieve all specified features and functions. The deliverable can be a product, service, or other result as defined by the customer.

Stage-gate process Stages are a group of activities that can be performed either in series, in an overlapped manner, or in parallel based on the magnitude of risks the project team can endure. Gates are structured decision points at the end of each stage. These decision points are used to assess project performance and determine if corrective action is necessary. Also known as phase exits and kill points or go and no go decision points. These points can change from project to project in order to satisfy the customer's requirements.

System A group of elements, either human or nonhuman, that is organized and arranged in such a way that the elements can act as a whole toward achieving some common goal or objective.

► Activities, Questions, and Exercises

Refer to Chapter Two of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information and assistance in completing each exercise. The following questions and exercises are associated with the knowledge area of the *PMBOK® Guide* Sixth Edition: 1.2: Foundation Elements.

Review each of the following questions or exercises and provide the answers in the space provided.

1. If you were assigned the task of developing a set of questions to assist an organization in determining if there is a need for a formal project management process, what questions would you ask?

   _____

   _____

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_____

_____

2. As project management evolved, it became apparent to many executives that a formal project management process might not provide benefits significant enough to justify the expense associated with developing a formal methodology. In many organizations, project management was considered as overhead. The driving forces of rapid technology changes, the increasing complexity of projects, and the increased demand for resources with specialized knowledge all contributed to the need for an effective project management methodology. How can a project management methodology assist in managing and resolving issues related to these driving forces? What benefits are obtained through the use of a project management methodology? Should some flexibility be given to the project manager in the use of the methodology? What other driving forces might influence the decisions associated with establishing a project management methodology in an organization?

_____

_____

_____

_____

3. Every organization encounters internal and external obstacles that may impede the achievement of success. For each obstacle listed, explain how a properly and effectively implemented project management methodology can overcome the obstacle.

Obstacle	Project management method, factor, or approach that may be used to respond to and overcome the obstacle
a. Resource shortages	_____
b. Increasing costs	_____
c. Poor quality of work	_____
d. Technology changes	_____
e. Competition	_____

Knowledge Note

Project success depends on setting objectives, establishing plans, organizing resources, staffing the team appropriately, establishing controls, and motivating the team. In addition, an understanding of the business value expected to be achieved at project completion will impact the perception of project success. Remember the importance of addressing the many competing demands in the project environment that may challenge the ability to achieve success.

4. Project management has been shown to significantly improve the overall performance of an organization. There are many approaches to managing projects, but providing the project manager with total integrative responsibility will result in some very specific advantages. Describe these advantages.

_____

_____

_____

5. For each of the following items in the life cycle phases for project management maturity, provide a recommendation for addressing and resolving the issue that will allow an organization to progress toward achieving project management maturity.

a. *Life cycle phase*: Embryonic *Issue*: Recognizing the need

Recommendation: _____

_____

_____

b. *Life cycle phase:* Executive management acceptance *Issue:* Executive understanding of project management

Recommendation: _____

_____

_____

c. *Life cycle phase:* Line management acceptance *Issue:* Line management support

Recommendation: _____

_____

_____

d. *Life cycle phase*: Growth phase *Issue*: Development of a project management methodology

Recommendation: _____

_____

_____

e. *Life cycle phase*: Maturity phase *Issue:* Developing an educational program to enhance project management skills

Recommendation: _____

_____

_____

6. The utilization of project management within an organization will vary depending on the type of business the organization is involved in. An organization may be project-driven, use a hybrid approach that combines elements of project management with operations, or be non-project-driven when projects are few and are generally used for internal process and operations improvements and changes. Review the list of characteristics that follows and select the appropriate industry classification for each (project-driven, hybrid, or non-project-driven).

Characteristic	**Classification**
a. Project manager has P&L responsibility	_____
b. Primarily production driven but with many projects	_____
c. Emphasis on new product development	_____
d. Income comes from projects	_____
e. Long life cycle products	_____
f. Large brick walls (functional structure)	_____
g. Multiple career paths	_____
h. Marketing-oriented	_____
i. Short product life cycles	_____
j. Project management is a recognized profession	_____
k. Very few projects	_____
l. Need for rapid development process	_____
m. Profitability from production	_____

7. To complete a project successfully a project manager is generally held accountable for a specific set of tasks, activities, and behaviors. Place a check next to each item that is typically associated with a project manager's role during the project life cycle.

Set objectives	_____
Estimate activity costs	_____
Organize resources	_____
Estimate activity duration	_____
Establish plans	_____
Motivate personnel	_____
Provide staffing	_____
Define how tasks will be done	_____
Issue directives	_____
Control each project task	_____
Remain flexible	_____
Establish project controls	_____

8. Few projects are completed without making decisions about trade-offs. This means that occasionally priorities will change, depending on project performance and

conditions that surround the project, to achieve the most desirable result. List three competing demands that are generally considered when making trade-off decisions during project execution to achieve an acceptable level of success.

1. _____

2. _____

3. _____

9. Critical Success Factors (CSF) identify what is necessary to meet the customer's desired performance levels for project deliverables. Another form of success measurement is known as Key Performance Indicators (KPI). CSFs and KPIs are used to establish expectations and measurements of success for the work that must be performed to complete a project. CSF and KPI should be established early in project planning and should be communicated to the key stakeholders at project start-up. Following is a list of typical CSFs and KPIs defined during project planning and monitored during implementation. In the spaces provided, identify the primary factors that are most commonly used to measure project success. What additional success factors and KPIs can be used as measurements of success?

Examples of Critical Success Factors and Key Performance Indicators (quantifiable gauge that an organization uses to measure its performance in terms of meeting its critical success factors):

CSF—Use of a project management methodology

CSF—Establishment of control processes (cost, schedule, quality, etc.)

CSF—Use of interim or phase metrics—progress, trends, variances

CSF—Quality of resources assigned versus resources that were planned

CSF—Client involvement and feedback

KPI—Call center metrics: waiting time, calls dropped

KPI—Quality: Number of defects per 1000, cost per defect repair, cost of product returns, number of product returns

Success Factors (Consider industry, strategic, and environmental factors)	
Primary	**Secondary**

10. Quantitative and qualitative failure. Occasionally projects become troubled and sometimes fail. There are several contributing factors to project failure. Some factors are quantitative and are directly associated with metrics and procedures will other are less tangible and qualitative. Review each of the following items and identify which items are considered quantitative and which are considered qualitative failures:

Quantitative = 1 Qualitative = 2

Ineffective planning _____

Poor motivation _____

Poor productivity _____

Ineffective scheduling _____

Ineffective estimating _____

Poor morale _____

Project objectives changing or not defined clearly _____

Poor human relations _____

Lack of control processes _____

Lack of employee involvement and commitment _____

No functional management commitment _____

Conflicting priorities _____

11. Explain the stage-gate process and why it is necessary during project planning and execution.

_____

_____

_____

_____

12. What are the four common decisions associated with the gate-keeping process?

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

13. Explain the difference between a product life cycle and a project life cycle.

_____

_____

_____

_____

14. What is the generally accepted reason why projects should be managed using a defined project life cycle?

_____

_____

15. Review each of the following characteristics of an effective project management methodology and explain why these characteristics are important to achieving project success.

Characteristic	**Importance**
Example: Standardized planning, scheduling, and cost control techniques	Provides consistency in preparing project plans and increases the ability to monitor and control project performance
Use of templates	_____
Standardized reporting format	_____
Use of standardized life cycle phases and end of phase reviews	_____
Flexibility of application to all projects	_____

16. It is important for project managers to be prepared to manage resistance to the application of a project management methodology. Explain why each of the following business units within an organization may resist the introduction of

a project management methodology. Consider how you may respond to resistance in each case.

Business unit or entity	Reasons for resistance	Responses or actions that will minimize resistance
a. Sales and Marketing		
b. Operations		
c. Finance and Accounting		
d. Procurement		
e. Human Resources		
f. Manufacturing		
g. Engineering		

17. How would you describe project portfolio management and what are the major benefits associated with portfolio management?

18. What are the major differences between a project, a program, and a portfolio?

19. Describe the differences between the terms "product scope" and "project scope."

20. Describe the typical factors that contribute to project failure.

21. Under what conditions would executive management or a steering committee decide to cancel a project?

22. What are the characteristics of a strong and well organized project methodology?

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

■ Project Management

Why do we need project management?

- To determine roles and responsibilities
- To identify and establish priorities
- To establish and manage realistic deadlines and schedules

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- To determine and assign accountability and authority
- To ensure proper documentation of work activities (determining what documentation is needed and to avoid over documentation)
- To provide a common methodology within an organization that will improve efficiencies in resource management
- To provide effective and timely and appropriate status and communications to each stakeholder
- To manage multiple projects more effectively
- To reduce rework and redundant work
- To capture and share lessons learned

Important Terms to Remember

Interpersonal skills Interpersonal relationships are key elements to the success of any project. Project managers must utilize effective communication, the ability to influence project teams and functional groups to "get things done," leadership, motivation, conflict management, negotiation, and problem solving to manage teams and achieve project objectives.

The project environment The project manager must maintain an awareness of the cultural and social environment, the international and political environment, and the physical environment when planning and implementing projects. These include such factors as education, ethnicity, economics, demographics, religion, time zone differences, regional holidays, and the physical surrounding that may affect how the project is managed. These elements are associated with the domain of project management known as "professional responsibility." Professional responsibility is embedded in the work activities and the role of the project manager. (Note: Professional and social responsibility were previously defined by the PMI as the sixth domain that project managers are held accountable for. The current domains are Initiating, Planning, Executing, Monitoring and Controlling, and Closing.)

Progressive elaboration Proceeding in steps and adding more detail as the project moves forward.

Phases and project life cycles We divide projects into phases to provide better management control. Project life cycles generally define what technical work will be done in each phase, when a deliverable is required, who will be involved in each phase, and how each phase will be controlled. The project life cycle may also be used to define how a phase and the associated deliverables will be approved.

Cost and staffing At the start of a project cost and staffing are generally low. As the project progresses, the cost and the required staff will increase through each progressive phase as a result of the increase in the number of activities. Work activities will peak during the intermediate phases, and then drop off rapidly as the project reaches closure.

Risk and uncertainty Generally, risk and uncertainty are considered to be at the greatest level during the start of the project but the certainty of project success progressively

improves through each phase (if proper planning continues and the appropriate and necessary control processes are in place).

Project-driven organizations These organizations derive their revenue from performing projects for other organizations through contractual agreements or they are organizations that have adopted a management by project approach using systems that have been established for tracking and reporting on multiple, simultaneous projects. Also referred to as project-based.

Non–project-driven organizations These organizations do not have the management systems in place to manage and support projects. They may have subunits that operate as project-based organizations but the absence of project-oriented systems at the enterprise level and the type of organizational structure in place may make project management more difficult. (Also referred to as non-project-based.)

► Answers to Questions and Exercises

1. How often are projects completed on time, within budget, and according to performance specification? How effective is the communication between functional units? What factors contribute to project failure? How can project management be used to improve overall performance? What is the level of customer satisfaction regarding completed projects? How are projects selected? How can resource management be improved?
2. Prioritization of projects. More effective management of changes. More effective utilization of available resources. Improved coordination between functional units.
3. a. Prioritization of projects, resource planning, effective schedule development.
   b. Change control process, cost estimating techniques, risk management.
   c. Establish a quality policy, schedule reviews and inspections, plan for requirements management.
   d. Phase end reviews, scope management, change control and configuration management.
   e. Quality control, cost management, effective planning, trade-off analysis.
4. Total accountability is assumed by a single person. Project rather than functional dedication. Coordination across functional interfaces can be achieved. Improved utilization of integrated planning and control processes.
5. a. Explain the benefits of repeatable processes, identify areas for improvement in schedule, cost and requirements management.
   b. Provide supporting information about project successes and the use of best practices.
   c. Obtain and communicate management support to functional managers, explain the benefits of project management, acknowledge the needs of the functional managers.

d. Establish a PMO, standardize methods, establish enterprise wide processes, and provide project management training.

e. Establish project management as a career path, continuous improvement through reviews and feedback, provide training to all levels of employees, maintain management support and visibility, document lessons learned.

6. **a.** Project-driven
b. Hybrid
c. Hybrid
d. Project-driven
e. Non-project-driven
f. Non-project-driven
g. Project-driven
h. Project-driven
i. Hybrid
j. Project-driven
k. Non-project-driven
l. Hybrid
m. Non-project-driven

7. Set objectives, organize resources, establish plans, motivate personnel, provide staffing, issue directives, remain flexible, and establish project controls.

8. Cost, time, scope.

9. Primary: Within schedule, within cost, within quality requirements, accepted by the customer.

Secondary: Follow-on work, customer authorizes use of the name for references, minimum or mutually agreed upon scope changes, no disturbance of normal operations, within safety requirements, managed fairly and ethically, supported corporate strategies, maintained corporate reputation or brand name, within government regulations.

10.

Ineffective planning	1
Poor motivation	2
Poor productivity	1
Ineffective scheduling	1
Ineffective estimating	1
Poor morale	2
Project objectives changing or not defined clearly	1
Poor human relations	2
Lack of control processes	1
Lack of employee involvement and commitment	2
No functional management commitment	2
Conflicting priorities	2

11. The stage-gate process establishes reviews at the completion of each phase to determine if the project should continue on to the next phase. Also used to determine where corrective action may be necessary to return project performance to acceptable levels.

12. Proceed to the next phase based on objectives, revise objectives and then proceed to next phase, correct variances before moving to the next phase, cancel the project based on current status and other factors.
13. The project life cycle includes the work required to produce the product or the project. The project life cycle ends when the product has been delivered. The product life cycle includes the R&D, project life cycle, operations and maintenance, and eventual termination or salvage of the product.
14. More effective manageability and control.
15. Use of templates: More efficient use of time, consistency.

    Standardized reporting format: consistency, facilitates analysis.

    Use of standardized life-cycle phases: Consistency in planning and control.

    Flexibility of application to all projects: All projects are unique. Some processes may not apply to all projects.
16. a. Potential loss of power and position with the customer, credit given to the project manager. Potential for the project managers to become associated with the marketing function. Customer has more contact with the project manager. Fear of loss of credit for sales.

    b. Improper handoff of the deliverable. The need for additional training when new technology is involved. Changes in responsibility. Use of operations resources to perform project work.

    c. Development of independent project accounting systems, loss of control.

    d. Bypassing of the established processes.

    e. Potential additional workload, new job descriptions, more training requirements.

    f. Potential loss of experienced resources to the project.

    g. May not agree with the methodology, may not support the planning process, may perceive project management as overhead.
17. A collection of projects and programs and other work that are grouped together to facilitate that work to achieve business objectives.
18. Projects have defined objectives and the planning details are progressively elaborated through a project life cycle. Programs are broader in scope and provide greater benefits through coordination of several related projects. Portfolios have a business scope that will change as strategic goals of the organization change
19. Project scope defines the work that must be accomplished to produce a deliverable with specified features and functions. Product scope defines the features and functions that characterize the deliverable. The complexity of the product scope will define the work required to produce the product.

20. Ineffective planning, ineffective scheduling, ineffective estimating, ineffective cost control, failing to follow process, poor communications, poor requirements definition, poor scope description, ineffective leadership, poor coordination and integration of project activities, no functional commitment, conflicting priorities
21. Additional risks that have been identified, resource availability, organizational capability, market shifts, mergers, changes in technology, changes in the strategic goals of the organization.
22. A specific and recommended level of detail, use of templates, standardized planning, scheduling and control techniques, standardized reporting format, flexibility for application to all projects, standardized life cycle phases, accepted by the entire organization.

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Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER THREE

Organizational Structures

There are many factors that influence decision makers regarding the type of organizational structure that would be most appropriate for their specific business purpose. These factors include the strategic objectives of the organization, management span of control, specialization capabilities, physical locations, and the path for management escalations and approvals. The organizational structure and how departments, business units, human resources, functional responsibilities, and job assignments are arranged, will affect the project planning process and will influence how project communication will be conducted. The authority of the project manager is also directly associated with the type of structure selected by executive decision makers. An understanding of organizational structure is essential for project managers to successfully negotiate with, and influence the stakeholders who control the functional entities, including operations, where project resources may be obtained.

Organizational structures vary by company and create unique challenges for the project manager. The business environment has gone well beyond the familiar Functional, Matrix, and Projectized structures. Project managers are now working within multidivisional organizations with no project management centralization and where replication of functions may exist. Many organizations are largely virtual, employ the use of Project Management Offices (PMOs) or are a composite or hybrid type of structure in which project responsibility and authority levels are mixed and sometimes ambiguous. The project manager must therefore develop and continually enhance a set of key competencies as described in the PMI® Talent Triangle, which includes Technical Project Management, Leadership, and Strategic and Business Management

Glossary of Terms

Accountability To be answerable for the satisfactory completion of a specific assignment. The project manager is typically held "accountable" for project success (or failure), but sometimes accountability is shared with the functional managers that provide the resources.

Authority The power granted to individuals (possibly by their positions) that enables them to make decisions. This is also referred to as legitimate or formal power.

Customer/user The person or organization that will use the final product or service provided as a result of the project. Sometimes referred to as "end user"

Organizations Groups of people and their associated resources and management personnel who must coordinate their assigned activities in order to meet specific objectives. Organizations are generally formed around a set of goals and the division of labor and span of control.

Organizational structures There are several types of organizational structure:

Organic or *simple:* Flexible work groups, little to no project manager authority, the project manager is a part-time position, very little resource availability

Functional: Also known as chimney, smoke stack, or silo structure. In this structure there is generally one manager overseeing the work and the type of work that is associated with a specific skill or expertise. Examples: accounting, marketing, engineering, manufacturing.

Hybrid: Generally a mix of several types of structures depending on the needs of the organization. Example: The organization may utilize matrix structures for some projects and utilize a projectized structure for high priority projects.

Matrix: This type of structure is designed to maximize the use of resources by assigning resources to multiple functions. This creates an environment where employees may report to two or more managers. In this type of structure, there will be horizontal as well as vertical channels of communication and, in some cases, intense negotiation for resources between project managers and functional groups. The matrix structure includes three sub-structures: Weak Matrix, Balanced Matrix, and Strong Matrix

Multidivisional: This type of structure is associated with product development, program management, portfolios, geographic regions, and customer type. Project manager authority is very low, and overall management responsibility is assigned to a functional manager.

Pure project or projectized: Also referred to as "project-oriented." Work groups are arranged by project with a specific project manager assigned. The project manager has near total authority and accountability for the project. All project staff and personnel report directly to the project manager.

Virtual: Distributed work groups in a network structure. The project manager may have low to moderate authority. Team members may be assigned full or part time

Project Management Office (PMO): An organizational unit established to centralize and coordinate the management of projects under its domain. A PMO will generally establish organizational guidelines for managing projects. This includes methodologies, best practices, policies, procedures, and templates.

Performing organization The business unit, enterprise, or entity whose employees are most directly involved in doing the work of the project.

Portfolio A collection of projects or programs and other work that are grouped together to facilitate effective management and the achievement of strategic objectives. Portfolio Management is defined as the centralized management of one or more portfolios.

Project coordinator This position is generally assigned by a higher-level manager such as a division manager, business unit vice president, or the CEO, and reports to that manager. The position is granted some authority for decision making.

Project expeditor Generally found in a functional organizational structure. The expeditor is a type of staff assistant with no actual authority for decision making. This position attempts to communicate information across functional boundaries.

Responsibility The obligation incurred by individuals in their roles in the formal organization to effectively perform assignments.

Transitional management The art and science of managing the conversion period from one organizational design to another. Transitional management necessitates an understanding of the new goals, objectives, roles, expectations, and employees' fears.

► Activities, Questions, and Exercises

Refer to Chapter 3 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided. The following questions and exercises are related to the *PMBOK® Guide*—Sixth Edition, Introduction and Chapters 1, 2, and 3.

Review each of the following questions or exercises and provide the answers in the space provided.

1. For many years most organizations utilized a hierarchal structure for managing operations and personnel. This traditional structure was based on divisions, departments, and functional units. Describe the advantages and disadvantages of the traditional or classic organizational structure. (The traditional structure is generally associated with several levels of management in a specific hierarchy with many levels between the lowest position and highest position.)

   Advantages: _____

   _____

   _____

   _____

   _____

   Disadvantages: _____

   _____

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_____

_____

_____

2. Which one of the following organizational structures would provide the most effective platform for building a high-performance project team? Provide the rationale to support your answer.

____ Functional ____ Matrix ____ Projectized

Rationale: _____

_____

_____

_____

_____

_____

3. Match the type of structure to the correct characteristics or descriptions.

Functional	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized or Pure Project
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____
____	____	____	____	____

Characteristic/description

1. Project manager has little to no authority
2. Project expeditor
3. Project manager has some authority
4. Project manager has high to total authority
5. There is equal authority between project manager and functional manager.
6. Project manager has a moderate to high level of authority
7. Project coordinator
8. One clearly defined manager
9. Staff members are grouped by specialty.
10. Project work is done independently.
11. Team members are often co-located.

12. Resources report directly to the project manager.
13. The project manager has no control of the project budget.
14. The project manager has full control of the project budget.

Remember

Project success in a matrix structure is more likely to be achieved if there is a good working relationship between the project manager and functional managers. Strong coordination and effective communication between the functional groups is also essential. This will help to ensure that project goals and objectives are understood at the functional and project level. The project manager works within the organizational culture and attempts to create the integrative environment and cross–organizational relationships that will drive project success.

4. **Matrix organizational structure.** Consider the matrix organizational structure. Describe the primary advantages and potential disadvantages if this type of structure is selected by an organization.

   Advantages: _____

   _____

   _____

   _____

   Disadvantages: _____

   _____

   _____

   _____

5. Explain the difference between authority, responsibility, and accountability:

   Authority: _____

   _____

   _____

   Responsibility: _____

   _____

   Accountability: _____

   _____

   _____

6. Explain the term "enterprise environmental factors" and provide examples.

7. Define the term "stakeholder" and provide examples of stakeholders that are typically associated with projects.

8. Why is organizational culture considered to be an "enterprise environmental factor"?

9. Complete the following table by describing the influences and relationships between the project characteristics and the organizational structure: Refer to the *PMBOK® Guide*—Sixth Edition, "2.4.4 Organizational Structure Types."

Project Characteristic	Functional Structure	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized
Project manager authority	Little or none				
Resource availability					
Who controls the project budget					

Project Characteristic	Functional Structure	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized
Project manager role					
Project management administrative support					

10. What methods can be used to improve the coordination of work flow between functional units without changing the organizational structure?

11. What are the major disadvantages of using a pure project or projectized organizational structure?

12. What are the major disadvantages of the matrix type organizational structure?

13. Organizational structures will vary depending on the needs of the organization. It may be necessary to establish and manage a project in a manner that is different from how the organization is structured. What factors should be considered when determining the appropriate structure for managing a project?

14. Describe the characteristics of each of the following PMO structures.

a. Supportive _____

_____

b. Controlling _____

_____

c. Directive _____

_____

15. Describe the three elements of the PMI® Talent Triangle

_____

_____

_____

_____

_____

_____

_____

16. For each of the following, indicate whether it is a function of leadership or management. (Refer to the *PMBOK Guide*—Sixth Edition, 3.4.5).

Administrate _____
Develop the team _____
Control _____
Focus on systems and structure _____
Encourage innovation _____
Long-range vision _____
Ensure things are done right _____
Challenges the status quo _____

17. Review each of the following and determine which are enterprise environmental factors (EEF) and which are organization process assets (OPA).

Organizational culture _____
Infrastructure _____
Risk data _____
Risk appetite _____
Lessons learned _____
Employee capability _____
Policies and procedures _____
Marketplace conditions _____

18. Determine if the answer statements are true or false.

Jeremy is one of the best engineers in the company and has come up with an idea for a new revenue-generating project. Everyone in the company knows that Jeremy is the expert in the field and trusts his decisions. There will be eight people assigned to the project team, and most of them will be part time except for Jeremy who will be the full-time project manager.

a. The best organization form for this project would be a weak matrix.

☐ True
☐ False

b. The employees will need to get permission from their functional managers for all decisions on the project.

☐ True
☐ False

c. In this type of organizational form, action items tend to be resolved quickly.

☐ True
☐ False

19. Determine whether the answer statements are true or false.

Ellen has been placed in charge of a project that is expected to last close to two years. The project is of high importance to the company and the functional manager has agreed to allow the assigned resources be committed full time to this project for the duration of the project.

a. The most likely structure for this project would be a projectized organizational form.

☐ True
☐ False

b. Ellen would have the responsibility for wage and salary administration for the assigned resources.

☐ True
☐ False

c. Ellen can expect to have the best functional resources assigned to her project.

☐ True
☐ False

▶ The Project Management Center of Excellence: A Review

Some organizations have created support groups to develop methodologies, templates, training programs, standards, and review processes to ensure consistency in the management of approved projects. These centers of excellence are also referred to as PMOs or project management offices. PMOs may be created to coordinate activities

associated with large complex projects or to manage several projects in a portfolio. A PMO may also be referred to as a "project office" or "program office."

The PMO can support an organization by:

- Centralizing coordination and communication across multiple projects
- Developing enterprise wide project management policies, procedures, templates, and documenting lessons learned
- Prioritization of projects and effective management of critical resources
- Centralized monitoring and standardized performance reporting for all projects
- Consolidating project progress and performance reporting for executive management
- Providing training, mentoring, and coaching for project managers
- Developing a historical database of lessons learned from exiting and previous projects
- Analyzing overall project risks, opportunities, and the interactions between projects
- The *PMBOK® Guide* Sixth Edition refers to three types of PMO.
  - Supportive: Consultative role. Provides training, templates, best practices
  - Controlling: Requires compliance with approved methods and tools
  - Directive: Controls project implementation by directly managing projects

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® Exam

- Review and become familiar with the PMI® Talent Triangle: Technical Project Management, Leadership, Strategic and Business Management.
- Review the various forms of organizational structures and the level of authority associated with the project manager in each type of structure.
- There are three types of matrix structures: weak, balanced, and strong. The project manager has the greatest level of authority in the strong matrix. In the balanced matrix, the project manager and functional managers share an equal level of authority and there is a potential for conflict due to a "two boss" reporting structure for the resources assigned to the project. Other organizational structures include functional, organic, hybrid, virtual, and multidivisional.
- Become familiar with the differences between enterprise environmental factors and organizational process assets.
- Make sure you can clearly explain the differences between management and leadership and be able to describe the generally accepted roles of the project manager.
- Review the definitions of the terms "project," "program," and "portfolio" and be prepared to explain the differences in how they are managed.

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- Be sure you can describe the different types of PMOs: supportive, controlling, and directive.
- Remember that projects are divided into phases for control purposes and the number of phases depend on the control needs of the organization and the key stakeholders. Each phase of a project is initiated, planned, executed, monitored and controlled, and closed.

Basic factors that influence the selection of a project organizational form:

1. Project size and complexity
2. Project length (duration)
3. Experience with project management organization and methodologies
4. Philosophy and visibility of upper-level management
5. Project location
6. Available resources
7. The unique aspects about the project (the deliverables, new technologies, visibility, type of resources to be used, experience of the project manager, stakeholder needs and expectations, impact of the project on organizational objectives)

► Answers to Questions and Exercises

1. Advantages: Specific manager, budgeting and cost control are easier to manage, effective control of technical issues and expertise, flexibility in the use of people resources, communications channels are well established, control over personnel, continuity of policies and procedures.

   Disadvantages: No specific responsibility for a project, coordination is difficult, decisions are based on politics and the influence of the strongest functional group, response to customer issues may be slow, tendency toward functional loyalty instead of project loyalty, communication through levels is slow and may become distorted.
2. Projectized or pure project. The project manager has the greatest level of authority and influence over the team. The team is a dedicated resource to the project with no other priorities. The project team performance reviews are linked to project success.
3. Functional: 1, 2, 8, 9, 13

   Weak matrix: 3, 7

   Balanced matrix: 5

   Strong matrix: 6

   Projectized: 4, 10, 11, 12, 14

4. Advantages: Better utilization of resources, improved coordination between functional units, and expertise of functional units is used more efficiently, project manager acts as a coordinator and may have some authority.

   Disadvantages: Functional resources must manage multiple priorities and demands, resources may become over allocated, schedule conflicts, conflicts between project manager and functional manager about task assignments and control of work.

5. Authority: The formal, justified or legitimate right granted to an individual (generally by position or rank) to make decisions and exercise available power to achieve a desired end.

   Responsibility: The obligation to effectively perform assigned tasks.

   Accountability: The acknowledgment and assumption of responsibility for actions, products, decisions, and policies including the administration, governance, and implementation within the scope of the role or employment position and encompassing the obligation to report, explain, and be answerable for resulting consequences.

6. Enterprise environmental factors are conditions not under the control of the project manager but may influence the planning and execution of a project. They may be internal or external to the organization. Examples: culture, geographic distribution, infrastructure, marketplace conditions, legal restrictions, industry standards.

7. A stakeholder is defined as any person or organization directly involved in or in some way affected either positively or negatively as a result of a project. Examples of stakeholders include project manager, project team, sponsor, customer, contractor, supplier, and business unit.

8. The culture of an organization and the cultures of specific functional groups within organizations are associated with norms that have been developed over time. These cultural norms often create internal organizational barriers between functional groups that may influence the project planning process. Example: the culture of an operations group that has direct contact with customers, suppliers, and other stakeholders may differ greatly from the culture of a headquarters group or Human Resource department. Refer to the PMBOK® Guide—Sixth Edition, "The Environment in Which Projects Operate and Enterprise Environmental Factors."

9.

Project Characteristic	Functional Structure	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized
Project manager authority	Little or none	Limited	Low to moderate	Moderate to high	High to almost total

Project Characteristic	Functional Structure	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized
Resource availability	Little to none	Limited	Low to moderate	Moderate to high	High to almost total
Who controls the project budget	Functional manager	Functional Manager	Mixed	Project manager	Project Manager
Project manager role	Part time	Part time	Full time	Full time	Full time
Project management administrative support	Part time	Part time	Part time	Full time	Full time

10. Defining enterprise environmental factors and organizational process assets, establishing mutually agreed upon rule and procedures, utilizing a standardized planning process, establishing a hierarchal referral or escalation process.

11. Flexibility in the use of resources is limited. Resources cannot be easily transferred to other projects and may result in additional cost to the organization. Resources are often held on projects longer than necessary resulting in lost opportunities. Motivating the project team may be challenging because projects are considered temporary and project employees that are reassigned from functional positions will be concerned about job security and future job assignments within their functional groups.

12. Power struggles, different priorities causing conflicts, shifting people between projects causing delays, reduced ability to gain specialized skills.

13. Project size, project duration, available resources, project location, and experience of project personnel.

14. a. Supportive: Consultative role, provides training, templates, best practices, and lessons learned

    b. Controlling: Requires compliance to specific governance frameworks

    c. Directive: Takes control of projects and manages projects directly

15. Technical project management: The knowledge of tool and techniques associated with planning, scheduling, managing costs and risks, and other traditional and agile approaches to managing projects.

    Strategic and business management skills: The ability to see the high-level strategy, mission, goals, and objectives of the organization. Understanding business risks, financial implications, and cost-benefit analysis

    Leadership skills: Ability to guide, motivate and direct teams. Building trust, seeking consensus, persuading, developing teams.

16.

Administrate	Management
Develop the team	Leadership
Control	Management
Focus on systems and structure	Management
Encourage innovation	Leadership
Long range vision	Leadership
Ensure things are done right	Management
Challenges the status quo	Leadership

17.

Organizational culture	EEF
Infrastructure	EEF
Risk data	OPA
Risk appetite	EEF
Lessons learned	OPA
Employee capability	EEF
Policies and procedures	OPA
Marketplace conditions	EEF

18. **a.** False

b. False

c. True

19. **a.** True

b. True

c. False

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER FOUR

Organizing and Staffing the Project Office and Team

Project management is not a one-person operation; it requires a group of individuals, part time and/or full time, dedicated to the achievement of a specific goal. Project management includes:

- A project manager
- Assistant project managers if necessary
- A project (home) office
- A project team

Achieving the objectives of a project and ensuring customer satisfaction are the main goals of the project manager. This requires a project team that is knowledgeable, has the necessary skill set, is fully committed to the project, and is managed by a project manager who possesses effective managerial, organizational, communication, and leadership skills. Staffing the project with the appropriate team members is often a challenge due to organizational policies, organizational structure, and availability of resources. During the staffing process, the project manager generally attempts to obtain the most highly qualified and capable team members from the various functional or technical support groups. These resources are in high demand and may not be available for the required project time frame, and the project manager must often accept team member who are defined as "competent performers." These team members will typically need additional training and may require a higher level of direct supervision, coaching, and mentoring. Organizing the project team by establishing a project organization chart will facilitate the communications between team members and clearly identify roles, responsibilities, and linkages between project team members. It also provides a basis for escalation and defines the project's decision chain of command.

Glossary of Terms

Acquiring the project team Consider the enterprise environmental factors such as availability, experience, and cost. There are organizational processes to follow for

recruiting or hiring, and roles and responsibilities should be clearly defined to minimize miscommunication and conflict.

Competency The skill or ability and capacity required to complete assigned project activities.

Developing the team After the team has been formed, the project manager must focus some energy and attention on building the team. A well-managed and motivated team is more likely to commit to the project objectives than a loosely formed group. Techniques for team building include general management skills as well as interpersonal or soft skills, training, team-building activities such as offsite meetings and events, team ground rules established early in the project, co-location (when applicable and feasible), and recognition and reward to maintain the motivation.

Factors that influence the team:

- Geographical location of team members
- Communications methods
- Internal and external politics
- Cultural differences
- Organizational structure

Human resource planning These processes determine the resource types and skills required, the project roles to be assigned, the responsibilities of team members, and reporting relationships within the project's organizational structure.

Organization A group of people brought together for a specific purpose or to perform some type of work within an enterprise.

Organizational chart A method for depicting interrelationships among a group of people working together toward a common objective.

Organizational theory This is associated with how different organizational structures affect the behavior of an organization. Remember the multidivisional, virtual, hybrid, PMO, functional, matrix, and projectized structures and how these structures may affect project staffing and planning activities.

PMO Project Management Office, an organizational unit established to centralize and coordinate the management of projects under its domain. It is an organization that standardizes project-related governance processes and establishes enterprise-wide project methodologies.

Project charter A document issued by the project initiator or sponsor for the purpose of formally authorizing a project and the use of organizational resources. The charter provides the project manager with the authority to apply organizational resources to project activities and defines the actual decision-making authority of the project manager. The charter also provides a clear indication that the project is supported by higher-level management and is useful for leverage during negotiations for resources.

Project organization chart A graphic display of project team members and their reporting relationships with the specific project environment. Detail depends on project complexity and size of the project team.

Project role This is the label or specific function assigned to a project team member or stakeholder. It describes the portion of a project that will be completed, or the function that will be performed, by the individual. Roles and responsibilities of project team members are often established by developing a Responsibility Assignment Matrix.

Project team The personnel assigned to the project, including the project manager, functional managers, and in some cases the project sponsor and customer.

Responsibility Assignment Matrix A Responsibility Assignment Matrix (RAM) uses the Work Breakdown Structure (WBS) and the organizational structure to link project deliverables to the person assigned as responsible for their successful completion. The RAM provides a picture of the key stakeholders involved in the project and clearly shows who is responsible for each major deliverable. Another common form of a responsibility assignment matrix is the RACI chart: Responsible, Accountable, Consult, and Inform.

Staffing management plan This subset of the project management plan describes when and how human resource requirements will be met. The staffing management plan is developed based on the specific needs of the project. The plan includes processes for acquisition of team members, a timetable for obtaining or recruiting team members, the allocation of work among the resources, and the release criteria. Training requirements, recognition and reward procedures, safety requirements, and compliance requirements are also generally included in the staffing management plan. The plan also addresses the impact of the project staffing process on the organization.

► Activities, Questions, and Exercises

Refer to Chapter 4 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. The following questions and exercises are related to the *PMBOK® Guide* Sixth Edition knowledge area Project Resource Management, and chapters 1 through 3.

1. List at least eight personal characteristics or skills a project manager should possess to be successful in managing a project team and achieving project objectives.

   1. _____
   2. _____
   3. _____
   4. _____
   5. _____

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6. _____

7. _____

8. _____

2. The project manager is usually selected and assigned to a project by the:

_____

_____

3. What characteristics and personality traits would be desirable to you when selecting your project team? List at least six traits or characteristics.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

4. What problems or obstacles may be encountered by the project manager when attempting to staff his or her project team? Review the list of problems or issues that may be experienced when staffing a project, and provide a recommendation for managing and resolving the issue. Consider the project or projects you are currently assigned to manage. What issues have you encountered? What were the root causes? How did you respond to those issues?

Issue or Problem	Recommended Action
Example: Critical resources may not be available when needed.	Identify alternative sources, escalate to the project sponsor, negotiate availability with functional managers, consider contractors and outsourcing.
Functional and technical support groups are not cooperating with the request for resources.	
Assigned team members are not motivated or are considered "poor performers."	
Multiple projects result in resource contention.	
Functional managers unwilling to release highly qualified resources.	
Lack of resources with subject matter expertise.	

Issue or Problem	Recommended Action
Resources reluctant to accept project assignment due to temporary nature of projects (start and end dates).	
Performance appraisals remain responsibility of functional manager.	
Resources are assigned to multiple projects and you cannot get them to commit sufficient time to your project.	
Resources prefer to perform some of the work according to their own way of doing things rather than according to the project plan.	
Certain "prima donna" resources prefer to work by themselves rather than in a group.	
Resources want their functional managers to bless their work before submitting it to the project manager.	

5. **PM Quick Check:** In which organizational structure will the project team members encounter a situation known as the "two boss syndrome"?

_____ Functional

_____ Matrix

_____ Projectized

6. Describe the major responsibilities of the project manager:

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

9. _____

_____

7. In addition to the desired personal characteristics listed in question one, a project manager must fully understand the needs of the project team members. The project manager must provide the appropriate level of training, support, and motivation to ensure the team has the ability to perform the project work efficiently and will commit to completing the objectives. To create an effective and motivated team, what information should the project manager communicate to the project team? Consider the expectations a project manager should establish with the team at the start of a project.

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

8. A team will perform more effectively if the project manager provides a positive atmosphere that is conducive to teamwork. List the actions a project manager may take to ensure he or she creates a positive team environment that will contribute to the development of a high-performing team.

9. The following criteria are sometimes used to select and assign a project manager. For each item listed, explain why the criterion may be used and why it may actually result in the assignment of the "wrong" project manager.

Criterion	Explanations
Maturity (age)	
Hard-nosed tactics (forcing, controlling)	
Availability (waiting for an assignment)	
Technical expertise (technically proficient)	
Customer orientation (customer desires a person because they are familiar with him/her)	
New exposure (to become familiar with the project environment)	
Company exposure (the person has experience in many areas or business units within the organization)	

10. **PM Quick Check:** What is the definition of a "stakeholder"?

11. Many project managers experience situations in which some team members become difficult to manage or create conflicts that may disrupt the entire project team and jeopardize the project. These situations include but are not limited to:

Non-acceptance of rules, policies, and procedures

Non-acceptance of established formal authority

Focusing on technical aspects at the expense of the budget and schedule

Failing to contribute to the planning process

Delays in providing project information

Incompetence or inability to perform assigned activities

Unwilling to perform assigned project work

What actions could be taken by the project manager to prevent or resolve these issues? There may be many answers to this question.

_____

_____

_____

_____

_____

12. Why is it important for the project manager to prepare and distribute a project organizational chart to the project team and other stakeholders? Provide at least three reasons.

_____

_____

_____

_____

_____

13. **PM Quick Check:** What is the project manager's primary function?

_____

_____

Remember

The staffing process usually involves asking the following questions: What people resources are required? What skill levels are needed? What organization will provide the resources? When will the resources be needed? How many resources are needed? When will the resources be available? When should the resources be released? What type of project organizational structure will be best?

14. A challenge faced by most project managers is the selection of the "right" people for the project team and the use of appropriate managerial, motivational, and

leadership skills to keep the team focused on project objectives and the completion of deliverables. This means managing a variety of personality types. Review each type of person that may become part of the project team and match the characteristics of each type.

Personality Type	Matching Characteristic (by letter)	Characteristic or phrase often used	Desired team member? (Y or N)
1. Aggressor		**A.** Cannot focus on ideas for long unless it's his/her idea. Must be first with new ideas.	
2. Dominator		**B.** Finds fault in all areas of the project/project management.	
3. Initiator		**C.** Likes to hear himself/herself talk. Likes to boast.	
4. Topic jumper		**D.** Criticizes everyone. Deflates the status and ego of other team members.	
5. Information seeker		**E.** There is a chance this may work. Let's try this!	
6. Encourager		**F.** Rejects the views of others.	
7. Withdrawer		**G.** Your idea has merit. What you said will really help!	
8. Clarifier		**H.** Obtains overall team agreement.	
9. Recognition seeker		**I.** Let me try to put this in perspective. Are we saying that . . . ?	
10. Information giver		**J.** Is afraid to be criticized. May be shy. Does not participate openly.	
11. Blocker		**K.** Always tries to take over. Tries to manipulate people. Challenges the leader or person in charge.	
12. Harmonizer		**L.** The literature says . . . Here is the documentation. Benchmarking shows that . . .	
13. Consensus seeker		**M.** How can we obtain lessons learned or best practices? Where can we find what we need?	
14. Devil's advocate		**N.** Your ideas and mine are very similar. How can we agree on this?	

15. What decision criteria are typically used in the selection of project team members and other human resources?

_____

_____

_____

16. What are the major difficulties associated with establishing and managing a virtual team?

_____

_____

_____

_____

_____

17. Project managers are often assigned to teams that have been predetermined without project manager involvement. What are the typical factors that drive the preassignment decision, and what challenges may be encountered when managing a preassigned team?

Factors that drive preassignment: _____

_____

_____

Difficulties: _____

_____

_____

_____

18. According to Dr. Harold Kerzner, what are the 10 major skill requirements for project and program managers?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

19. Match each type of conflict management technique with the appropriate definition.

Withdrawing /avoiding _____

Smoothing/accommodating _____

Compromising _____

Forcing _____

Collaborating _____

Confronting/problem solving _____

A. Offers only win/lose solutions

B. Emphasizes areas of agreement instead of areas of disagreement

C. Give-and-take attitude and dialogue

D. A win lose/lose win situation in which some satisfaction is gained by both sides

E. Retreating from a potential conflict

F. Incorporating multiple viewpoints and achieving consensus

20. In order for project managers to fulfill their responsibilities successfully, they are constantly required to demonstrate their skills in managing multiple interfaces. What typical interfaces are encountered during project planning and execution?

_____

_____

_____

21. What are the major factors that must be considered when planning for project resources?

_____

_____

_____

22. Occasionally the project manager must deal with an incompetent or difficult team member. What steps may be taken to effectively manage this type of situation?

_____

_____

_____

_____

_____

23. What is the main purpose of the Project Management Office (PMO) and how can a PMO effectively support the project managers and project teams as they plan and implement projects?

_____

_____

_____

_____

_____

_____

_____

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The six processes associated with project resource management are:

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

1. Plan resource management
2. Estimate activity resources
3. Acquire resources
4. Develop team
5. Manage team
6. Control resources

► Answers to Questions and Exercises

1. Eight of any of the following:

- Honesty and integrity
- Understanding of personnel problems
- Understanding of project technology
- Business management competence
- Alertness and quickness
- Versatility
- Energy and stamina (toughness)
- Decision-making ability
- Ability to evaluate risk and uncertainty
- Communications
- Planning
- Interface management
- Team building

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- Leadership
- Conflict resolution
- Organizing
- Creativity and entrepreneurship

2. The project manager is usually selected by the project sponsor or project executive. For most projects, especially large, complex projects that may impact an organization's reputation, this is an executive decision.
3. Any six of the following:
   - Technical ability and competence
   - Willingness to work with the team
   - Willingness to accept changes
   - Flexibility, good listener
   - Honesty
   - Reliability
   - Understanding and acceptance of their responsibilities
   - Accuracy
4. Answers provided in the following table.

Issue or Problem	Recommended action
Example: Critical resources may not be available when needed.	Effective scheduling of resources. Identify backup sources, escalate to the project sponsor, negotiate availability with functional managers.
Functional and technical support groups are not cooperating with the request for resources.	Meet with the manager of the functional group and develop working relationship based on the business needs of the organization and how the project supports the business needs.
Assigned team members are not motivated or are considered "poor performers."	Conduct individual meetings, set objectives and expectations, attempt to align work assignments that match skills. Focus on the importance of the team members' contribution to achieve success.
Multiple projects result in resource contention.	Prioritize projects to ensure that highest-priority projects receive the appropriate resources.
Functional managers unwilling to release highly qualified resources.	Explain relationship of the project to organizational objectives. Negotiate time frames to minimize length of time the resources are needed.
Lack of resources with subject matter expertise.	Subcontract the work, provide training, hire additional resources.
Resources reluctant to accept project assignment due to the temporary nature of projects (start and end dates).	Bonuses and rewards at project completion, job placement support, training for other positions, negotiate return of the resource with functional managers.

(*Continued*)

Issue or Problem	Recommended action
Performance appraisals remain the responsibility of the functional manager.	Negotiate joint performance appraisal input and supervisory responsibility.
Resources are assigned to multiple projects and you cannot get them to commit sufficient time to your project.	May need to negotiate with functional managers for assistance.
Resources prefer to perform some of the work according to their own way of doing things rather than according to the project plan.	Need to verify that the results are acceptable. If not, workers must be "forced" to perform the work according to the plan.
Certain "prima donna" resources prefer to work by themselves rather than in a group.	There are people like this, and it is best to give them assignments where they can work alone.
Resources want their functional managers to bless their work before submitting it to the project manager.	This is a situation that project managers must live with.

5. Matrix structure.
6.
   - Integration of project work across functional lines
   - Ensure the project plan is developed.
   - Direct the preparation of the project budget.
   - Direct the preparation of the project schedule.
   - Establish monitoring and control procedures.
   - Create the project organizational chart.
   - Explain duties and responsibilities of the project team.
   - Set expectations with the project team and sponsor.
   - Select the project team, communicate project objectives.
   - Estimate resource requirements.
   - Direct the project work.
   - Develop a high-performing team.
7.
   - Project objectives
   - Contractual requirements
   - Quality requirements
   - Constraints
   - Assumptions
   - Customer/client information
   - Relationship of the project to organizational objectives
   - Status reporting
   - Change management process
   - Milestone dates, sponsor expectations

8.
- Clearly define roles and responsibilities
- Empower the team members to perform their responsibilities
- Regularly reward and recognize excellent job performance
- Provide coaching and mentoring
- Avoid aggressive control of the team members
- Avoid doing functional manager work
- Establish a supportive environment
- Avoid personal recognition and assuming credit for the work done by the team
- Ensure the team receives credit for achievements
- Invite participatory decision making when possible

9.

Criterion	Explanation
Maturity (age)	Age is not always an indicator of strong experience. Age is often confused with work maturity, ability, and experience. Decisions should be made based on an assessment of performance and competency.
Hard-nosed tactics (forcing, controlling)	This type of manager may achieve some results in the short term but may create interpersonal conflicts that will affect project performance later, including low morale and poor productivity.
Availability (waiting for an assignment)	An "available" person may not have the appropriate skill set or experience. Sometimes referred to as the "accidental" project manager, a person is assigned to manage a project but has no actual experience or training in project management. This may result in serious project issues throughout the project life cycle.
Technical expertise (technically proficient)	Technically strong project managers may tend to manage the technical details of the project instead of the cross-organizational issues and overall integration of project deliverables.
Customer orientation (customer desires a person because they are familiar with him/her)	The person selected may have a personality desired by the customer but may not possess the necessary project management skills for the project.
New exposure (to become familiar with the project environment)	Some projects, due to their complexity, may not be suitable for use as "training ground" for new project managers. This type of assignment may be perceived as short term and may result in a lack of commitment from the project team.

(*Continued*)

Criterion	Explanation
Company exposure (the person has experience in many areas or business units within the organization)	This type of action is often referred to as "ticket punching." The assignment is associated with career advancement, and the project manager may not be fully committed to the project. This type of assignment may be perceived as short term and may result in a lack of commitment from the project team.

10. **PM Quick Check.** A stakeholder is any person or organization that is directly involved in or in some way impacted, either positively or negatively, as a result of the project.
11. Screen project personnel before adding them to the team, set expectations early, establish roles and responsibilities early, explain the integrative project management process and communicate the importance of teamwork; set vision and goals.
12. The organizational chart defines the various relationships within the project team and defines at a high level the roles and responsibilities of the team members. It assists in the overall communications process with the project team and organizes the project.
13. **PM Quick Check.** Project manager's primary function is the integration of project activities.
14. Selecting the project team.

Personality Type	Matching Characteristic (by letter)	Characteristic or phrase often used	Desired team member? (Y or N)
1. Aggressor	D	**A.** Cannot focus on ideas for a long time unless it's his/her idea. Must be first with new ideas.	N
2. Dominator	K	**B.** Finds fault in all areas of the project/project management.	N
3. Initiator	E	**C.** Likes to hear himself/herself talk. Likes to boast.	Y
4. Topic jumper	A	**D.** Criticizes everyone, attacks ideas. Deflates the status and ego of other team members.	N
5. Information seeker	M	**E.** There is a chance this may work. Let's try this!	Y
6. Encourager	G	**F.** Rejects the views of others.	Y
7. Withdrawer	J	**G.** Your idea has merit. What you said will really help!	N
8. Clarifier	I	**H.** Obtains overall team agreement.	Y

Personality Type	Matching Characteristic (by letter)	Characteristic or phrase often used	Desired team member? (Y or N)
9. Recognition seeker	C	**I.** Let me try to put this in perspective. Are we saying that . . . ?	N
10. Information giver	L	**J.** Is afraid to be criticized. May be shy. Does not participate openly.	Y
11. Blocker	F	**K.** Always tries to take over. Tries to manipulate people. Challenges the leader or person in charge.	N
12. Harmonizer	H	**L.** The literature says . . . Here is the documentation. Benchmarking shows that . . .	Y
13. Consensus taker	N	**M.** How can we obtain lessons learned or best practices? Where can we find what we need?	Y
14. Devil's advocate	B	**N.** Your ideas and mine are very similar. How can we agree on this?	N

15. Cost, availability, ability, experience, knowledge, skills, attitude, international factors.

16. Few to no actual face-to-face meetings, widespread geographical areas, availability of communications technology, additional time required to resolve conflicts, cultural differences, time zones, language.

17. Factors that drive preassignment: specific resource identified in a competitive proposal, expertise of an individual, availability of an individual, personal preferences of the project sponsor. Difficulties: team member responsibilities determined without PM input, personality differences, work ethics, managerial style of the project manager, negative relationships between project manager and team members formed during previous assignments.

18. **1.** Team building

2. Leadership

3. Conflict resolution

4. Technical expertise

5. Planning skills

6. Organizational skills

7. Entrepreneurship

8. Administrative skills

9. Ability to gain management support

10. Resource allocation skills

19. Withdrawing/avoiding: E

Smoothing/accommodating: B

Compromising: D

Forcing: A

Collaborating: F

Confronting/problem solving: C

20. Product, organizational, external, technical, customer, and management interfaces.

21. Time (schedule), manpower, money, facilities, equipment, material, information/technology.

22. Provide an on-the-spot appraisal of the employee to clearly define the issue or issues. This includes identification of weaknesses, corrective action to be taken, and consequences if the situation continues. Reassignment of the employee to less critical activities. Removal of the employee.

23. The PMO generally develops standard project procedures and policies, determines and acquires the necessary tools and supporting materials that will assist project teams, performs project audits to ensure compliance with standards, and establishes project management best practices for an organization. The actual role of the PMO will vary by organization and can be designated as supportive, directive, or controlling.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER FIVE

Management Functions

General management functions such as planning, organizing, delegating, and administration are closely related to and, in many cases, overlap with the roles and responsibilities of the project manager. It is important for the project manager to fully understand the connection between his or her role as the key integrator for planning and effective management of the project team, while maintaining an awareness of organization and project priorities. To be successful, project managers must monitor and assess the total project environment. This includes the cultural and social environment, the international and political environment, and the physical environment. This understanding, combined with general management skills, interpersonal skills, and the appropriate application of project management skills, tools, and techniques, will establish a foundation for project success. Specifically, the success of the project manager depends on a balance between leadership and managerial skills. It is essential for the project manager to develop an understanding of the team's physiological needs, emotional needs, and motivational needs and to be flexible depending on the behaviors displayed when people perform in groups and in teams.

Remember

An understanding of the social, cultural, political, and international factors that may affect a project and the project stakeholders is necessary in today's global project environment and is directly related to a project manager's **professional and social responsibility**.

Glossary of Terms

Accountability An obligation or willingness to accept the consequences and results of project success or failure.

Authority The legal or rightful power to command, act, or direct the activities of others. The right of an individual to make necessary decisions required to achieve objectives. Also referred to as legitimate or formal power.

Autocratic leadership A leadership style characterized by strong focus on task completion with very little concern for the project team. The autocratic leader has a high level of formal authority and makes or approves all decisions. *See also* **Laissez-faire leadership; Democratic or participative leadership**.

Communications. *See under* communication type: **Downward communication; Lateral communication; Upward communication**.

Controlling A management function or process for measuring progress toward an objective, evaluating what remains to be done, checking for deviations from a plan, minimizing deviations and taking the necessary corrective action to achieve objectives. Measuring the degree to which progress toward objectives is being made, evaluating and determining the cause of significant deviations from planned performance, correcting an unfavorable trend, or taking advantage of an unusually favorable trend.

Democratic or participative leadership This leadership style encourages team members to communicate with one another and to become involved in decision making. Authority is often delegated to the workers or team members. *See also* **Autocratic leadership; Laissez-faire leadership**.

Directing The implementation and execution of approved plans through others to achieve or exceed objectives. Directing may involve staffing, training, supervising, delegating, motivating, counseling, and coordinating resources.

Downward communication Usually provides direction to the project team. It is generally associated with project job-related information such as delegation of activities, schedules, performance evaluation, and feedback to the team or to an individual. Downward is a term that is used to show direction of communication but is not meant in terms of authority or position power. A better term may be "teamward" communication. *See also* **Lateral communication; Upward communication**.

Empirical data A source of knowledge or data obtained by experimentation, studying the experiences of others, or observation.

Laissez-faire leadership A leadership style in which the leader or project manager assigns all work to the project team or workers. The project manager makes occasional appearances but remains mostly inactive and not involved in day-to-day management. Generally the term means "let them do as they will." *See also* **Autocratic leadership; Democratic or participative leadership**.

Lateral communication This is the horizontal flow of information to peers, functional groups, contractors, clients, and support personnel. Most of the communications activities associated with the project manager's position will be the lateral type. This is also referred to as cross-organizational communication. *See also* **Downward communication; Upward communication**.

Leadership The development of a vision and strategy and motivating people to achieve that vision. The ability to influence and cause people to follow. A style or behavior designed to integrate both the organizational requirements and one's personal interests into the pursuit of some objective. (There are many definitions of leadership.) *See also* **Autocratic leadership; Democratic or participative leadership; Laissez-faire leadership**.

RAM Responsibility Assignment Matrix. The RAM is used to align major project tasks with the individuals associated with each task. The RAM assists the project manager and team in defining clear responsibility for project tasks. The RACI chart (Responsible, Accountable, Consult, Inform) is commonly used to document project work assignments.

Responsibility The assignment of a specific event or activity and the expectation to complete that task.

Upward communication Primarily associated with information of interest to high-level or executive management for assessing overall project performance. This type of communication includes status of milestones, dashboards, major project issues, and items that require escalation. Exception reporting is sometimes used to provide project status or feedback about production or customer satisfaction issues when a major issue arises. *See also* **Downward communication; Lateral communication**.

In addition to the glossary terms, you should also familiarize yourself with the following authors and contributors to the study and practice of managing people. These are referenced later in this chapter.

Douglas McGregor, Theory X and Theory Y

William Ouchi, Theory Z

Abraham Maslow, Hierarchy of Needs

Frederick Herzberg, Hygiene Factors and Motivators

Chris Argyris, Victor Vroom, Expectancy Theory

There are numerous references and books about human behavior, leadership, and management effectiveness. The contributors listed have been traditionally included in PMP® study programs. As the project environment evolves and social and business values change, it will be necessary to review new theories and modifications of existing human behavior theories.

► Activities, Questions, and Exercises

Refer to Chapter Five of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*: Project Resource Management, Project Communications Management, and Project Stakeholder Management. Some elements of Professional and Social Responsibility and the Code of Professional Ethics are also addressed in this chapter.

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1. List five principal functions of management.

_____

_____

_____

_____

_____

2. List the appropriate term (either *measuring, evaluating*, or *correcting*) with each definition.

Definition	Term
a. Taking controlled action to resolve an unfavorable trend or deviation or taking advantage of an unusually favorable trend.	_____
b. Determining through formal or informal reports the degree to which progress toward objectives is being made.	_____
c. Determining the cause of and possible responses to significant deviations from planned performance.	_____

3. Complete this statement: The project manager is responsible for ensuring the:

_____

_____

Remember

General management encompasses planning, organizing, staffing, and controlling the operations of an ongoing enterprise. Project management includes many elements of general management in the effort to achieve project objectives

4. As a project manager you will occasionally find yourself in the role of director (someone who supervises the actors and directs the action in the production of a show). Considering your role as director of a project, review each of the following definitions and match them with the appropriate term (either *staffing, training, supervising, delegating, motivating, counseling*, or *coordinating*).

Definition	Term
a. Giving day-to-day instruction, guidance, and discipline	_____
b. Seeing that activities are carried out in relation to their importance and with minimum conflict	_____
c. Holding private discussions with another about how he or she might do better work, solve a personal problem, or realize his or her ambitions	_____
d. Seeing that a qualified person is selected for each position	_____
e. Encouraging others to perform by fulfilling or appealing to their needs	_____

Definition	Term
f. Assigning work, responsibility, and authority so others can make maximum utilization of their abilities	_____
g. Teaching individuals and groups how to fulfill their duties and responsibilities	_____

Exam Tip

Theory X, Theory Y, and Theory Z

Understanding the effect of managerial styles on a project team is extremely important. The style of management and the motivational techniques used can significantly impact project team performance. Project managers may exhibit many styles of management throughout the project life cycle. The Theory X manager believes significant supervision is required. The Theory Y manager believes workers can perform unsupervised. Theory Z refers to a collective decision-making environment.

■ The X, Y, and Z Factors

Theory X and *Theory Y* are theories about human motivation created and developed by Douglas McGregor in the 1960s and have been used in the study of human resource management, organizational behavior, and organizational development. They describe two very different attitudes about employees and workers regarding the willingness to complete assignments. McGregor felt that companies followed either one approach or the other.

Theory Z focuses on increasing employee loyalty to the company by providing a job for life with a strong focus on the well-being of the employee, both on and off the job. According to Dr. William Ouchi, its leading proponent, Theory Z management tends to promote stable employment, high productivity, and high employee morale and satisfaction.

5. Review each situation and indicate which style of management (X, Y, or Z) is being demonstrated:

Situation	Style (X, Y, or Z)
a. The project manager provides opportunity for discussion and participation in decision making.	____
b. The project manager spends a great deal of time observing and supervising the project team.	____
c. The project team collectively makes decisions.	____
d. The project manager directs all project work.	____
e. Strong discipline and punishment are used to induce the required work effort.	____
f. There is great opportunity for personal improvement and advancement.	____
g. An informal administrative control process is utilized.	____

■ Are You Motivated? Maslow's Hierarchy of Needs

Maslow created his hierarchy of needs based on the theory that human needs are filled in order of priority, culminating in self-actualization: physiological needs, safety, social needs, esteem, and self-actualization.

His hierarchy of needs is arranged in order of importance. It is often depicted as a pyramid consisting of five levels.

6. Correctly label each level of Maslow's Hierarchy of Needs on the figure below.

7. **Exam Tip: More Maslow**. Classify each of the following situations by matching the associated level of Maslow's Hierarchy of Needs (*physiological, safety and security*, *social, esteem*, and *self-actualization*).

Situation	Level in Maslow's Hierarchy of Needs
a. A project manager expresses feelings of pride and personal accomplishment.	_____
b. A new project team member requests frequent rest periods, wants the latest labor-saving devices, and expects efficient work methods.	_____
c. A project team member expects to be rewarded publicly for doing his job well.	_____
d. The project team is concerned about the total duration of the project and employment at project completion.	_____
e. The project environment provides an opportunity to work with a team, interact with co-workers, and improve the ability to network with other teams.	_____

8. **PM Quick Check:** Abraham Maslow developed the X and Y management theories.
   - ☐ True
   - ☐ False
9. Maslow postulated that once a need is satisfied, it loses its motivational importance and is replaced by a different need.
   - ☐ True
   - ☐ False

■ Herzberg's Motivator Hygiene Theory

Frederick Herzberg viewed motivation from a different perspective than Maslow. He believed that certain factors, if present, can result in dissatisfaction among employees; these are referred to as *hygiene factors*. The work environment is associated with hygiene factors, but the existence of a good work environment does not necessarily result in a motivated work force. In addition to a pleasant work environment, the manager must include *motivating factors* that will encourage employees or project teams to expand their potential and increase their interest in achieving project objectives.

10. Review the following list of factors and place them in the appropriate columns as either a *hygiene factor* or a *motivator*.

    Compensation (pay)
    Sense of responsibility
    Opportunity for advancement
    Level of supervision
    Opportunity for personal growth
    Peer relationships
    Company policies and administrative procedures
    Challenging work
    Reward and recognition
    Working conditions
    Variety in the work
    A more autonomous environment

Hygiene factor	Motivator

Remember

The project manager who fails to build and maintain alliances and positive relationships with team members and key stakeholders will soon find opposition or indifference to project requirements and objectives.

Motivating techniques: items that will improve the project manager–team member relationship

- Assigning work that is challenging
- Defining and communicating clear expectations about project work and performance
- Providing appropriate feedback and proper criticism
- Giving honest performance appraisals
- Developing a team attitude toward completion of objectives
- Providing the proper level of direction and support

11. **PM Quick Check:** In Maslow's hierarchy of needs, the first level of the hierarchy is associated with hygiene factors such as good working conditions and appropriate levels of supervision.

☐ True
☐ False

12. Theory Z managers are authoritarian in style, distrust their employees, and spend great amounts of time observing and directing the work that is being performed.

☐ True
☐ False

Remember

Authority, Power, and Responsibility

Responsibility for work assignments is typically delegated by the project manager. The Responsibility Assignment Matrix or RACI chart is often used to align project team members with specific WBS elements. The RAM provides the project team with clearly assigned work responsibility and improves internal project communication.

A project manager's authority is a combination of his or her power and influence. Authority is generally associated with rank or position and granted or delegated by higher-level management or one's superiors. Power comes from credibility, expertise, and sound judgment. Failure to establish a project manager's authority may result in:

- Poor communications
- Misleading information
- Antagonism

- Poor working relationships with upper management, peers, and associates
- Surprises from the customer or the project team

Common sources of power and authority problems

Poorly documented or no formal authority
Dual accountability of personnel: two bosses/project managers
Organizational encouragement of individualism
Shifting of personal loyalties from vertical to horizontal lines
Ability to influence or administer rewards and punishment

13. Exam Tip: Complete the following statements:

a. The RAM (Responsibility Assignment Matrix) is a tool that: _____

_____

_____

b. William Ouchi came to prominence with his studies and observations associated with: _____

14. Project managers are frequently required to obtain performance results and achieve project objectives by influencing others to perform activities that they would not normally become involved in; therefore an understanding of interpersonal influences and types of power is critical for a project manager to be successful.

Match each definition with the correct type of interpersonal influence (*legitimate* or *formal power, reward power, penalty power, expert power*, or *referent power*).

Definition	Type of influence
a. A person has the authority or is enabled to offer salary increases, promotions, bonuses, and future work assignments.	_____
b. Officially empowered by rank or position in the organization (also known as position power).	_____
c. A person has strong ties to another person of much greater authority and influence.	_____
d. Ability to coerce people through actions that are perceived as resulting in unpleasant or undesirable results; use of disciplinary actions or the threat of disciplinary action.	_____
e. Ability to influence others through special knowledge, experience, or demonstrated ability.	_____

15. Motivating employees so that they feel secure during a project may be difficult, especially since a project has a finite life cycle. Describe methods that can produce a greater feeling of security among team members in a project environment.

_____

_____

_____

_____

16. Exam Tip: **Power-Up.** What type of power or interpersonal influence is being used in each of the following situations (*formal* or *legitimate*, *reward*, *penalty*, *expert*, or *referent*)?

Situation	Type of power or influence
a. As stated by the project sponsor in the project charter, I am the project manager and the team will be expected to take direction from me on any matter that is related to the project.	_____
b. The project manager is a close friend of the CEO and they live next door to each other. It would be a good idea to do what she asks.	_____
c. I have two tickets to tomorrow night's playoff game. They are yours if you complete this assignment today.	_____
d. Either you complete the work assigned to you by the end of the week or the bonus associated with this project will be canceled.	_____
e. The speaker is worth listening to. He has a lot of experience and has written several books on the subject.	_____

17. Team Development. Project managers must develop an environment that encourages teamwork and mutual support. The goal of every team member should be the successful completion of the project deliverables by working together and through effective integration of all project components. Sometimes barriers to team development are experienced. The project manager, as the leader of the team, must work toward the resolution of these barriers to achieve objectives.

For each of the following potential barriers to team development, provide a possible approach or solution that may be taken by a project manager to overcome the barrier:

Barrier	Recommended Solution or Action
a. Different priorities and interests	
b. Role conflicts	
c. Project objectives and expectations are not clear.	
d. Dynamic project environment: scope changes, new or frequently changing objectives	
e. Competition over team leadership	
f. Lack of a defined team structure	
g. Selection of team personnel	
h. Credibility of the project manager	
i. Lack of team member commitment to the project	
j. Poor project communications	
k. Lack of sponsor, senior management, or executive-level support	

18. **Leadership.** Project managers are expected to manage the project by integrating all of the components of the project, communicating information, negotiating for resources, and maintaining control of overall project performance. For many project managers this means working with a team of people that may not report directly to the project manager. To accomplish the objectives of the project, the project manager must be perceived by the project team as a strong leader. This includes the development and communication of clear and complete project as well as individual expectations.

Remember

Project leadership is the ability to get things done well through others. It is the ability to attract followers by providing a clear destination, inspiring high performance, and motivating team members to succeed. The effective leader attracts people through sincerity and commitment and then motivates the team to perform at a level higher than each team member believed he or she was capable of.

Review each of the following roles and list under either "Leader" or "Manager" using the table provided. Some roles may be shared by both leaders and managers.

Plan and budget
Motivate and support
Organize work groups
Inspire team spirit
Staff the project
Establish a vision
Align the team members
Control the work flow
Short-term view
Winning team respect
Establishing loyalty
Enabling a group to perform as a team
Tactical approach
Excellent communicator
Directs work
Sees risks only as threats
Rewarding performance
Explaining and selling an idea
Setting objectives
Focus on the bottom line
Encouraging innovation
Enabling the team
Telling how and when
Sees risks as opportunities
Long-range view

Leader	Manager

(Continued)

Leader	Manager

19. PM Quick Check: Describe the major differences between Maslow's theory and Herzberg's theory about motivation.

Maslow: _____

_____

Herzberg: _____

_____

■ Communications

Project managers must ensure that the right information gets to the right people at the right time and in a cost-effective manner. Effective communication is essential for project success, and a process for communicating information should be established in the early stages of the project.

Remember

Effective communication may include:

- An exchange of information
- An act or instance of transmitting information
- A verbal or written message
- A process by which meanings are exchanged between individuals through a common system of symbols
- A feedback loop to ensure mutual understanding

20. What are the basic elements of the communications process?

_____

_____

21. How much time does a project manager typically spend communicating while managing a project?

a. 50%

b. 25%

c. 90%

d. 40%

22. List activities a project manager may perform that require some form of communication.

_____

_____

_____

_____

_____

Communications Breakdowns

Many project managers experience barriers that impede communications or distort information. These barriers can disrupt project plans, create conflict, and ultimately affect the outcome of the project. It is the responsibility of the project manager to create an environment in which project communications requirements have been aligned properly with the stakeholders involved. Many barriers can be overcome or prevented by clearly stating objectives, establishing roles and responsibilities, and identifying the specific requirements of the stakeholders involved in the project.

Remember

Typical communications barriers

Sender credibility

Personality and interests

Attitude and emotion

Position or rank

Existing relationships

Selective listening

Lack of feedback

Evaluative tendency

Assumptions about the sender

■ Exam Tip: Communications Channels—A Formula Worth Remembering

If you have ever wondered just how many channels of communication exist within a project team, try the formula $N(N - 1) / 2$ where N equals the number of people on the project team, or $N = X (X - 1) / 2$ where X is the number of people on the team and N equals the number of channels. It is important to remember that communications channels in the team network are two-way, and the project manager should be aware of the complexity of the network and the potential for communications breakdowns to occur.

23. PM Quick Check: If the number of team members increases from 6 to 12, what is the increase in the number of communications channels?

_____

Remember

The communications environment is affected by:

Logistics and geographic issues
Personal contact
Virtual or extended teams
Technology: telephone, electronic data transfer
External factors: politics, economic climate, regulatory agencies
Internal factors: power games, withholding information, indirect communications, blocking, or selective listening

24. Match the description or characteristic with the correct communication style/personality type (*authoritarian, promotional, facilitating, conciliatory, judicious, ethical, secretive, disruptive*, or *combative*).

Communication style/personality type	Characteristic or description
a. Eager to fight or be disagreeable	_____
b. "Tough guy," can lower morale through threats	_____
c. Gives expectations and specific guidance	_____
d. Not open or outgoing; does not offer opinions or share information	_____
e. Cultivates team spirit	_____
f. Provides guidance as required, non-interfering	_____
g. Uses experience to arrive at sound decisions	_____
h. Honest, fair, generally "by the book"	_____

Communication style/personality type	Characteristic or description
i. Breaks apart unity of the group, an agitator	_____
j. Friendly, agreeable, builds a compatible team	_____

25. Which of the following are hygiene factors according to Herzberg?

a. Working conditions
b. Reward program
c. Promotion opportunity
d. More challenging assignment
e. Compensation
f. Level of supervision

26. Describe the characteristics of a highly effective team.

_____

_____

_____

_____

27. List the typical factors that cause a dysfunctional team.

_____

_____

_____

_____

28. Cross-cutting skills are the type of skills needed to successfully manage each phase of the project life cycle. Provide examples of the cross-cutting skills that are necessary for effective project leadership.

_____

_____

_____

_____

29. Team leaders often use idea-generating techniques to assist in solving a problem or break through a stalled project situation. What is the difference between the brainstorming technique and the nominal group technique?

_____

_____

_____

30. Effective meetings. Project managers can expect to attend many meetings during the project life cycle and may be required to lead many of them. Meetings are actually projects within the project and, depending on the type of meeting and the intended audience, could require a significant amount of planning.

Create a list of activities that would be required to schedule and conduct a productive meeting. Create a list of guidelines or rules that should be followed to ensure a meeting is facilitated effectively and achieves its objectives.

Meeting Scheduling Activities	Meeting Rules and Guidelines

31. List the five stages of team development in the Tuckman Model and the role of the project manager in each stage

Stage	Project Manager Role

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

■ Project Resource Management and Communications Management

Project management is related to many of the functions of general management—planning, organizing, staffing, executing, and controlling. The communications model refers to the importance of the region of experience of the sender and the receiver, the encoding of the message and the decoding process, and the potential distortion of the message as it passes through the personality and perception screens. A feedback loop is necessary to ensure that the message is delivered and understood to the satisfaction of the sender and receiver. Feedback is critical for effective communication and is necessary to verify a complete understanding of the message. The communications channel formula is $N(N - 1)/2$ where N is the number of people on the team. The result of this calculation provides the number of communications channels within a team. Project communication can be formal, informal, verbal, or written. Approximately 80% of communication is nonverbal. Maintain an awareness of body language and other nonverbal forms of communication. In the virtual environment, communication is often conducted using technology that does not support visual capability. The project manager must adapt to this environment to ensure engagement is maintained.

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Listening is one of the most important factors in effective communication. Communications barriers are likely to be encountered during the project life cycle. Project managers must maintain an awareness of potential barriers and develop methods to prevent them or resolve them to minimize the potential negative impact on the project. Examples include language, time zones, culture, politics, leadership style, gender, and age.

Every meeting should be considered to be a project. Meetings should be planned appropriately to minimize unproductive time and should always include an agenda. Avoid unnecessary meetings and establish meeting guidelines to ensure greatest productivity and accomplishment of meeting objectives. Project managers assume both leadership and managerial roles during project planning and implementation.

Managerial Styles

There are many theories about how and why managers behave the way they do. As you study it is important to be able to explain the differences between McGregor's Theory X and Theory Y and Ouchi's Theory Z. Theory X implies distrust of the workers and employees, Theory Y promotes a trusting and participative environment, and Theory Z focuses on the well-being of employees and the larger goals of an organization.

It is also important to become familiar with two specific theories about motivation.

Maslow focused on the Hierarchy of Needs: physiological needs, safety, social needs, esteem, and self-actualization.

Herzberg focused on hygiene factors and motivating factors. Hygiene factors include work environment, level of supervision, and compensation. Motivating factors include the chance for advancement, rewards, challenging work, and bonuses.

Another factor associated with the management of people is the perception of power and how people influence others. There are five basic types of power: (1) reward power, (2) penalty power, (3) expert power, (4) formal/legitimate power, and (5) referent power.

Other terms that are associated with resource management and the management of people include:

- *Responsibility Assignment Matrix (RAM).* The RAM is a table or matrix that is used to assign responsibility for completion of tasks identified in the work breakdown structure with specific stakeholders or project team members.
- *Enterprise Environmental Factors*. These are inputs to many project management processes and will influence how plans are developed and how decisions are made. Examples of EEFs are organizational culture, geographic distribution, competencies of resources, and marketplace conditions.
- *Organizational Process Assets.* These are policies, procedures, checklists, and other artifacts developed by an organization. OPAs are inputs to many project management processes. Examples are HR policies and procedures, safety policies, templates, lessons learned, and historical information.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

▶ Answers to Questions and Exercises

1. Planning, organizing, staffing, controlling, directing.
2. a. Correcting
   b. Measuring
   c. Evaluating
3. Project completion and accomplishment of group and organizational objectives.
4. a. Supervising
   b. Coordinating
   c. Counseling
   d. Staffing
   e. Motivating
   f. Delegating
   g. Training
5. a. Y
   b. X
   c. Z
   d. X
   e. X
   f. Y
   g. Z
6. First (top) level: Self-actualization
   Second level: Esteem
   Third level: Social
   Fourth level: Safety and security
   Fifth (lowest) level: Physiological needs/shelter
7. a. Self-actualization
   b. Physiological
   c. Esteem
   d. Safety and security
   e. Social
8. False
9. True

10.

Hygiene factor	Motivator
Compensation (pay)	Sense of responsibility
Level of supervision	Opportunity for advancement
Peer relationships	Opportunity for personal growth
Company policies and administrative procedures	Challenging work
Working conditions	Reward and recognition
	Variety in the work
	A more autonomous environment

11. False
12. False
13. a. Aligns project team members with activities of the WBS
    b. Theory Z
14. a. Legitimate
    b. Reward
    c. Referent
    d. Penalty
    e. Expert
15. Letting people know why they are assigned to the project, making individuals feel they belong, placing people in positions they are trained for, explaining how their efforts fit into the bigger picture.
16. a. Legitimate or formal
    b. Referent
    c. Reward
    d. Penalty
    e. Expert
17. a. Establish objectives, goals, and vision. Connect project to personal value.
    b. Use a RAM to establish roles and responsibility.
    c. Review objectives and revise to meet SMART criteria.
    d. Establish change control process, clarify requirements, review and revise scopes statement.
    e. Obtain sponsor support, establish roles and responsibility early in the project.
    f. Create an organizational chart for the project.
    g. Establish staffing requirements, obtain sponsor support.
    h. Demonstrate leadership, display confidence, ask for assistance when it is needed, recognize technical expertise of the team, maintain integrity, gain trust through actions, listen to the team.
    i. Explain importance of the project, connect project to organizational goals, obtain sponsor support.

j. Identify stakeholder needs, create a communications plan, use a PMIS.

k. Establish expectations with management, provide executive-level status reports, involve the sponsor when necessary, connect project to strategic objectives.

18.

Leader	Manager
Motivate and support	Plan and budget
Inspire team spirit	Organize work groups
Establish a vision	Staff the project
Winning team respect	Align the team members
Establishing loyalty	Control the work flow
Enabling a group to perform as a team	Short-term view
Excellent communicator	Winning team respect
Rewarding performance	Establishing loyalty
Explaining and selling an idea	Enabling a group to perform as a team
Setting objectives	Tactical approach
Encouraging innovation	Excellent communicator
Enabling the team	Directs work
Sees risks as opportunities	Sees risks only as threats
Long-range view	Rewarding performance
	Setting objectives
	Focus on the bottom line
	Telling how and when

19. Maslow: Motivation is a set of clear steps in a hierarchy. As one step is achieved, it is no longer a motivator.

Herzberg: Separated hygiene needs from motivation.

20. Transmit, Encode, Receive, Decode, Feedback

Communications Process

21. c.

22. Developing the scope statement, explaining objectives, preparing status reports, solving conflicts, negotiating for resources, obtaining and reporting status (many other activities may be listed).

23. 6 × (6 – 1) divided by 2 = 15 – the channels of the current team, add 6 more people for a total of 12 team members. 12 × (12 – 1) / 2 Answer = 66.

24. **a.** Authoritarian

b. Promotional

c. Facilitating

d. Conciliatory

e. Judicious

f. Ethical

g. Secretive

h. Disruptive

i. Intimidating

j. Combative

25. a, e, and f.

26. a. Innovative, committed, clear objectives, high degree of trust, interdependent, effective conflict management.

27. Absence of trust, fear of conflict, lack of commitment, avoidance of responsibility, inattention to results.

28. Active listening

Brainstorming ideas	Leadership motivation techniques
Communication	Negotiating
Conflict resolution	Presentation skills
Cultural sensitivity	Prioritization techniques
Data-gathering techniques	Problem solving
Facilitation techniques	Relationship management
Information management including knowledge repositories	Stakeholder identification and impact analysis

29. In the brainstorming process the participants generate ideas openly and then discuss prioritization of the major issues. In nominal group technique the prioritization of issues is conducted using anonymous voting to eliminate bias and establish an equal voice for all participants.

30.

Meeting Scheduling Activities	Meeting Rules and Guidelines
Set meeting time	Start and end on time
Identify location	Use an agenda
Prepare agenda	Use a parking lot for new issues
Prepare meeting documentation	Do not allow interruptions
Provide directions to the location	One conversation at a time
Send notice/invitation	Encourage listening
Test technology	Arrive on time

31.

Stage	Project Manager Role
Forming	Directive style, provide information, explain the reason for the project
Storming	Facilitate, manage conflict, provide direction and support
Norming	Less direction, continued support, verification of job assignments, track performance
Performing	Supportive, high trust
Adjourning	High directions and support, focuses on accomplishments and new opportunities; emphasizes the accomplishments of the team

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER SIX

Communications Management

Project communications management includes the processes designed to ensure that project stakeholders receive the information needed to make decisions, support project activities, initiate changes, and remain updated about project performance and work progress. The project communications plan is a subsidiary to the project management plan and defines how information will be gathered, who will receive information, and how information will be controlled. The three main processes in communications management are: plan communications management, manage communications, and monitor communications.

Project communication is focused on the effective exchange of information and may be accomplished in written form, verbally, through gestures, tone of voice, and body language. Communication can also be conducted in a formal structured environment using documentation and specific procedures, or through informal channels such as social media.

It is clear and has been proven through years of lessons learned that proper communication is vital to the success of a project. Typical definitions of effective communication include:

- An exchange of information
- An act or instance of transmitting information
- A verbal or written message
- A technique for expressing ideas effectively
- A process by which meanings are exchanged between individuals through a common system of symbols

Key communications topics include:

- The communications plan
- Communications methods
- The sender–receiver model
- The 5 Cs of written communication

- Communications skills
- Interpersonal communications

Remember

Project communications management is an ongoing process and involves the entire project team. Planning for project communications requires the answers to the following questions:

- What information needs to flow in and out of the project?
- Who needs what information?
- When is the information needed?
- What is the format of the information?
- Who will be responsible for transmitting and providing the information?

▶ Glossary of Terms

Communications The act or process of using words, sounds, signs, or behaviors to express or exchange information or to express ideas, thoughts, and feelings, to someone else. A process by which information is exchanged between individuals through a common system of symbols, signs, or behavior.

Communications channels formula Number of channels = $[N (N - 1)] / 2$ where N is the number of people involved in the team or group being assessed.

Communications management The systematic planning, implementing, monitoring, and revision of all the channels of communication within an organization, and between organizations. There are two main parts to communications management: developing a strategy to ensure communication is effective, and carrying out the necessary activities to implement the strategy.

Communications model The basic model for communications is generally referred to as the sender–receiver model. Information is encoded by the transmitter and decoded by the receiver. A feedback loop or response is included to ensure effective transfer of information hierarchical focus, the position of the stakeholder or group within the project team or in the organization. This will affect the type of message, format, content, and delivery of the message. Hierarchal focus addresses three forms of communication: vertical or upward communication to senior-level managers, downward communication to employees and team members, and horizontal communication to peers and lateral groups.

Interactive communication Exchange of information in real time: meetings, phone calls, instant messaging, video conferencing. *See also* **Pull communications; Push communications; Work performance reports**.

Pull communications Intended for large audiences. Requires the intended audience to access content from web pages, e-learning portals, intranet sets, lessons-learned repositories. *See also* **Interactive communication, Push communications, Work performance reports**.

Push communications Information sent to specific recipients: letters, memos, email, voice mail, reports. This form of communication does not ensure that the message was received or understood by the intended audience. *See also* **Interactive communication, Pull communications, Work performance reports**.

Work performance reports Information from work performance data that has been analyzed and formatted for delivery to project stakeholders. Examples: Status reports and progress reports. These reports may contain earned value graphs, histograms, or reserve burn-down charts, and may be presented as dashboards, stoplight charts, or other forms of information display. *See also* **Interactive communication, Pull communications, Push communications**.

► Activities, Questions, and Exercises

Refer to Chapter Six of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*: Project Communications Management, Project Resource Management, and Project Stakeholder Management.

1. **Communications Management Quick Check: A Self-Assessment.** Review the following statements and provide your response based on your current work environment. Write a recommendation for managing or improving your skills or performance.

Question	Response based on current environment 1 = Strongly disagree 5 = Strongly agree	Recommendation for managing the issue
When planning my communications I anticipate causes of confusion and address them up front.		
When I write a memo, email, or other document, I make sure that my message will be understood.		

(Continued)

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Question	Response based on current environment 1 = Strongly disagree 5 = Strongly agree	Recommendation for managing the issue
If I don't understand something, I seek clarification immediately.		
People always have a clear understanding of what I have said.		
I tend to say what I think without considering how other people may perceive my statements.		
I listen carefully to understand other ideas and perspectives.		
I pay attention to body language when speaking to people.		
Before I send a message, I consider the best method for delivery: email, phone, in person, etc.		
I am thinking about my response while the other person is speaking to me.		
I am aware of cultural barriers and prepare messages accordingly.		

2. Communications barriers: The basic communications sender–receiver model illustrates that barriers to communication may be experienced during the transfer of information. These barriers are also referred to as "noise," which may distort or block information from being exchanged. Consider the following typical communications barriers and provide suggestions for managing each barrier.

Barrier	Recommended Action
Sender's communications goals not clear	
Sender's credibility questioned	
Personality of the sender	
Attitude of the sender	
Communications skills of the sender	
Sender's assumptions about the audience	
Existing relationship with the receiver/audience	

Remember

Rules and actions for meeting management

- All meetings should have an agenda.
- Meetings should have specific time limitations.
- Ensure that the purpose of the meeting has been clearly communicated.
- Prepare meeting participants in advance by sending meeting documents in advance.
- Ensure that invitations are sent to the appropriate people.
- Focus on interests, not positions.
- Be prepared and show up early (especially if you are the meeting organizer).
- Stick to the schedule.
- Conclude meetings with a clear statement of next steps.

Project management quick note: A common cry among project managers is "I have to implement plans I didn't design, but if the project fails, I'm responsible." This can be a serious situation for a project manager. Whenever possible, become involved in planning decisions. Explain your concerns using factual information. Develop your ability to influence others. Communicate status frequently and engage the sponsor and decision makers early when problems develop.

3. Project managers may communicate using different methods. The type of message, the urgency of delivery, and the type of audience are all factors in determining the method of communication. Review the situations in the first column below and identify the appropriate communication method for each (*interactive, push communication*, or *pull communication*).

Situation	Communication method
a. An argument is developing and could create a serious project delay.	_____
b. Updated meeting minutes to be sent to the project team	_____
c. Updates to lessons learned repository	_____
d. Urgent situation requiring immediate response	_____
e. A press release updating key stakeholders about project status	_____
f. Memo to project team members about a change in policy	_____
g. All-employee notice about a town hall meeting	_____

Remember

The communications management plan is a component of the project management plan. It contains information about stakeholder communications requirements, the specific information to be communicated, methods of distribution, who will receive information, and a glossary of terms commonly used during the project.

The communications environment can be complex and is often controlled or impacted by internal and external influences. These influences can act separately or collectively and can either assist or restrict the attainment of project objectives.

Typical internal factors include:

- Power games
- Withholding information
- Management by memo
- Reactive emotional behavior
- Mixed messages
- Indirect communications
- Stereotyping
- Transmitting partial information
- Blocking or selective perception

Typical external factors include:

- The business environment
- The political environment
- The economic climate
- Regulatory agencies
- The technical state of the art

The project manager must develop a high level of awareness about these factors and develop strategies for managing the potential problems they may introduce.

4. **PM Quick Check:** Project managers spend approximately 50% of their time communicating during project planning and implementation.

   ☐ True
   ☐ False

5. Project managers should position themselves to be the central point and gate keeper for all project communication.

   ☐ True
   ☐ False

6. Letters, memos, and email are forms of pull communications.

- ☐ True
- ☐ False

Remember

The 5 Cs of communication (*PMBOK Guide,* Sixth Edition):

1. Correct grammar
2. Concise expression
3. Clear purpose
4. Coherent logical flow of ideas
5. Controlling flow of words and ideas

Listening actively will result in greater engagement of team members and stakeholders.

Meetings should always have a PALpurpose, agenda, and limitation (a scheduled time to end).

Become aware of politics and power struggles within the organization.

The formula for calculating the number of channels of communication within a team is $N (N - 1) / 2$ where N = the number of people in the team. This formula assists in determining the complexity of the communications network within a team and illustrates the number of potential interfaces where communications breakdown may occur.

7. You are managing a team of 10 people. How many channels of communications exist? _____

8. Problems are often encountered during project planning and implementation. What is the first step in the problem-solving process?

_____

_____

_____

9. Explain the importance of each of the 5 Cs of communication.

Communication "C"	Importance
Correct grammar and spelling	
Concise expression and elimination of excess words	
Clear purpose directed to the recipient	
Coherent logical flow of ideas	
Controlling flow of words and ideas	

Managing Communications

Here are six simple steps to improve your communications skills:

1. Think through what you wish to accomplish.
2. Determine the way you will communicate.
3. Appeal to the interest of those affected.
4. Give feedback on ways others communicate to you.
5. Get feedback on what you communicate.
6. Test effectiveness through reliance on others to carry out your instructions.

The project manager's communication skills and personality screen often dictate the communication style. Typical communication styles include:

- Authoritarian: gives expectations and specific guidance
- Promotional: cultivates team spirit
- Facilitating: gives guidance as required, noninterfering
- Conciliatory: friendly and agreeable, builds compatible team
- Judicial: uses sound judgment
- Ethical: honest, fair, by the book
- Secretive: not open or outgoing (to project detriment)
- Disruptive: breaks apart unity of group, agitator
- Intimidating: "tough guy," can lower morale
- Combative: eager to fight or be disagreeable

Consider your style of communication. Which of the listed styles relates to you specifically? Your style will have a direct impact on the project team's morale, their willingness to listen to your directives and information, and the quality of the work produced. Become aware of your style and adapt as necessary to ensure effective communication is accomplished.

Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

Communications Management

There are three major processes in project communications management:

1. Plan communications management: developing an appropriate approach to meet the information needs of project stakeholders
2. Manage communications: the timely gathering, storing, analyzing, and dissemination of information

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3. Monitor communications: ensuring that stakeholders receive the appropriate information throughout the project life cycle.

Communication is accomplished through written, spoken, formal, and informal methods, and through gestures and body language. The 5 Cs of communication will guide the project manager and enhance the delivery of the message.

Communications may be tailored based on the following considerations:

- Stakeholders internal and external to the organization
- Physical location of the team and stakeholders
- Communications technology available
- Knowledge management: availability of repositories and access to data

Enterprise environmental factors and organizational process assets are key inputs to the plan communications management process.

The number of channels of communication in a team is calculated by the formula $N(N-1)/2$.

The basic sender–receiver model describes the process by which a sender delivers a message to the receiver. The message is encoded, noise factors must be managed, the message is decoded, and a feedback process is used to ensure communication is successful.

Interpersonal skills will significantly affect the communication process. Style of communication, political awareness, and cultural awareness will improve the ability to engage stakeholders and team members.

- Manage meetings effectively. Make sure meetings have an agenda, have a good reason to be scheduled, include the right people, and start and end on time.
- Manage communications using the appropriate technologies, adapting to the changing needs of stakeholders, and remaining flexible in the use of communications methods.
- Monitor communications to ensure that stakeholders remain engaged and are receiving the information they need.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. This is an exercise that has many possible answers and is intended to provide you an opportunity to plan possible actions based on your current project environment. Use this exercise as a basis for planning your personal time management processes and to identify priority issues to address.

   Example:

Question	Response based on current environment 1 = Strongly disagree 5 = Strongly agree	Recommendation for managing the issue
When planning my communications I anticipate causes of confusion and address them up front.	3	Minimize the use of acronyms, obtain information about my target audience, prepare back-up and supporting information, keep things in a simple format when possible.

2. There are several possible actions that may be taken to address these issues. Some examples:

Barrier	Recommended Action
Sender's communications goals not clear	Prepare objectives in advance and explain them at the start of the communications session.
Sender's credibility questioned	Provide background about qualifications and experience.
Personality of the sender	Personality is difficult to change. Awareness of personality traits is necessary. Obtain feedback from trusted and respected sources. Adapt to the audience and remain sensitive to their needs. Minimize the focus on personal needs.
Attitude of the sender	Focus on delivering information that is important and relevant to the audience. Consider that your time and the time of the recipients is important. Maintain a professional approach.
Communications skills of the sender	Practice the delivery of the message. Become conscious of habits during delivery; obtain coaching and training.
Sender's assumptions about the audience	Obtain information about the audience. Avoid making judgments without obtaining facts. Focus on the message and the quality of the content and delivery.
Existing relationship with the receiver/ audience	Ensure that the purpose of the session or the message is clear. Avoid reference to past negative experiences. Provide factual information in a professional and unbiased manner. In some cases, a facilitator may be appropriate to manage exchanges between sender and receiver.

3. a. Interactive
   b. Push communication
   c. Pull communication
   d. Interactive

e. Push communication

f. Push communication

g. Pull communication

4. False

5. False

6. False

7. Number of channels = $N(N - 1) / 2$. In this case there are 11 people involved, the team of 10 plus the project manager. Answer $[11 (11 - 1)]/ 2 = 55$

8. Start the process by defining the problem clearly. Identify a problem well, and you have 50% of the solution.

9.

Communication "C"	Importance
Correct grammar and spelling	Poor grammar and spelling are a distraction and may be perceived as a lack of professionalism.
Concise expression and elimination of excess words	Well-designed messages reduce the possibility of misunderstandings and increase the likelihood that the message will be received successfully.
Clear purpose directed to the recipient	Ensuring that the needs of the recipients are addressed will create greater interest.
Coherent logical flow of ideas	A logical flow of information will assist with time management and listener engagement: introduction, body of the message, and closure.
Controlling flow of words and ideas	Use of graphics to illustrate a key item or enhance a point can keep the communication moving. Strategic points for explanation and pauses to ensure comprehension will increase the retention of the audience.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER SEVEN

Conflicts

Conflict is defined in simple terms as:

- A struggle for power, property, or position
- Strong disagreement between people or groups that often results in angry argument
- A difference that prevents agreement

Conflicts can be expected to be encountered in most, if not all, phases of a project life cycle. They may occur at any level of management, between functional groups, and among any of the project stakeholders. Conflicts often arise when discussing resource requirements, developing schedules, estimating activity durations, negotiating contract terms, and determining levels of product or deliverable quality. Project managers often assume the role of conflict manager in addition to many other roles and may be required to respond to and resolve a wide range of issues that have developed between project personnel or between other stakeholders. The ability to execute this role effectively is critically important in achieving successful project completion.

The ability to manage conflict requires an understanding of why conflicts occur, the sources of the conflict, and the specific needs of the stakeholders involved. In many cases conflict begins with poorly defined objectives and unclear roles and responsibilities. Another major root cause of conflict is poor communication. Many conflicts can be prevented and others reduced in intensity if the parties involved focus on the very basic concepts of effective communication.

Remember

Project Objectives. To avoid conflict, project objectives should be based on the following criteria: specific, not overly complex, measurable, tangible, verifiable, realistic, attainable, established within resource constraints, and consistent with organizational plans, policies, and procedures. These criteria are often summed up using the acronym SMART—*specific*, *measurable, attainable, realistic*, and *time-based*. Team members who have been

(Continued)

given a clear description of the project at the start will generally buy in to the project more quickly, and the probability of serious conflict is often reduced significantly.

▶ Glossary of Terms

Collaboration Any cooperative effort between persons or organizations to achieve common goals.

Compromise Determine a solution where each side leaves with some degree of satisfaction. Generally, a give-and-take process where neither side achieves 100% of its objectives.

Conflict Conflict is a natural disagreement resulting from individuals or groups that differ in attitudes, beliefs, values, or needs. It can also originate from past rivalries and personality differences. Other causes of conflict include trying to negotiate before the timing is right, misunderstanding of information, different priorities, and confusion about roles and responsibilities.

Conflict escalation The escalation of a conflict to make it more destructive, more confrontational, or otherwise uncomfortable. Not to be confused with escalation of issues to higher levels of management, which is necessary in many cases to resolve a conflict.

Conflict management The variety of ways by which people handle grievances, clashes, or the perceptions of right and wrong. It may include common techniques such as avoidance, withdrawal, compromise, forcing, and collaboration.

Conflict resolution The use of conflict analysis, negotiation, facilitation, mediation, arbitration, or judicial settlement to resolve an issue. The act of arbitrating differences of belief or opinion about a given state of conditions or circumstances. A process of resolving a dispute or disagreement.

Emotional intelligence The capacity of individuals to recognize their own and other people's emotions, to discriminate between different feelings and label them appropriately, to use emotional information to guide thinking and behavior, and to manage and/or adjust emotions to adapt to environments or achieve one's goals.

Forcing Imposing a decision or resolution without opportunity for suggestions or feedback.

Needs Things that are essential to our well-being or to achieve an objective. Conflicts arise when we ignore others' needs, our own needs, or the group's needs. Needs are different than desires or wants, and focusing on needs generally provides a path to more expedient conflict resolution.

Smoothing Removing short-range erratic variations, eliminating jagged edges. In conflict management it is the attempt to give the appearance that progress is being made or that the conflict is not as severe as originally perceived. Smoothing also

refers to avoiding discussion of any issues that may result in disagreement or conflict. Smoothing does not necessarily resolve a conflict but may provide a short period of calmness. Smoothing encourages dialogue and is used to make people feel comfortable by saying, "We've agreed on two points thus far, and we can certainly find some agreement on the remaining three points." Smoothing actually tries to "smooth out" the emotional arena where conflicts take place such that people are willing to remain at the bargaining table.

Values Values are beliefs or principles we consider to be very important. Serious conflicts arise when people hold incompatible values or when values are not clear. Conflicts also arise when one party refuses to accept the fact that the other party holds something as a value rather than a preference. Values may include such items as timeliness, teamwork, quality, safety, respect, integrity, trust, truthfulness, courage.

Withdrawing Avoiding or stepping away from a conflict and taking time to rethink one's position. Withdrawal does not necessarily mean that the conflict no longer exists.

▶ Activities, Questions, and Exercises

Refer to Chapter Seven of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—6th Edition: Project Resource Management and Project Communications Management. Some elements of Professional and Social Responsibility and the Code of Ethics are also addressed in this chapter.

■ Importance of Objectives in Conflict Management

The specific objectives of the project must be communicated to all stakeholders. Failure to provide clearly defined objectives will result in different interpretations at all levels of management and across all organizations involved in the project. Key points about conflict:

- Conflict is not always negative. It can lead to positive outcomes when effectively managed.
- Well-managed conflict may result in improved personal performance, the generation of innovative ideas, higher levels of performance, and significant organizational growth.
- Conflict often results in a change from the normal or routine thinking process and can generate new ways for solving problems and increased creative thinking. Conflict may result in a change in managerial approach to a more participative style that encourages idea generation and collaboration through techniques such as brainstorming, mind mapping, and simply listening to new ideas.

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1. **PM Quick Check:** There are generally three types of objectives associated with a project. List the three primary types of project objectives: (Hint—think of the big picture, the intermediate levels, and the detailed outputs as the project progresses).

_____

_____

_____

Remember

Project conflict will vary depending on the size and complexity of a project and the number of people involved. The most common types of project conflicts involve:

- Staffing resources
- Equipment and facilities
- Capital expenditures
- Costs
- Technical opinions and trade-offs
- Priorities
- Administrative procedures
- Scheduling
- Responsibilities
- Personality clashes

2. **PM Quick Check:** Well-written objectives are generally associated with five main criteria. These criteria are often described using a common word as an acronym (each letter of the word has a specific meaning). What is the word and what are the criteria each letter signifies?

Letter	Criteria
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Remember

In some cases, objectives may start out very general in nature due to a lack of detailed information at project start-up. The objectives are refined and clarified as the project evolves and progresses. This process is known

as progressive elaboration, meaning "moving forward in increments, adding more detail as you go."

The abbreviation MBO—management by objectives—was commonly used in many organizations as a means to emphasize the need to establish clear direction and to have the ability to compare results with the desired outcome.

3. Which of the following tools or techniques is specifically used to clearly define the roles and responsibilities of the project team members by aligning responsibility with project activities and tasks and thereby minimizing the potential for conflict between functional groups?
   a. WBS
   b. RAM
   c. Activity list
4. List at least 10 common sources of conflict. For additional learning value, provide possible solutions for, or measures that can be taken to avoid or minimize, the conflict.

Sources of Conflict	Bonus Section—Solutions

Remember

Experienced project managers realize that conflicts are inevitable, and that the use of best practices and defined procedures or techniques can help resolve them. Once a conflict occurs the project manager must:

- Study the problem and collect all available information
- Develop a situational approach or methodology
- Set the appropriate environment for resolution

5. **PM Quick Check**: Conflict is a risk factor that always produces a negative result.
   - ☐ True
   - ☐ False
6. Conflict always results in an unpleasant work environment and leads to more serious issues that cannot be resolved.
   - ☐ True
   - ☐ False
7. The most effective method for resolving conflicts is to compromise.
   - ☐ True
   - ☐ False

Project conflicts can occur with anyone over anything. How would you manage the conflicts in exercises 8 and 9?

8. Two functional managers on your team appear to be having personality clashes and almost always assume opposite points of view during decision-making discussions. They are both from the same functional organization.

   _____

   _____

   _____

   _____

   _____

9. The manufacturing department reports that it cannot produce the end product according to engineering specifications.

   _____

   _____

   _____

   _____

   _____

10. Explain how conflict may be beneficial to a project team or an organization as a whole.

_____

_____

_____

_____

Remember

Many executives feel that the best method for minimizing and resolving conflicts is to establish very specific priorities. This will work most effectively when priorities are not changed frequently and when only a "reasonable" number of priorities are established.

11. The connection between the organizational goals and project priorities is established by the project manager and the:

a. Project team

b. Customer

c. Sponsor

d. Stockholders

12. During the project life cycle, a project team will go through several stages of team development. As the project life cycle progresses, the level of conflict generally decreases in intensity. In some cases the conflict intensity resulting from personality clashes can increase significantly to the point where it becomes a sensitive issue. Likewise, issues such as cost changes, schedule changes, or failure to deliver qualified resources when promised can also cause increased levels of conflict as the project progresses. The project manager must address these challenges through leadership and facilitation. Considering the progressive changes in the relationship of team members, name the five stages of team development as described in the Tuckman model and explain how conflict intensity changes in each phase.

Team Development Phase	Conflict Intensity

13. **PM Quick Check** The less specific the objectives of a project, the more likely that conflict will develop.

    ☐ True
    ☐ False

14. When conflict occurs during project implementation, the project manager should:

    a. Study the problem and collect all available information
    b. Develop a situational approach or methodology
    c. Set the appropriate atmosphere or climate
    d. All of the above

15. List the five major conflict resolution modes. Which of the modes will actually resolve the conflict?

Conflict-Handling Mode	Solves Conflict? (Yes or No)
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

16. How can each of the following be used to prevent, reduce, or resolve conflict within the project environment?

    a. Authority or position of power: _____
    _____

    b. Penalty power: _____
    _____

    c. Work challenges: _____
    _____

    d. Promotion/advancement opportunity: _____
    _____

    e. Theory X-style management: _____
    _____

    f. Theory Y-style management: _____
    _____

    g. Communications plan: _____
    _____

    h. RAM: _____
    _____

17. During the project life cycle, it may become necessary for the project manager to schedule a conflict or confrontation meeting between conflicting parties to find a solution. Review the steps in the process and write the number of the correct description or explanation in the space provided.

Steps or events in the conflict process	Description or explanation of the step or event
a. Setting the climate _____	**1.** Obtaining feedback on the implementation
b. Analyzing the images _____	**2.** Obtaining cross-organizational involvement, obtaining commitment
c. Collecting the information _____	**3.** Taking action on the plan
d. Defining the problem _____	**4.** Forming cross-functional problem-solving groups
e. Sharing the information _____	**5.** Obtaining input to be used to resolve the problem
f. Setting the appropriate priorities _____	**6.** Establishing a willingness to participate
g. Organizing the group _____	**7.** How do you see others? How do they see you?
h. Problem solving _____	**8.** Identifying and clarifying all positions
i. Developing the action plan _____	**9.** Making the information available to all participants
j. Implementing the work _____	**10.** Getting the feelings and concerns out in the open
k. Following up _____	**11.** Developing work sessions and time tables

18. Review each of the following situations and indicate the conflict-handling mode (*withdrawal, smoothing, forcing, compromise,* or *collaborate/confront*) in use.

Situation	Mode
a. The requirements are my decision, and we are doing it my way.	_____
b. I've thought about it and you are right; we'll do it your way.	_____
c. Let's discuss the alternatives. Perhaps there are other options.	_____
d. Let me explain again why we need the new requirements.	_____
e. See my section supervisors; they are handling it now.	_____
f. I've looked over the problems, and I might be able to ease up on some of the requirements.	_____

19. List at least five common factors that influence executive decisions when prioritizing projects.

_____

_____

_____

_____

_____

_____

20. Minimizing the potential for conflict is part of the strategy of the effective project manager. List actions, behaviors, or activities that could reduce the potential for undesirable conflicts to occur.

_____

_____

_____

_____

_____

_____

_____

21. According to the *PMBOK Guide*, Sixth Edition, there are several factors that influence decisions about how conflicts will be resolved. List the factors that may drive the method of resolution.

_____

_____

_____

_____

_____

22. Conflicts are normal and they are a part of our life. Conflict during projects happens when the interests of two or more _____ interfere with one another.

23. What are the advantages and disadvantages of the compromise conflict resolution technique?

_____

_____

Conflict Management in Practice: Applying Techniques

When conflict is experienced, it is generally a good practice to analyze the situation before taking action. Consider asking each of the following questions and, using the information obtained, develop strategies that will result in a positive outcome or reduce the intensity of the conflict.

- Who are the groups involved?
- Why are they involved?
- How are they organized?
- Are the groups capable of working together?
- What is the history between the groups?
- How did the conflict develop?
- What are the main issues? What are the secondary issues?
- How can negative issues be reframed into more positive statements?
- How negotiable are the positions that have been taken?
- What are the common issues?
- What values and interests have been challenged?
- What external constraints or other influences must be considered?
- What past positive experiences can be used to influence cooperation?
- What is the timeline or urgency of the conflict and the need for a solution?
- How would an outside negotiator be received?
- Is an external negotiator needed?

Remember

Identifying potential conflicts early in the project life cycle is important. This will allow the team to develop preventive action to minimize the possibility of a conflict occurrence and to determine the appropriate corrective action that will prevent escalation of the conflict. The longer the project manager waits, the greater the chance that conflict intensity will increase to the point where fewer options are available for its resolution.

Use the conflict analysis table to assist in assessing conflicts that may be experienced during the project life cycle. Consider how the conflict originated, who is involved, and the specific needs of the people involved. Awareness of the motivators that drive performance and sometimes cause conflict is also helpful in resolving situations.

Conflict Analysis Table

People or Groups Involved: Whom do they represent? Who are the leaders? Cultural issues? Sensitivities?	Conflict Description	Reason for the Conflict: Background information, history, incidents leading to the conflict Primary and secondary issues What values and/or interests are affected? What is negotiable?	Strategy for Resolution

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

■ Resource Management and Communications Management

Remember the five types of conflict-handling modes: withdrawing, smoothing, compromise, forcing, and collaboration.

There are many sources or causes of conflict. The most frequent causes are different views about schedules, project priorities (especially in a matrix environment), use of resources, technical opinions, administrative procedures, budget, cost estimates, and personality differences.

Remember the five phases of team development: forming, storming, norming, performing, and adjourning. Conflict is at its highest level in the storming phase and requires the project manager to demonstrate several leadership and facilitation skills, including listening, directing, and influencing.

There are basically five types of power and influence that are associated with conflict and the management of conflict: expert power, reward power, penalty power, legitimate or formal power, and referent power.

The application of Theory X, Theory Y, and Theory Z styles of management may impact the level of intensity of conflicts and the frequency of occurrence. Styles will vary and project managers may actually utilize different styles depending upon the circumstances.

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Effective and well-planned negotiation techniques are key factors in conflict management.

A well-prepared project communication plan and a project management information system may assist in the prevention of conflict.

Clearly defined and communicated objectives are a key element in reducing and preventing conflict.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

▶ Answers to Questions and Exercises

1. Ultimate project objective, Phase or deliverable objectives, Task and activity objectives.
2. SMART: specific, measurable, attainable, realistic, time-based.
3. b
4.

Sources of Conflict	Bonus Section—Solutions
Resources	Establish good working relationships with resource owners.
Equipment	Secure equipment early, test equipment before use, maintenance.
Facilities	Check to ensure facilities are conducive to the project environment.
Capital expenditures	Reliable estimating, negotiation.
Cost estimates	Use accepted estimating tools and techniques; use experienced estimators.
Trade-off decisions	Listen to opposing viewpoints; compromise.
Priorities	Minimize the number of priorities, use business value and benefits to determine priorities.
Administrative procedures	Validate procedures; train on procedures.
Assignment of responsibility	Listen, match activities to skill and experience.
Personality	Set expectations for the work environment.

5. False
6. False
7. False
8. There are several possible answers to this question: Set up a conflict resolution meeting, identify the specific conflicts, identify the needs of each side, and search for common ground.
9. Review the requirements. Identify where the problems exist. Arrange for a meeting between engineering and production. Identify alternatives. Decide on the appropriate course of action. Reach agreement.

10. Conflict surfaces problems as well as opportunities. Brainstorming solutions can be a team-building exercise and can generate new ideas and opportunities.

11. c

12.

Team Development Phase	Conflict Intensity
Forming	Low but will increase during this phase
Storming	Highest: Team members deal with uncertainty, roles, responsibilities.
Norming	Decreasing as work is performed
Performing	Lowest: Conflict is not eliminated but in this phase the team is working well together and can resolve most conflicts without project manager intervention.
Adjourning	Conflict is generally minimal in this phase, and the team is focused more on the break-up of the team. There is some regret in this phase, and it's a time for the project manager to offer support, acknowledgment, and encouragement about the future.

13. True

14. d

15.

Conflict-Handling Mode	Solves Conflict? (Yes or No)
Withdrawal	No
Smoothing	No
Compromise	Yes: This is a win-lose/lose-win approach, but it does solve the conflict to some extent.
Forcing	Yes: This approach solves the immediate problem but causes other conflicts.
Collaboration	Yes: Best approach to a win-win solution.

16. **a.** Eliminates debate.

b. Forces resolution through fear of punishment.

c. Creates environment that encourages teamwork.

d. Provides incentive to work as a team.

e. Related to forcing; no participative decision making.

f. Participative style; encourages collaboration.

g. Effective distribution of information can reduce the potential for conflict.

h. Clear understanding of responsibilities often reduces conflict.

17. **a.** 6

b. 7

c. 10

d. 8

e. 9

f. 11

g. 4
h. 2
i. 5
j. 3
k. 1

18. **a.** Forcing
b. Withdrawal
c. Collaborate/confront
d. Smoothing
e. Withdrawal
f. Compromise

19.
- The technical risks in development
- The risks that the company will incur, financially or competitively
- The nearness of the delivery date and the urgency
- The penalties that can accompany late delivery dates
- The expected savings, profit increase, and return on investment
- The amount of influence that the customer possesses, possibly due to the size of the project
- The impact on other projects or product lines
- The impact on affiliated organizations

20.
- Pausing and thinking before reacting
- Building trust
- Trying to understand the conflict motives
- Listening to all involved parties
- Willingness to compromise
- Educating others tactfully about your views
- Being willing to admit when you were wrong

21.
- Importance and intensity of the conflict
- Time pressure for resolving the conflict
- Relative power of the people involved
- Importance of maintaining a good relationship
- Motivation to resolve the conflict on a longterm or short-term basis

22. Stakeholders

23. The advantages of this technique are that it may result in arriving at a resolution faster, may lower stress, and may provide time to search for a more acceptable and permanent solution.

The disadvantages of this technique are that each side will give up something. It's a win-lose/lose-win situation and the conflict could resurface.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items	
Action Item	**Target Date for Completion**

CHAPTER EIGHT

Special Topics

Managing a project can become a challenging assignment depending upon the complexity of the project. In addition to the responsibilities generally associated with project planning and execution, the project manager may be expected to address and manage a number of administrative items and organizational processes, policies, and procedures. During the assignment, the project manager's main focus of attention is the successful delivery of business value at the completion of the project, but the type of project, the diversity of the project team, the types of personal interfaces, and the overall project environment may require the project manager to address and manage many, if not all, of the following items:

- Performance measurement
- Compensation and rewards
- Managing small projects
- Managing mega projects
- Morality, ethics, and the corporate culture
- Internal partnerships
- External partnerships
- Training and education
- Integrated project teams
- Virtual teams
- Innovation projects
- Agile project management team member performance appraisals

The specific responsibilities of the project manager will vary by industry and organization, and the level of authority will depend on organizational structure and policy. But the project manager should be prepared to manage or participate in an environment where a blend of project management and organizational administrative duties exists. This can also be dependent on the organization's project management maturity level.

Remember

Benefits of performance measurement and appraisal systems:

Ensure that the right people with the right skills are assigned to the appropriate positions

Identify skills areas and behavioral issues among employees and team members that require attention before they become unmanageable

Provide an objective approach to measure levels of individual and team accomplishment and to determine appropriate compensation or corrective action

Identify team and individual employee training requirements

Provide project managers with the data needed to determine if employees have potential for advancement or can assume additional work assignments and responsibility

► Glossary of Terms

Competency The ability of an individual to do a job properly. The ability to transfer and apply skills and knowledge to situations and environments. The knowledge and skill and the application of that knowledge and skill to the standard of performance required in employment.

Conflict of interest A situation where an individual is placed in a compromising position where the individual can gain something of personal value or enrichment based on the decisions made.

Expectation A result that is considered most likely to happen. A belief that is centered on the future. Project managers develop a set of expectations for the project team early in the project life cycle and revisit those expectations periodically. The defined expectations provide the basis for preparing performance appraisals.

Mega project A large undertaking with multiple components and technologies that requires a significant amount of resources over a long period of time and at substantial cost and risk. The definition and use of the term "mega project" will vary by organization, and its application is often determined by the monetary value of the project.

Performance appraisal A method by which the ability of an employee to complete job assignments (generally in terms of quality, quantity, cost, and time) and other assigned responsibilities is evaluated and reported to the employee through feedback. Performance appraisal is a part of career development.

Performance measurement The process of developing measurable indicators that can be systematically tracked to assess progress made in achieving predetermined goals. Determining performance gaps between what customers and stakeholders expect and what each process produces in terms of quality, time, and cost.

Performance standard An objective performance level that must be met. A statement of expectations or requirements established by a supervisor or manager for a performance element at a particular rating level.

Professional responsibility A mastery of a special body of advanced knowledge that bears directly on the well-being of others. The special moral responsibilities and requirements that constrain professionals to apply their knowledge in ways that benefit society.

▶ Activities, Questions, and Exercises

Refer to Chapter 8 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Resources Management and Project Communications Management. Some elements of professional and social responsibility are also addressed in this chapter.

Remember

The employee performance appraisal process allows the project manager to identify, evaluate, and prepare developmental actions to improve poor performance and to motivate an employee to continue to reach for higher levels of performance.

1. Measuring project team performance: During project execution, what areas of team performance should be evaluated by the project manager?

   _____

   _____

   _____

   _____

   _____

2. **PM Quick Check:** In which structure will the project manager have the greatest influence in the preparation of an employee's performance appraisal?
   a. Functional
   b. Matrix
   c. Projectized

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Remember

360-degree feedback: A process in which a manager obtains feedback, generally anonymously, from peers, subordinates, supervisor, and customers. This process assists in defining strengths and areas for improvement in interpersonal and managerial skills.

3. During which stage of the project life cycle should the project manager establish performance appraisal criteria?

_____

4. What actions can a project manager take to increase functional employee loyalty and commitment to the project?

_____

_____

_____

_____

5. Besides monetary compensation, what can a project manager do to motivate his/her project team?

_____

_____

_____

_____

Remember

The foundations of compensation practices are based on four systems: job classification, base pay, performance appraisals, and merit increases.

6. **PM Quick Check:** Defining job titles and corresponding responsibilities is critical to project success and should be acted upon in the early stages of project planning.
   - ☐ True
   - ☐ False
7. **PM Quick Check:** According to Frederick Herzberg, compensation is a motivating factor.
   - ☐ True
   - ☐ False

8. Why are proper financial compensation and rewards important to the morale and motivation of the project team?

_____

_____

_____

_____

_____

9. What is the purpose of the employee performance appraisal?

_____

_____

_____

_____

_____

10. Generally, organizations measure the performance of their project managers in what two major areas?

_____

_____

_____

11. Project managers are measured on their performance in specific areas. These areas are viewed in terms of primary and secondary importance. Review each measure and identify if it is a primary or secondary measure of performance.

Measure	Primary	Secondary
a. Target costs	_____	_____
b. Overhead reduction	_____	_____
c. Low team conflict	_____	_____
d. Key milestones	_____	_____
e. Quality	_____	_____
f. Technical accomplishments	_____	_____
g. Project staffing	_____	_____
h. Budget development and control	_____	_____
i. Performance measures and controls	_____	_____
j. Reports and reviews	_____	_____
k. Interfunctional communication	_____	_____
l. Responsiveness to changes	_____	_____

12. The project team, functional managers, and project resources are usually assessed on their abilities associated with:

a. Technical implementation

b. Team performance

c. a and b

Remember

When properly prepared, the appraisal will provide particular measures of job performance that assess the level and magnitude at which the individual has contributed to the success of the project, including managerial performance and team performance components.

The following are common challenges or issues that may be encountered by a project manager in a small company or when working on small projects:

- The project manager may have to assume several responsibilities and act as a functional manager and a project manager.
- The project manager may have to manage multiple projects.
- There may be limited resources, especially in a matrix environment.
- There is a significant need for strong interpersonal skills.
- There are generally shorter lines of communication.
- In small companies there is usually no PMO.
- In small companies there is a greater risk to the total company if the project fails.
- There may be greater financial constraints and tight control of funding in small organizations.
- Upper management may be more likely to interfere with or become directly involved in day-to-day project activities.
- Estimating activities are usually required to be more precise in smaller companies.

13. Whether managing a small project or a mega project, the project manager may encounter similar issues. Review the issues and explain strategies for dealing with each.

Issue: Multiple projects

Strategy: _____

_____

_____

_____

_____

Issue: Limited resources

Strategy: _____

_____

_____

_____

Issue: Lack of trained or competent resources

Strategy: _____

_____

_____

_____

Issue: Internal competition for materials

Strategy: _____

_____

_____

_____

14. During project planning and implementation, a project manager may be required to develop strategies to meet project objectives. Review each strategy and explain the advantage and disadvantage of each strategy.

Strategy	Advantage	Disadvantage
Assigning the best employees to the most visible or highest-priority projects		
Establishing a projectized organizational structure		
Utilizing a balanced matrix structure		

■ Study Notes: Professional and Social Responsibility, Morality, Ethics, and Corporate Culture

Professional responsibility is generally the mastery of a special body of advanced knowledge that bears directly on the well-being of others. The special moral responsibilities and requirements of a chosen field constrain professionals to apply their knowledge in ways that benefit that community. Project managers must maintain sensitivity to cultural, ethical, political, and geographical factors when planning a project and managing a team. There are factors both internally and externally that may create significant challenges for the project manager and impact how decisions are made.

Internally driven adversity: Being asked by your management to take action that is in the interest of your company but violates your own moral and ethical beliefs.

- You are asked to lie to the customer in a proposal in order to win a contract.
- You are asked to withhold bad news from your management.
- You are asked to withhold bad news from the customer.
- You are ordered by management to violate ethical accounting practices to make your numbers look good to senior management.
- You are instructed to ship a potentially defective unit to a customer to meet production quotas.
- You are asked to cover up acts of embezzlement or charge the wrong account codes.
- You are asked to violate the confidentiality of a private personal decision by a team member.

Externally driven adversity: You are asked by your customer to take action that may be in the customer's best interest but violates your own moral and ethical beliefs.

- You are asked to destroy information that could be damaging to the customer during legal action taken against the customer.
- You are asked to lie to consumers to help maintain the customer's public image.
- You are asked to release unreliable information that could be potentially damaging to a customer's competitor.

Tasks associated with project management professional and social responsibility:

- Ensure individual integrity and professionalism.
- Contribute to the project management knowledge base.
- Enhance individual competence.
- Balance stakeholder interests.

The PMI® Code of Ethics includes responsibility, respect, fairness, and honesty

Remember

Cultural difference should be considered before deciding on and delivering a recognition or reward.

What would you do? For the next two questions, review each situation and select a response that most closely represents your viewpoint.

15. An assistant project manager had the opportunity to be promoted and manage a new large project that was about to begin. She needed the project manager's permission to accept the new assignment, but if she left, the project manager would have to perform her work in addition to his own for about three months.
    a. Deny the promotion due to the work load.
    b. Delay the promotion until a suitable replacement can be found and trained.
    c. Approve the promotion and develop a transition process for the assistant project manager.
    d. Convince the assistant project manager that the promotion is not really a good opportunity.
16. In the first month of a 12-month project, the project manager discovers that the end date was too optimistic and cannot be met.
    a. Hold the information and wait for a miracle to happen.
    b. Change the scope statement to reduce the work required.
    c. Advise the customer and the sponsor about the issue and provide alternatives.
    d. Continue with the project as planned and arrange for a new project manager to take over as soon as possible.

PM Quick Check: Review each statement and select the word or phrase in parentheses that completes the statement most appropriately.

17. A good project manager will explain the individual and team performance appraisal process (before/immediately after) the first major milestone.
18. Proper (financial compensation/rewards to improve morale and stimulate) is/are the greatest motivator(s) for project teams.
19. The first step in job classification and creating job descriptions is to (define job titles/establish base pay).
20. Traditionally, the purpose of the performance appraisal is to (provide justification for salary treatment/prepare for future goal setting).
21. The performance of the project manager is measured through (technical implementation and task performance/business results and managerial ability).
22. Companies that promote morality and ethics usually create (internal adversity/a supportive working environment).

Project managers depend on functional groups to provide resources that are competent and to provide support to accomplish project objectives. Establishing partnerships with internal and external organizations and developing good working relationships will assist the project manager in obtaining the best available resources and creating a willingness to cooperate. For each of the four examples below, describe actions a project manager may take to establish partnerships with

internal functional groups or external organizations such as subcontractors and customers.

23. Internal functional groups (example: engineering, operations):

_____

_____

24. Subcontractors: _____

_____

25. Customer: _____

_____

26. Sponsor: _____

_____

27. Project managers must continually assess the needs of their project teams as well as their own personal needs for continued self-development. There are three general opportunities for training to occur: on-the-job training, formal education, and knowledge transfer.

To ensure that project objectives are achieved, what activities should a project manager perform to assess the capabilities of each team member and to determine the training needs of the project team?

_____

_____

_____

_____

_____

28. From the project manager perspective, describe an *integrated project team* (IPT):

_____

_____

_____

_____

_____

29. In today's project environment the project manager can expect to manage project teams that are dispersed geographically due to the nature of the project. These dispersed teams, also known as *virtual teams*, present unique challenges to the project manager. Consider each of the following virtual team situations

and develop a potential solution. There may be several potential solutions to each situation.

Situation	Solution
a. Time zone differences make it difficult to organize team conference calls.	
b. Team members have different perceptions of the project scope.	
c. Cultural differences are creating conflicts among some team members.	
d. Technology differences make it difficult to keep team members updated and informed.	

30. What are the basic measures used in the development of team incentive plans?

_____

_____

31. Ethics and professional conduct are critically important in the project environment. In order to ensure awareness of these factors, the Project Management Institute developed a Code of Ethics and Professional Conduct, which is divided into four sections. What are the four sections?

_____

32. Acting in a professional manner is an expectation established by many organizations, and it is common for an organization to conduct mandatory annual reviews of its policies regarding professional conduct. Provide examples of the items that may be discussed during these reviews.

_____

_____

_____

33. Organizations establish relationships with suppliers to ensure the appropriate level of quality, reasonable price for services, and reliability. What are the three most common types of external partnerships established by an organization?

_____

_____

_____

34. A project manager may be required to establish a specific team of people to develop and deliver a complex or highly integrated product or service. These

special teams are referred as integrated product teams, or IPTs. What skills or characteristics would you seek when forming an integrated product team?

_____

_____

_____

_____

_____

35. In today's project environment, virtual teams (also known as distributed teams) present unique challenges for the project manager. What are the typical characteristics of the virtual team, and what factors are important to ensure the team works effectively?

_____

_____

_____

_____

_____

36. Project management continues to evolve, and in the last decade agile project management has been growing in popularity, especially in the software development field. What are the major differences between agile project management and what is referred to as "traditional" project management?

_____

_____

_____

_____

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

Maintain awareness that professional responsibility is embedded in each knowledge area of the *PMBOK® Guide*—Sixth Edition. Professional responsibility includes these actions:

- Ensure individual integrity and professionalism.
- Contribute to the project management knowledge base.
- Enhance individual competence.
- Balance stakeholder interests.

These items are considered to be part of the daily practices and behaviors of the professional project manager.

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Review the PMI® Code of Ethics and Professional Conduct for information about ethics, guidelines, and requirements that professional project managers are expected to honor. The purpose of the Code of Ethics is to instill confidence among business leaders, business owners, and their clients in the project management profession and in the business and personal values of the individual practitioner.

The PMI® Code of Ethics and Professional Conduct focuses on: responsibility, respect, fairness, and honesty.

Your personal integrity is the key factor in professional responsibility.

Performance appraisals, just like project reviews, should be conducted at specific intervals to measure progress and identify areas for improvement.

Become familiar with your company's policies regarding diversity, culture, and ethics.

Review the differences between Enterprise Environmental Factors (EEFs) and Organizational Process Assets (OPAs).

Examples of EEFs: Organizational culture, geographic distribution, infrastructure, employee capability

Examples of OPAs: policies and procedures, project artifacts, lessons learned

Review performance measurement criteria and expectations with your project team at the start of the project. Communicate objectives early and provide feedback about performance on a regular basis. Plan to recognize good performance.

Review project constraints (time cost, scope, resources), and assumptions (planning items and statements that have not been verified and may have significant risk) during project status meetings and scheduled performance reviews.

Creating internal partnerships with functional managers is an effective way of ensuring that project objectives will be accomplished. Maintain an awareness of functional manager priorities and constraints, and establish positive working relationships.

Project managers are required to develop the team and maintain their engagement throughout the project life cycle. The Tuckman model refers to five stages of team development: forming, storming, norming, performing, and adjourning.

- Forming: Learning about the project
- Storming: Differing ideas surface about the project management approach, roles, work assignments
- Norming: Team begins to work together, some trust is developing
- Performing: A well-organized and supportive team structure
- Adjourning: Work is completed, team is reassigned, some regret is experienced

The *PMBOK Guide* Sixth Edition is a significant source of information for use in preparing for the PMP® or CAPM® exams. Read the *PMBOK Guide* as part of your study plan. It will provide basic information about each process group and knowledge area. Additional sources of information will be required to provide a deeper understanding of each knowledge area. It is important to focus your study on the flow of work during project planning and implementation. The five process groups provide a high-level integrated flow of work, and the sub-processes define how the knowledge areas interact with the

five major process groups. The inputs, tools and techniques, and outputs described in the *PMBOK Guide* provide a general flow of work to complete project deliverables.

The *PMBOK Guide* Sixth Edition, Chapter 9, "Project Resource Management," addresses many of the special topic areas project managers are expected to become involved with. The process groups in Project Resource Management include:

- Plan resource management.
- Estimate activity resources.
- Acquire resources.
- Develop team.
- Manage team.
- Control resources.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. How the assigned work is planned, ability to communicate, attitude toward the team and the project, cooperation and willingness to collaborate, work habits, timeliness, quality of work, on-time completion, adherence to standards and procedures, willingness to accept feedback.
2. c. In the projectized structure the project manager generally has a high level of authority, and the team members report directly to the project manager.
3. At project initiation or during the first phase of the project (at project start-up or kickoff).
4. Connect the project to organizational goals, create a sense of urgency and esprit de corps, obtain and ensure an understanding of their needs, listen and act on concerns, ensure they perceive their work as meaningful.
5. Recognize accomplishments, offer thanks for work well done, prepare formal recognition and communicate it to management, respect the team, trust the team, remain visibly enthusiastic about the project.
6. True
7. False. According to Herzberg, compensation is a hygiene factor. A bonus or reward is considered a motivator.
8. Proper compensation should be established to provide a foundation from which to build. Inadequate compensation can lead to employee dissatisfaction. Reward and recognition of work generally improves morale and increases the willingness to perform at higher levels.
9. Assess the employee's work performance against preestablished objectives. Provide justification for salary actions, establish new goals and objectives for the

next review period, identify and manage work-related problems, serve as a basis for career discussions.

10. Business results (ROI, profit, on-time delivery, within budget, according to requirements) and managerial ability (effectiveness, leadership, direction, team performance).

11. The answers provided are typically associated with a project manager's duties, but conditions will vary by organization.

    a. Primary
    b. Secondary
    c. Secondary
    d. Primary
    e. Primary
    f. Primary
    g. Secondary
    h. Primary
    i. Primary
    j. Secondary
    k. Secondary
    l. Secondary

12. c

13. *Multiple projects:* Use of portfolio management, prioritize all projects, focus on most critical projects first, obtain additional support from the sponsor(s), transfer some projects to other project managers.

    Limited resources: Identify critical tasks, schedule resources to meet critical path dates, obtain additional resources externally, escalate to sponsor.

    Lack of trained or competent resources: Outsource/subcontract, schedule training, establish specific staffing criteria, negotiate with functional managers for more qualified resources.

    Internal competition for materials: Portfolio management, prioritization, escalation, identify alternate sources.

14.

Strategy	Advantage	Disadvantage
Assigning a technical expert as the project manager	Understands the technical issues, respected by the team for expert knowledge, less risk of missing details.	The technical project manager may focus too much attention on technical details
Establishing a projectized organizational structure	Project manager has high level of authority, controls all resources, streamlined decision making	Must obtain resources from functional groups, may not obtain critical resources when needed, resources become concerned about next assignment
Utilizing a balanced matrix structure	Project manager and functional manager have equal authority, potentially better coordination across functional lines	Potential conflict about authority between the functional manager and the project manager, resources generally report to the functional manager, functional manager has greater influence on resources

15. c
16. c
17. before
18. rewards to improve morale and stimulate
19. define job titles
20. provide justification for salary treatment
21. business results and managerial ability
22. a supportive working environment
23. Obtain information about their needs first, avoid "telling" them what they have to do, empathize.
24. Establish clear expectations, tie performance to progress payments, discuss opportunities for future business.
25. Establish expectations, define customer responsibilities, obtain customer input and approval of plans, involve the customer in planning exercises.
26. Establish expectations, define communications needs, agree on level of support, involve the sponsor as needed.
27. Obtain information about the competency level of the team members, review past performance, obtain appraisal information from functional managers, interview team members to determine abilities, ask for input about training needs, and assess work output early in the project.
28. The integrated project team (IPT) includes the supplier's project team, the client's project team, and the consultants and industry specialists required to achieve project objectives. The IPT brings together the designers, construction resources, maintenance resources, and other entities that will exchange information or provide deliverables in support of the project's product.
29. a. Alternate meeting times to balance the needs of the team members.
    b. Schedule a project kickoff meeting (in person if possible) to review project objectives and project scope of work.
    c. Review the various cultures associated with the team, investigate areas of potential conflict. Set expectations based on the needs of the project and the client. Seek additional support and advice from those who are trained in this area. Research the conflicts to gain an understanding before taking action.
    d. Establish technology standards at the start of the project. Look for common applications. Research technology that is available within the organization. Create standards for communicating information.
30. Project milestones, project completion, value added.
31. Responsibility, fairness, respect, honesty.

32. Truthful representation of all information, protection of company-proprietary information, responsibility to report violations, full disclosure in a timely manner of all conflicts of interest.
33. Approved supplier, preferred supplier, and strategic partner supplier.
34. Self-starter ability, work without supervision, good communication skills, cooperative, technical understanding, willing to learn back-up skills, able to perform feasibility studies and cost/benefit analyses, able to perform or assist in market research studies, able to evaluate asset utilization, decision maker, knowledgeable in risk management, understand the need for continuous validation.
35. Team members may be multinational, may not meet face to face, and may be accustomed to different methodologies. In the virtual team environment, trust, consistent communication, and ensuring a connection between team members are critical for success.
36. Agile project management is highly participative; the focus is on shorter-term results and deliverables, solutions are constantly evolving, and there is less detailed planning.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER NINE

The Variables for Success

Project success for many executives, managers, project managers, and project teams refers to the elements of what has been referred to in the past as the triple constraint: the balance of time (schedule), cost (budget), and scope (quality and performance specifications). Today, success is actually defined much more specifically and more comprehensibly than completing the project within the parameters of the triple constraint. Success depends on a systems approach to the project where all project elements, planning components, and deliverables of the project are coordinated in an interrelated manner and managed with an understanding that failure in one area will most likely have an effect on many other areas of the project. Today, the competing demands associated with project success have grown in complexity. They reach deeply into the values of the supplier organization and the buyer organization and are directly connected with the creation of business value, short and long term. Safety, aesthetics, risk sensitivity, and the values of society impact the perception of success.

It is important to note that establishing success criteria with project stakeholders and communicating that information to project team members are two of the key responsibilities of the project manager. During the planning process, the project manager provides the team with the information needed to prepare the project plan and establish the controls to keep the project on track to achieve client satisfaction and project success. Common variables for project success include:

- Setting expectations early and intentionally
- Planning, including the relationships with the triple constraint and other competing demands
- Predicting project success, through analysis and performance measurement
- Project management effectiveness

Project success, in many ways, depends on the actions of three key stakeholder groups: the project manager and team (including external contractors), the project sponsor or parent organization, and the customer or client organization (the end users, the group that will ultimately receive the final project deliverable). Ensuring project success requires the following actions:

- Select the “right” people for the project team.

- Develop commitment and a sense of "urgency" within the project team, to complete the project successfully.
- Establish the appropriate level of project manager authority and management support.
- Establish a good relationship with client, sponsor, and team members (including functional managers).
- Create a positive public image about the project.
- Establish a participative relationship with team members for decision making and problem solving.
- Develop realistic project objectives for cost, schedule, and performance (SMART objectives).
- Anticipate problems and establish risk management plans and back-up strategies.
- Create an appropriate team structure that is flexible, supportive, and has minimal managerial levels, to enhance communication.
- Maintain an awareness of project team needs and establish a strategy for motivation.
- Maintain focus on the project objectives and the final end product.
- Establish a change control process and communicate the importance of managing change.
- Develop a strategy for rewarding and recognizing the project team.

Additionally, the project manager must address the financial measures that may be included in a project benefits management plan. These include:

- Net present value (NPV)
- Return on investment (ROI)
- Internal rate of return (IRR)
- Payback period (PBP)
- Benefit–cost ratio (BCR)

Remember

A project cannot be successful unless it is recognized as a project by upper-level management and is visibly supported. The project charter is a means to establish the "official" existence of the project. Without upper-management support and a clearly identified sponsor, the project manager will experience great difficulty when negotiating for the resources required to achieve project objectives. Project success is also associated with the business value that is achieved at project completion. In some cases, true project value, in terms of financial and/or business benefits and user satisfaction, may not be realized until many years after the project is completed.

▶ Glossary of Terms

Here are key terms and definitions to review and remember.

Benefit–cost ratio An indicator, used in the formal discipline of cost-benefit analysis, that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Best practice Something that works well on a repetitive basis. Something that leads to a competitive advantage. Something that provides value to both the buyer and seller. A process, technique, or action that has been proven to produce superior results consistently and can be applied enterprise-wide.

Deliverable A tangible, verifiable work output. Projects are generally expected to produce several deliverables that will be integrated to achieve the final aggregated or summary deliverable. Project management deliverables include the project management plan, subsidiary plans, work breakdown structure, status reports, and project documents.

Expectation Something that is considered reasonable, due, necessary, or obligatory. The project manager and team set expectations early in the project life cycle. Expectations may be focused on timeliness, quality, communication, level of precision, and reliability.

Functional manager Generally a subject matter expert or technical expert from a specific functional group, such as engineering, design, or other technological areas, who may control or manage resources required to meet project objectives. The functional manager is a person with management authority over a specific organizational unit that performs a specialized function or produces a product.

Internal rate of return Internal rate of return (IRR) is a metric used in capital budgeting measuring the profitability of potential investments. Internal rate of return is a discount rate, determined through iterations, that will drive the net present value (NPV) of all cash flows from a particular project to be equal to zero.

Lessons learned Information obtained through experience that may be shared to improve performance, increase opportunity, or prevent occurrence of negative events, results, or activities.

Net present value Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. NPV is used in capital budgeting to analyze the profitability of a projected investment or project.

Payback period The payback period is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment positions. The payback period ignores the time value of money, unlike other methods of capital budgeting, such as net present value, internal rate of return, or discounted cash flow.

Project sponsor The person or organization that has authorized the project and provides the funding to support the project. (Note: Some organizations feel that it is best for the ultimate sponsor to be associated with an area or internal entity that does not have a direct vested interest in the project. This allows for impartial decisions to be made, such as termination for failing to provide the expected value or to reassign resources to a higher-priority project.)

Return on investment A performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. ROI measures the amount of return on an investment relative to the investment's cost. To calculate ROI, the benefit (or return) of an investment is divided by the cost of the investment, and the result is expressed as a percentage or a ratio.

Stakeholder Any person or organization directly involved in or impacted either positively or negatively as a result of the project.

Triple constraint The triple constraint consists of three major project elements: schedule (the estimated timeline for the project), cost (the estimated cost to deliver the product or service), and performance specifications (scope and quality). It is usually depicted as a triangle and indicates the commonly defined competing demands associated with project success. The triple constraint emphasizes the relationship between each of the elements and the impact of a change to any of the elements or sides of the triangle. Traditionally, most project trade-off decisions were based on the relationships with the triple constraint.

The competing demands associated with projects are now expressed more broadly and include risk, resources, quality, safety, and other factors depending on the industry and the specific project environment.

Value An amount, as of goods, services, or money, considered to be a fair and suitable equivalent for something else; a fair price or return. Monetary or material worth. Worth in usefulness or importance to the possessor; utility or merit. In the project management environment, the perception of value is associated with the views of the project stakeholders and the realization of their specific needs. Value may be perceived in terms of achieving the objectives defined for the project, or it may also be defined in terms of return on investment, level of customer satisfaction, and benefits that may be realized in the future, well after the project has been completed.

► Activities, Questions, and Exercises

Refer to Chapter Nine of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*: Integration Management, Scope Management, Project Resource Management.

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1. List five principal factors that are commonly used to measure and determine if a project is successful.

_____

_____

_____

_____

_____

2. Explain how each of the following organizational variables can have an impact on project success.

   a. Strategic planning: _____

   _____

   _____

   _____

   b. Enthusiastic management support: _____

   _____

   _____

   _____

   c. Prompt and accurate communication from upper-level management: _____

   _____

   _____

   _____

   _____

   d. Organizational structure flexibility: _____

   _____

   _____

   _____

   _____

   e. Emphasis on past experience (lessons learned): _____

   _____

   _____

   _____

3. There are many methods available and actions that may be taken to achieve project success. Review the following statements and complete each statement by selecting the appropriate phrase from the list provided:

   Projects are more likely to be successful if you:

   a. Encourage openness and honesty from ____
   b. Create an atmosphere that ____
   c. Plan for ____
   d. Develop short and informal ____
   e. Avoid excessive ____
   f. Allow adequate time to ____
   g. Ensure that project work packages are ____
   h. Match the right people with ____
   i. Develop effective working relationships with ____
   j. Establish and use effective ____
   k. Connect project assignments and task responsibility with ____
   l. Plan for project completion and transfer of final deliverables ____

      1. Adequate funding to complete the entire project
      2. The start of the project
      3. Encourages teamwork and healthy competition
      4. Lines of communication
      5. Paperwork and administrative workload
      6. Establish the project groundwork or foundation and define the project work
      7. The proper size, are manageable, and have been assigned organizational responsibility
      8. Performance appraisal and rewards
      9. The right jobs and with the appropriate level of training and competency
      10. The project team, functional managers, and project sponsor
      11. During project execution and before actual project completion
      12. Planning and control procedures

Remember

After completion and acceptance of deliverables, many projects require a period of time (one to two months or more) after the work is completed for administrative reporting, final cost summary, and hand-off to the receiving organization. An acceptance period may be established within the contractual terms and conditions of the project and included in the project life cycle. Final payments and a project review may be arranged at completion in the acceptance phase.

Major Causes of Project Failure

Project managers concentrate on the successful completion of a project but should maintain an awareness of why projects may fail. There are several reasons for project failure, but the most common causes are:

- Selection of a concept that is not applicable or does not have a sound basis
- Forcing a change at an inappropriate time
- Selecting the wrong person as project manager: assigning a person who possesses significant technical skills but does not have sufficient managerial and interpersonal skills
- Executive or upper management is not supportive of the project: Lack of support from management will, in most cases, create significant roadblocks and eventually result in project cancellation.
- Inadequately defined tasks: A system for planning that includes task definition, development of a schedule, estimated costs, and control processes is required, or the project team will experience considerable amounts of rework, delays, and additional costs.
- Management techniques: A tendency to do more than what is required, failure to build teamwork, lack of motivation, over-supervision, and poor communications skills will contribute to project failure.
- Unplanned project termination: may be caused by a change in strategic direction, loss of funding, uncontrolled costs, poor quality, lack of team commitment, or contract default

Note

Project Management Knowledge Note: Long before the project ends, the project manager should plan for its end:

- Disposition of personnel
- Disposal of material and other resources
- Transfer of knowledge
- Closing out work orders
- Customer/contractor financial payments and reporting

4. For each of the potential reasons for project failure, provide a possible solution or recommended preventive action.
   a. Concept is not applicable or is unsound. _____

b. Forcing a change at the wrong time. _____

_____

_____

c. Selecting the wrong person as project manager. _____

_____

_____

d. Management is not supportive of the project. _____

_____

_____

e. Inadequately defined tasks. _____

_____

_____

f. Ineffective management techniques. _____

_____

_____

Unplanned project termination due to:

g. Change in strategic direction. _____

_____

_____

h. Loss of funding. _____

_____

_____

i. Uncontrolled costs and other variances. _____

_____

_____

j. Poor communication. _____

_____

_____

■ Project Management Effectiveness

Project success and a successful career path are dependent upon the project manager's ability to establish and maintain good working relationships with management as well

as the project team. Clear expectations between the project manager and all key project stakeholders must be established early in the project-planning process. There are four key variables in measuring the effectiveness of the project manager in dealing with stakeholders: credibility, priority, accessibility, and visibility.

5. Review the following list of characteristics and match them with the four key variables of management effectiveness.
   a. Credibility: _____
   b. Priority: _____
   c. Accessibility: _____
   d. Visibility: _____

   1. Sound decision maker
   2. "Selling" the importance of the project and connecting it with organizational goals
   3. Experience from a variety of assignments
   4. Making a positive impression when presenting the project to upper management
   5. Emphasizing facts over opinions
   6. Ensuring that others receive appropriate credit for work performed
   7. Obtaining testimonial support for the project from functional groups, customers, and other managers
   8. Ability to communicate as needed with stakeholders
   9. Becoming personally known by managers in several departments, including upper management
   10. Creating an environment where managers and customers desire your involvement
   11. Conducting timely informational meetings
   12. Using available publicity media appropriately
   13. Creating a common understanding about the project through presentations and emphasizing project successes

Remember

Generally, a project manager is expected to assume total accountability for project success or failure. This means providing timely and accurate project reports and information, minimizing disruption of organizational operations during project execution, managing interpersonal issues among project team members, maintaining a self-starting attitude and approach, and growing in experience with each assignment.

■ Managing Expectations

Project success is dependent not only on the abilities of the project manager but also on a set of clearly defined expectations that have been established between the project manager and the project sponsor or executive, between the project manager and project team members, and between the project manager and the customer.

6. The following items are typical expectations that are established during the beginning stages of the project life cycle. Review each item and determine if it is an expectation set between the project manager and project sponsor/upper management or between the project manager and project team.

Expectation	Project team expectation of the project manager	Sponsor/executive expectation of the project manager	Project manager expectation of the project team
Take action on requests			
Provide clearly defined decision channels			
Assist in problem solving			
Provide direction and leadership			
Assist in conflict resolution			
Provide feedback			
Facilitate interaction between functional groups			
Provide strategic direction			
Define expectations clearly			
Demonstrate innovation and creativity			
Stimulate team building and group process			
Facilitate the addition of new team members			
Protect the team from external pressures and politics			
Remain results-oriented			
Communicate effectively and in a timely manner			

Expectation	Project team expectation of the project manager	Sponsor/executive expectation of the project manager	Project manager expectation of the project team
Fully commit to the project objectives			
Provide reward and recognition for the work accomplished			
Show respect			
Motivate and maintain high morale			

Remember

Lessons can be learned during any phase of a project. To make them useful they should be documented and shared with other project managers and project teams within your organization. Sharing lessons learned is associated with the professional and social responsibility domain of project management. Transfer of knowledge, increasing the project management historical database of your organization, and enhancing the processes you work with are all associated with the overall responsibilities of the project manager and are factors that impact the continuing success of the organization.

7. **PM Quick Check:** Lessons learned should only be reviewed and documented after the project has been completed.
   - ☐ True
   - ☐ False
8. **PM Quick Check:** Project success will be ensured if the project team maintains control of the scope, schedule, and cost of the project.
   - ☐ True
   - ☐ False

■ Best Practices

Most organizations, especially those that are considered "project-based," have experienced the advantages of documenting and sharing lessons learned. Examples of lessons learned include:

- Establishing project life cycle phases
- Standard methodology for planning

- Use of templates for planning, scheduling, control, and risk management
- Control of customer- and contractor-generated changes
- Use of earned value measurement

It is important to note that what is considered a best practice in one organization may not work effectively in another organization. The project manager and project team may be required to adapt industry best practices to meet their organization's specific needs.

9. Describe at least one best practice for each of the following items that would be useful to share with project team members and other project managers.

a. Managing project scope: _____

_____

_____

b. Engaging stakeholders: _____

_____

_____

c. Establishing standards: _____

_____

_____

d. Developing consistent and reliable estimating procedures for time and cost: _____

_____

_____

10. Explain what is meant by "critical success factors" and provide examples that would typically be used in the project environment. _____

_____

_____

_____

_____

11. Consider the following: You are assigned to a PMO and have been requested to develop a template that will define the criteria for establishing a "best practice" for your organization. What criteria would you use?

_____

_____

_____

_____

Remember

Best practices are those actions or activities undertaken by the company or individuals that lead to a sustained competitive advantage in project management.

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The topic "Variables for Success" is most closely related to the following knowledge areas in the *PMBOK® Guide* Sixth Edition: Understanding the Project Environment, Interpersonal Skills, Project Life Cycle and Organization, Project Management Processes, Integration Management.

The most common factors used to determine project success are the elements of the triple constraint: time, cost, and scope. (Scope is also associated with quality and performance specification.)

Project success is no longer based on managing the triple constraint. Customer satisfaction, minimizing substantial changes, team satisfaction, and minimizing the impact of the project on business operations are also key factors.

There are five major process groups that are integrated in the planning of a project: initiating, planning, executing, monitoring and controlling, and closing.

The project manager works in collaboration with the project team to determine how the processes will be managed and at what level of effort to achieve project success. The five major process groups are applied to each phase of a project.

Communicate and utilize lessons learned from project successes and project failures to improve performance of future projects, enhance the risk management process, identify potential problem areas, and develop preventive measures.

Preventive measures are generally less costly than repair, rework, and failure. Prevention is preferable to correction.

A project review at the end of a phase or at the completion of a milestone will assist in identifying areas for improvement and increasing the probability for overall project success.

Review stakeholder needs to ensure that project performance is on track with expectations.

Review project planning assumptions and constraints on a regular basis. Validate assumptions and maintain an awareness of how constraints may impact project performance.

Set expectations specifically and intentionally between project team members and the project manager, project sponsor and project manager, and key stakeholders

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

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▶ Answers to Questions and Exercises

1. On time, within budget, according to scope/specifications, quality at the required level, to customer's satisfaction. (Several other factors may be included.)
2. **a.** Strategic planning drives the selection of projects.
   b. The project will be supported by the entire organization and result in greater buy-in of the project team.
   c. Regular feedback and communication from management indicates involvement and continued interest in the project.
   d. Enables resources to be moved as necessary to support the project
   e. More efficient planning including better risk management, avoidance of repeated errors, and improved probability of success
3. **a.** 2
   b. 3
   c. 1
   d. 4
   e. 5
   f. 6
   g. 7
   h. 9
   i. 10
   j. 12
   k. 8
   l. 11
4. **a.** Perform proof of concept or feasibility study. Obtain additional information. Review requirements and specifications.
   b. Utilize a change control process and analyze the impact of the change before deciding to implement.
   c. Review the complexity of the project and the visibility of the project, and establish performance expectations for project results and managing people. Establish specific qualifications for the project manager.
   d. Review the project charter, verify project objectives, determine if the project is related to organizational objectives, and review project risks. Obtain feedback from management.
   e. Ensure the WBS has been properly defined to the appropriate level of detail. Verify the scope statement. Conduct a project kickoff and planning meeting.
   f. Establish performance criteria for the project manager, obtain a coach or mentor, escalate to the next level of management, and provide appropriate training.
   g. A change in strategic direction may result in project termination. The project manager may not be able to prevent this from occurring. Effective and regular communication with decision makers is recommended.
   h. Similar to the situation described in (a). Loss of funding may be an organizational issue. Ensuring that the project objectives remain connected with organizational objectives, ensuring the project is viewed as a priority project, and controlling project results to show positive project progress may prevent termination.

i. Establish project monitoring and control procedures, and initiate corrective action before variances approach established thresholds.

j. Establish a communications plan at project start-up. Emphasize the importance of teamwork and integration of project components. Identify stakeholder needs and act on those needs.

5. a. 1, 3, 5, 6, 10, 13

b. 2, 7

c. 8, 9, 10

d. 4, 9, 10, 11, 12, 13

6.

Expectation	Project team expectation of the project manager	Sponsor/executive expectation of the project manager	Project manager expectation of the project team
Take action on requests	X	X	X
Provide clearly defined decision channels	X	X	
Assist in problem solving	X	X	X
Provide direction and leadership	X	X	
Assist in conflict resolution	X	X	
Provide feedback	X	X	X
Facilitate interaction between functional groups	X	X	
Provide strategic direction		X	
Define expectations clearly	X	X	X
Demonstrate innovation and creativity	X	X	X
Stimulate team building and group process	X	X	
Facilitate the addition of new team members	X	X	X
Protect the team from external pressures and politics	X		

(Continued)

Expectation	Project team expectation of the project manager	Sponsor/executive expectation of the project manager	Project manager expectation of the project team
Remain results-oriented		X	
Communicate effectively and in a timely manner	X	X	X
Fully commit to the project objectives		X	X
Provide reward and recognition for the work accomplished	X	X	
Show respect	X	X	X
Motivate and maintain high morale	X	X	

7. False
8. False
9. a. Define the scope as completely as possible using previous projects for guidance. Use the experience of the team, apply templates when available and appropriate, and obtain the input from all key stakeholders. Explain the reason for the project and who will be affected by the project.
   b. Identify all project stakeholders. Ensure that all team members understand the definition of a stakeholder. Establish communications plans to meet the needs of the stakeholders. Become aware of the specific biases of each stakeholder. Plan for engagement of stakeholders.
   c. Communicate standards to the project team. Provide appropriate documentation about applicable standards. Establish control procedures to ensure that the project conforms to standards. Identify exceptions to organizational standards.
   d. Establish a risk management plan. Conduct a SWOT analysis. Provide risk management training to the project team. Schedule periodic risk reviews.
   e. Use reliable sources for all estimates. Avoid padding. Consider risk when estimating.
10. Any of the aspects of a business that are identified as vital for desired targets to be reached and maintained. Critical success factors are normally identified in such areas as production processes, employee and organization skills, functions, techniques, and technologies. The identification and strengthening of such factors may be similar.

Examples of critical success factors:

1. Appropriate training and education
2. Standards for quality performance data gathering and reporting
3. Clearly visible management commitment
4. Ability to measure customer satisfaction levels
5. Supportive organizational structure
6. Defined quality assurance process
7. Effective communication across organizational boundaries
8. Defined and managed processes for continuous improvement

11. Is it a measurable metric?

Does it identify measurable efficiency?

Does it identify measurable effectiveness?

Does it add value to the company?

Does it add value to the customers?

Is it transferable to other projects?

Does it have the potential for longevity?

Is it applicable to multiple users?

Does it differentiate us from our competitors?

Will the best practice require governance?

Will the best practice require employee training?

Is the best practice company proprietary knowledge?

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER TEN

Working with Executives

In most project-based organizations, the project manager is positioned to lead a team assigned to deliver a product or service that has been determined to have business value. Generally, the project selection process involves a proposal or submission of an idea, a vetting process that includes a business case analysis to ensure alignment with company strategic objectives, and the issuance of a project charter. The project charter, usually prepared and signed by the project sponsor, identifies the project manager and authorizes the project manager to use organizational resources to complete project objectives. The project sponsor is, in most cases a senior-level manager, an executive, or an executive steering committee. Establishing a positive relationship with the sponsor and/or project executive and continually interfacing with them as the project is planned and implemented are major factors in achieving project success and securing additional project assignments.

The role of the executive in the process of managing projects varies significantly from one organization to another but generally an executive either introduces a project for selection or is positioned to support a project that has been approved. The executive aligned with the project is referred to as the project sponsor. The project sponsor is involved in the organization's project selection process and participates in the decisions that determine which projects are approved for implementation and those projects that should be denied or terminated. The project sponsor may also be involved in contract negotiations with clients and suppliers. At completion of the selection process, the sponsor provides or authorizes the necessary funding and resources for the approved project. The project sponsor's role includes providing guidance about project objectives and ensuring alignment with organizational strategy, high-level information on the enterprise environmental factors, setting business priorities for the project, and creating or approving the project organizational structure. The project sponsor also provides oversight during initial planning and may be required to engage in conflict resolution related to resource assignments, budget approval, and project prioritization.

In the early stages of the project, the project sponsor will oversee the planning process and provide support to the project manager in several activities:

- Justification and prioritization of the project within the performing organization
- Establishing and or approving the project objectives

- Aligning the project with strategic organizational goals
- Providing information about organizational environmental factors and political issues that may impact the project
- Providing guidance regarding organizational policies and procedures
- Establishing the appropriate level of executive involvement to effectively engage and manage clients and contractors

During the project life cycle, the sponsor continues to provide oversight for the project and receives updates and status reports from the project manager. The level of involvement of the sponsor depends on project complexity, the political environment, project performance, contractual agreements, competency of the project manager, and many other factors.

Remember

When establishing a relationship with the project sponsor, the project manager should become familiar with what are described in the *PMBOK® Guide*—Sixth Edition as *organizational process assets* (policies, procedures, and standards) and *enterprise environmental factors* (organizational culture and political climate as examples). Knowledge of these items may assist in defining expectations, developing more complete and reliable plans, and developing strategies for managing project issues that may require sponsor involvement.

To avoid the possibility of micromanagement (also known as executive meddling), the project manager must establish clear expectations with the sponsor at the start of the project and communicate effectively with the sponsor throughout the project life cycle. Today's project environment demands more fluid information flows and project-based organizations have turned to the use of project dashboards as a more efficient method for providing project information. Dashboards provide sponsors and executives with key project information that can be analyzed quickly. Dashboards are convenient and allow for customization to address the needs of specific stakeholders.

► Glossary of Terms

Enterprise environmental factors Factors that have been established over time or influence an organization's general operating practices. These factors include the organization's recognized culture, government or industry standards, existing human resources and capabilities, infrastructure, the political environment, and organization risk tolerances,

Exit champion/sponsor: This is an individual or committee at the senior-most levels of management that periodically performs a health check on projects to make sure that

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the project is performing at an acceptable level and should either continue or terminate. Project sponsors generally do everything possible to support the project manager and to make sure that the project meets objectives and remains aligned with organizational strategies to ensure it will continue. The champion determines whether or not the resources can better serve the company elsewhere, whether the enterprise environmental factors have changed, whether the assumptions are still valid, and whether the perceived value will be realized at project completion. Champions validate the continuation or termination of the project and generally have the authority to override the decisions of the project sponsor.

Objective A planned or intended outcome. Refer to the acronym "SMART" (Specific, Measurable, Attainable, Realistic, Time-based).

Organizational process assets Formal and informal processes established and in use within an organization. These may include standard policies for safety, product quality, communications requirements, financial controls, change control, risk management, and project closure procedures.

Portfolio Projects, programs, and operations managed as a group to achieve strategic objectives.

Project sponsor The person or organization that has authorized the project and approves or provides the funding and resources to support the project.

Scope creep Unauthorized or uncontrolled changes to the project scope. Scope creep sometimes occurs when a project team member or project manager attempts to exceed customer expectations by providing additional work or product features that are not included in the approved scope of work.

Stakeholder Any person or organization that is directly involved in, or impacted either positively or negatively as a result of, a project or program.

Stakeholder engagement The processes by which an organization or project leader involves people who may be affected by a project. Stakeholder engagement involves communication about project activities, updates about progress, and maintaining active and ongoing interest in the project. Maintaining stakeholder engagement is a critical success factor and requires significant project manager attention.

SWOT analysis A strategic planning method used to evaluate the *strengths*, *weaknesses*, *opportunities*, and *threats* (SWOT) involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that may affect the achievement of an organization's vision, mission, and business objectives. The SWOT analysis is discussed in the *PMBOK® Guide* (6th edition), Chapter 11, and in the Kerzner textbook in Chapter 17.

► Activities, Questions, and Exercises

Refer to Chapter 10 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information and assistance in completing each exercise.

The following questions and exercises are associated with the following *PMBOK® Guide*—Sixth Edition chapters, sections, and knowledge areas: Introduction, Project Life Cycles and Project Organization, Projects and Strategic Planning, Organizational Project Management and Strategies, Organizational Structure and Influences on Project Management Methods, Roles, Responsibilities and Competencies of the Project Manager, Project Stakeholders, Organizational Cultures and Styles, Planning Process Group, The Environment in Which Projects Operate, Project Resource Management, Project Communications Management.

Study tip: The project sponsor or executive generally provides guidance for the following:

- Project objective setting
- Priority setting (when multiple projects are in progress)
- Project organizational structure (for communications and escalation of issues)
- Project policies and procedures
- Project master planning: connecting the project to higher level strategic goals
- Up-front planning: connecting projects to business value
- Key staffing: ensuring assignment of appropriate resources
- Monitoring execution: through dashboards and status reports
- Conflict resolution: typically involving resource assignments, funding, project priorities, disputes between functional groups

Review each of the following questions or exercises and provide answers in the space provided.

1. Executives should be involved in all phases of project planning and implementation.
   - ☐ True
   - ☐ False
2. The project sponsor provides assistance "as needed" during the execution of the project.
   - ☐ True
   - ☐ False
3. Expectations should be mutually established between the project sponsor and project manager at the start of the project.
   - ☐ True
   - ☐ False
4. The project executive or executive steering committee is responsible for establishing project priority within the organization.
   - ☐ True
   - ☐ False

5. Every project requires a formally identified sponsor.
   - ☐ True
   - ☐ False
6. The project sponsor should be visible to the entire team as well as the customer and constantly informed about project status.
   - ☐ True
   - ☐ False
7. The goals and objectives of the sponsor should be aligned with the strategic goals and objectives of the organization supporting the project and should clearly align with the defined project success criteria
   - ☐ True
   - ☐ False
8. During the initiation or kickoff phase of a project, the project sponsor must be actively involved in setting objectives and priorities
   - ☐ True
   - ☐ False
9. During the execution stage of a project, the sponsor must be *selective* in the problems that he or she wishes to help resolve.
   - ☐ True
   - ☐ False
10. The project manager should be prepared to challenge decisions made by the project sponsor
    - ☐ True
    - ☐ False
11. Role identification**:** Review each role and identify if it is associated with the project manager or project sponsor. Place a checkmark in the appropriate columns.

Role	Project Manager	Project Sponsor
a. Major decision-making role and participation in the sales effort and contract negotiation	_____	_____
b. Prepares detailed project reports	_____	_____
c. Provides assistance in getting the project underway by communicating processes and procedures and securing appropriate staffing	_____	_____
d. Liaison to executive committees and steering committees	_____	_____
e. Prepares the detailed project budget estimate	_____	_____
f. Prepares performance appraisals for project team members	_____	_____

(*Continued*)

Role	Project Manager	Project Sponsor
g. Interprets company policies and communicates information about organizational process assets	_____	_____
h. Becomes involved in solving major project related problems	_____	_____

12. What is the most effective method for managing a project sponsor or executive who closely manages, observes, and influences day-to-day project manager activities?

a. Provide the sponsor with large amounts of administrative work to prevent the sponsor from becoming involved in the project activities.

b. Ask for role clarification and establish expectations for providing project information and managing project activities.

c. Invite the project sponsor to every project status meeting and have all team members provide status reports directly to the project sponsor.

Remember

The project sponsor works with the project manager to establish objectives, set priorities, create the project organization, communicate organizational policies, establish client-executive contact, obtain key staffing, establish monitoring and control processes for use during execution, and develop processes for escalation and conflict resolution.

Project-based organizations often refer to project status using what is known as the "traffic light" reporting process or red, yellow, and green status condition.

- Green light or green status: Work is progressing as planned. No major issues. Sponsor involvement is not required.
- Yellow light or yellow status: A potential problem exists. The sponsor is informed but sponsor action is not required at this time.
- Red light or red status: A problem exists that may affect the project scope, schedule, or budget. Sponsor involvement and action is required.

13. Categorize the status of each of the following situations as green, yellow, or red light.

Situation	Status Type (Green, Yellow, Red)
a. A task that is not on the critical path is delayed. There is sufficient slack to manage the delay.	_____
b. A critical resource may not be available at the scheduled time. Negotiations are underway to resolve the issues.	_____

Situation	Status Type (Green, Yellow, Red)
c. A report shows project performance regarding scope and schedule, and budget is within acceptable variance thresholds.	_____
d. The customer insists on a major requirements change well after acceptance had been obtained and production is in advanced stages.	_____
e. The project manager discovers that a major component of the scope of work is missing in the project plan due to an oversight by the customer.	_____
f. The client has issued a change request that could delay the completion of a contractual milestone.	_____
g. A functional manager advises the project manager that overtime may be needed to complete a task on time. A contingency had been included in the cost estimate for the task.	_____

Exam Tip

The Status Reporting Process

Generally, there are three types of status reporting: progress reports (what has been accomplished), status reports (the current state of the project), and forecasts (what is expected to occur). Project managers must identify specifically what information the project sponsor expects to receive and when.

Remember

Today, new roles for the project executive are developing, including:

Establishing a center for excellence in project management

Establishing a project office or centralized project management function

Creating a project management career path

Creating a mentorship program for newly appointed project managers

Creating an organization committed to benchmarking the best practices in project management in other organizations

Providing strategic information for risk management and business intelligence

14. To avoid scope creep, which of the following would be the most appropriate action to take?

a. Issue an authorization to change the scope each time the customer submits a requirements change request.

b. Ignore all change requests and review them at the completion of the project to determine if a new project should be initiated.

c. Conduct periodic project reviews with the project sponsor to compare project baselines with actual work.

d. Prepare, sign, and deliver to the sponsor a statement that specifically commits to the sponsor that there will be no changes to the project plan once it has been approved.

15. Why is a SWOT analysis important to the strategic planning process?

16. What conditions would cause a project executive or sponsor to become directly involved in the day to day activities of a project?

17. Describe the characteristics of a "mature" project management organization.

18. The project sponsor role is often misunderstood. It is important to ensure that the project manager and team members are aware of the multiple roles and responsibilities of the sponsor. Describe the key roles generally associated with the project sponsor

_____

_____

_____

_____

_____

_____

19. Stakeholder identification, stakeholder mapping, and developing strategies for managing different stakeholders are important elements in managing project requirements and dealing effectively with change. Stakeholder influence and interest in a project are also important. What tool or technique can be used to determine the relative interest and influence a stakeholder may have regarding a project?

_____

20. What are the generally accepted strategies to manage the following stakeholder categories?

a. Low power or influence, low interest or concern _____

b. High power or influence, low interest or concern _____

c. Low power or influence, high interest or concern _____

d. High power or influence, high interest or concern _____

21. Why is an "exit champion" sometimes necessary throughout the life of a project?

_____

_____

_____

_____

22. What are the major reasons why a project team should conduct a stakeholder analysis?

_____

_____

_____

_____

_____

_____

Remember

Occasionally a project manager may disagree with a project sponsor regarding decisions about the project. Disagreements may occur due to the project sponsor's lack of understanding about technical issues, the project sponsor's workload or span of control, which may limit available time to support the project, or the communications gaps that may be formed in the organization's hierarchal structure. To avoid disagreements the project sponsor and project manager must establish clear expectations about roles, responsibilities, and project communications and establish agreement about how the project is related to organizational strategic goals and objectives.

Organizational politics is another area that a project manager should become familiar with. The project sponsor is often the first line of defense to protect the project from internal and external influences. It is important to gain an understanding of an organization's political environment, establish appropriate business relationships with key stakeholders, and discuss political strategies with the project sponsor.

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The topic of working with executives is most closely related to the following areas in the *PMBOK® Guide*—Sixth Edition: Project Resource Management, Communications Management, Project Scope Management, and Project Integration Management. The project sponsor is generally considered to be the person, group, or organization that authorizes a project and provides the financial resources for the project. Project sponsors may be executives within an organization or they may be an entire steering committee or group of decision makers. Project managers are usually selected by the project sponsor during the approval of the project charter, which is a document prepared by the sponsor that officially authorizes a project and assigns a project manager. Project managers should set expectations with the project sponsor at the start of the project and revisit those expectations frequently during the project life cycle. Executives and project sponsors generally require higher-level summary information about project status and progress. Milestone charts and high-level summary Gantt charts are usually appropriate methods of communicating the status to executives and sponsors. Dashboard reporting is commonly used to provide the status to executives and sponsors.

Project management is related to many of the functions of general management: planning, organizing, staffing, executing, and controlling. Before escalating a problem

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to a project sponsor, the project manager should verify that resolution actually requires sponsor intervention. When escalating an issue to a project sponsor, it is important for the project manager to provide the appropriate level of information for the sponsor and offer recommendations and possible solutions or alternatives for the sponsor to review. The project sponsor is considered to be a *key stakeholder*. The project manager must become familiar with the processes of engaging stakeholders and *managing stakeholder needs,* which requires an understanding of communications requirements and the ability to resolve issues that may cause stakeholder dissatisfaction or conflict. Balancing stakeholder needs is also associated with professional and social responsibility. The project manager should become familiar with the project business case: a documented economic feasibility study used to establish the validity of the business benefits of the potential project.

Review and become familiar with the differences between project, program, and portfolio management. Projects are temporary endeavors to create a unique product or service. A program is a group of related projects that are managed in a coordinated manner to achieve higher levels of benefits realization. Portfolios are collections of projects, programs, and operational items managed in groups to achieve strategic objectives.

Multinational stakeholders: Projects that are considered to be "global" may involve stakeholders that are not clearly visible. Project managers should continually assess the project environment to identify stakeholders that may not have been identified in the early stages of planning. Project management centers of excellence and project management offices may be established as organizational project management matures. These organizations may assume the roles of the project sponsor.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. False
2. True
3. True
4. True
5. False
6. True
7. True
8. True
9. True
10. True. Sponsors do not always have the necessary details when making a decision, and the project manager should be prepared to dispute a decision in a politically appropriate manner.

11. a. Sponsor
    b. Project manager
    c. Sponsor and project manager
    d. Sponsor
    e. Project manager
    f. Project manager
    g. Sponsor
    h. Sponsor
12. b
13. a. Green
    b. Yellow
    c. Green
    d. Yellow
    e. Red
    f. Red
    g. Green
14. c
15. The SWOT analysis (strengths, weaknesses, opportunities, threats) provides the sponsor and the organization with useful information that will assist in the decision to approve a project or to move forward with a project and also assists in assessing the probability of project success. The SWOT analysis may also generate alternatives to the original project solution. SWOT analysis is commonly used as a tool to establish or update strategic plans. Additional information about SWOT will be found in Chapter 11 of the PMBOK® Guide Sixth Edition.
16. Failure to report status in a timely manner. Inaccurate or late project status information. Lack of useful information. Failure to maintain adequate levels of communication with the project executive or sponsor. Failure to meet agreed upon expectations.
17. Executive involvement is usually passive, there is visible and continuous support for the project, trust between the project manager and project sponsor is evident.
18. Sets project priorities, communicates with senior management about strategic issues, communicates policies, serves as liaison with senior client executives, reviews and approves the project master plan, setting expectations with the project manager, assuring protection of intellectual property. Ensures deadlines are realistic, provides constructive feedback to the project manager.
19. Stakeholder power and interest grid
20. a. Monitor
    b. Keep satisfied

c. Keep informed

d. Manage closely

21. To make sure that the project has "exit ramps" to terminate a project before massive resources are committed and consumed. To ensure that the project closure process is managed effectively and as quickly as possible.

22. A project team should conduct a stakeholder analysis to determine:

- Who is powerful and influential and who is not
- Who will have or require direct or indirect involvement in project decision making
- Who has the power to terminate the project
- The urgency of project the deliverables
- The appropriate amount of information to be provided
- Who will make decisions regarding change requests and modifications to the project baseline plans

Your Personal Learning Library

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Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER ELEVEN

Planning

"Failure to plan means planning to fail."

—Ben Franklin and Winston Churchill

"The primary benefit of not planning is that failure will then come as a complete surprise rather than being preceded by periods of worry and depression."

—Anonymous

"In preparing for battle I have always found that plans are useless, but planning is indispensable."

—Dwight D. Eisenhower

Planning is one of the most important activities performed by the project manager and project team. It is the process of preparing a sequence of action steps to achieve some specific goal.

Planning can best be described as the functions associated with developing and communicating objectives of an enterprise, project, or program and then establishing the policies, procedures, programs, and activities necessary to achieve them. Planning in the project environment involves a team effort to establish a course of action that will achieve a set of predetermined objectives within a constrained environment. The constraints are generally associated with time, cost, scope, quality, risk, and resources. However, there can be other competing constraints such as safety, image, reputation, and the like.

From the business value perspective the project manager is the key to successful project planning and is responsible for identifying, coordinating, and integrating the functions and activities required to deliver the desired project results. Ideally, to maximize the output of the planning process, the project manager should be assigned to the project during contract negotiations or at the earliest stage of the project. The project manager is positioned as the team leader and remains committed to the project until completion of objectives or termination of the project.

Planning requires a systematic yet flexible approach that will identify and define specific activities, involve the entire project team, and emphasize the need for integration of all plan components as part of a higher-level project management plan. Project planning

involves multifunctional input and discipline through change control procedures and scheduled project performance reviews. Due to the presence of risk and the likelihood that stakeholders will request changes to the plan and or the product or service involved, planning is an iterative process that will continue throughout the life of the project.

The major objective of project planning is to define completely (or as completely as possible) all work required to produce the desired result, to develop the schedule for completion of the work, to determine the cost of the work, and to ensure that risk and uncertainty are addressed to minimize the impact to the plan.

Remember

In the project environment

If a task is well understood prior to being performed, much of the specific work activities can be planned.

If a task is not understood, then during the actual task execution more knowledge will be gained that, in turn, may lead to changes in resource allocation, schedules, and priorities.

The more uncertain the task, the greater the amount of information that must be processed in order to ensure the effective performance of the project team members assigned to the task. Planning involves making choices, deciding about trade-offs, and managing interdependencies among the project management knowledge areas: scope management, time management, cost management, quality management, resource management, communications management, risk management, procurement management, and stakeholder management.

Planning: The Basic Four

There are four basic reasons for project planning:

1. To eliminate or reduce uncertainty
2. To improve efficiency of the project team
3. To obtain a better understanding of objectives
4. To provide a basis for monitoring and controlling work

The following items provide additional rationale for planning:

- To make sure that the project's objectives and deliverables are aligned with corporate or strategic objectives
- To provide some degree of assuredness that the perceived value can be obtained at project completion[1]

[1] For more information on the importance of "value" in project management, see H. Kerzner, F. and Saladis, *Value-Driven Project Management* (Hoboken, NJ: John Wiley and Sons, and, New York: International Institute for Learning, 2009).

Planning is a continuous process and often requires several iterations before a finalized plan is developed. It is intended to assist the project managers and project team, including the project sponsor, in making decisions with a focus on producing the desired outcome of the project. Effective planning will improve the efficiency of the team and increase the probability of meeting objectives. It is important to note that a project plan, created by the project team and based their combined experience, lessons learned, expert judgment, and an effective agreed upon methodology, will generally produce the specified deliverables with minimal scope changes. It is also important to note that the plan should be expected to change during execution. These changes are generally associated with stakeholder needs, uncertainty, and shifting project priorities. The main value of the plan is that it provides the initial guidance required to organize resources and establishes direction and purpose for the project team.

Planning is also defined in terms of strategic, tactical, and operational perspectives. Strategic planning generally refers to a longer-term view of three to five years and focuses on an organization's vision and direction. Tactical planning may include a one- to two-year view and focuses on the interim steps necessary to achieve the strategic goals. Operational planning addresses a shorter-term view generally associated with a six months to one year and is focused on the ongoing production of goods and services, business efficiency, and optimization of resources. Operations and project management may intersect at various points during a product life cycle. These points may include the project closeout phase and the development of plans to improve operational efficiency or to change product

When planning a project, the project manager and team should consider the purpose of the project and the relationship of the project objectives and final deliverable to the higher-level strategic objectives of the organization. A clear connection between project objectives and organizational strategic objectives will, in most cases, generate sustained upper management support.

General planning and project planning have a number of similarities. These include:

- Setting objectives
- Relationship to a higher level program or business operation
- A schedule
- A budget
- Forecasting: a projection and estimate of the desired results and other factors that may impact objectives
- An organization: the duties and responsibilities associated with achieving objectives
- Policy: guidelines for decision making
- Procedures: the method for carrying out policies and plans
- Standards: guidelines for acceptable performance

Project planning is actually a system that includes a process for:

- Setting objectives
- Developing work descriptions

- Developing a network diagram to identify dependencies
- Scheduling tasks
- Defining activities at the appropriate level of detail
- Budgeting based on task identification, risk assessment, quality requirements, and resource requirements
- Tracking performance
- Managing variance
- Reporting progress
- Providing feedback
- Managing change
- Making decisions
- Closing the project

▶ Glossary of Terms

Assumptions For planning purposes, items that are believed to be true, real, or certain. Assumptions are not grounded in fact and carry with them some element of risk. Assumptions should be revalidated as the project progresses.

Configuration management A process to manage authorized changes to products through surveillance as well as preventing unwanted changes from taking place. Configuration management ensures that changes to physical and functional characteristics of the products or deliverables of the project are reviewed and approved. Configuration management also includes the establishment of an archived audit trail of all changes, approved and not approved, as well as updates and a history of all baseline changes.

Constraints Limitations that may affect planning such as contractual dates, project funding, or resource availability. The existence of the constraints, and the prioritization of the constraints can change over the life of a project. Typical project constraints, also referred to as competing demands include time, cost, quality, scope, risk, and resources. Other constraints include specific directives, such a: Must start no later than, Must finish no later than, Must start no earlier than, Must finish no earlier than.

Objective An aim or desired end of an action. Something toward which effort is applied. A purpose to be attained. Generally, objectives are described using the acronym SMART: Specific terms, can be measured, and are attainable and action oriented, realistic, and bound by time.

Plan A formal and approved document that defines how the project will be implemented. It guides project execution, documents assumptions, facilitates communication among stakeholders, and provides a baseline for measuring project performance. The project plan is expected to change through the project life cycle. The amount of change depends upon the complexity of the project, the changing needs of the client, the level of risk and uncertainty, the economic and technical environment, and the completeness of the planning process.

Portfolio A collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives.

Procedure A series of steps followed in a definite order to accomplish a desired objective or result.

Process A set of interrelated actions and activities designed to bring about a specific result.

Program A group of projects managed in a coordinated way to obtain benefits and control not available from managing them individually.

Progressive elaboration A process of continually moving forward in increments, adding greater levels of detail.

Project A temporary endeavor (has a start and finish date) undertaken to create a unique product or service, and most likely involving multifunctional disciplines.

Project charter The document that formally authorizes the existence of the project and the use of organizational resources perform project activities. Usually issued or approved by the project sponsor or project initiator.

Project life cycle Generally, the project life cycle is a collection of sequential project phases that define the work and duration of the project. In some cases, based upon the assessment of risk, project life cycle phases can overlap to compress the total duration of the project. This technique is known as *fast tracking*).

Project phase A discrete component or element of a project that includes specific work activities to be completed in a scheduled time frame. Project phases are bound by specific start and end dates often referred to as milestones. The project life cycle is composed of a series of project phases the number of which are determined by the control needs of the organization.

Project scope The work that must be performed to deliver the product, service, or desired result of the project.

Rolling wave planning Rolling wave planning is the process of planning for a project in a progressive manner where work to be accomplished in the near term is planned in detail and work that is planned for the future is planned at a higher level and elaborated later as the project continues through the life cycle. Rolling wave planning is also used when downstream work cannot be clearly defined at the low levels of the WBS until certain upstream information such as test results can be evaluated.

Scope The sum of the products and services to be provided as a project.

Scope statement Description of the major deliverables, project objectives, and project assumptions. The scope statement provides a basis for making future decisions about the project. The scope statement is developed to answer the questions: What must be accomplished? Why is it necessary? Who will perform the work? When must the work be accomplished? Where will the work be performed? How will the work be accomplished?

Standard A document established by consensus and/or history that provides for common and repeated use. Generally considered as rules or guidelines to be followed in an organization.

Statement of work A narrative description of work to be done under contract. The statement of work provides the contractor with specific information and the details about the work that must be performed and the deliverables to be produced.

Subsidiary plan A subset of the project management plan. Subsidiary plans are documents that provide detailed guidance about specific planning elements that support the project management plan and are developed based on the needs of the project. Examples of subsidiary plans are scope management plan, cost management plan, risk management plan, communications plan.

Work breakdown structure A deliverable-oriented hierarchal decomposition of the work to be executed by the project team. The WBS organizes and defines the total scope of the project and is used to provide a basis for more detailed planning including the estimating of activity durations, cost of activities, and resource requirements.

Work breakdown structure dictionary A document that describes the components of the work breakdown structure in detail

► Activities, Questions, and Exercises

Refer to Chapter 11 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information and assistance in completing each exercise.

The following questions and exercises are most closely associated with the knowledge areas of the *PMBOK® Guide*: Introduction (The Project Management Framework), Project Life Cycle and Organization, Projects and Strategic Planning, Understanding the Project Environment, General Management Knowledge and Skills, Project Integration Management, and Project Scope Management.

Review each of the following questions or exercises and provide the answers in the space provided. Some questions and situations will have more than one appropriate answer or response. Project managers are aware that many issues they face on a daily basis may have several possible solutions. These exercises are designed to encourage you to think about alternatives before taking action and to select the option that would produce the greatest benefit or most effectively resolve a situation.

■ The Logic of Planning

To be truly effective, planning requires a team and multifunctional approach and must include:

- Agreement about the purpose and objectives of the project
- Agreement about the level of involvement and influence of stakeholders associated with the project

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- Input from all key stakeholders
- Visible and active management support
- Assignment and acceptance of individual responsibilities within the project team and among key stakeholders
- Coordination and integration of all work activities (including the possible impact on operations)
- Commitment of the team to the organization's or project goals and objectives
- Effective lateral or cross-organizational communication

1. **Key questions to consider during the planning process:** match the question to the planning process step.

Planning process step	Questions
a. Prepare environmental analysis	_____
b. Set objectives	_____
c. List alternative strategies	_____
d. List threats and opportunities	_____
e. Prepare forecasts	_____
f. Select strategy portfolio	_____
g. Prepare action programs	_____
h. Monitor and control	_____

1. Where are we now? How did we get here?
2. Where are we capable of going? What do we need to take us where we want to go?
3. Are we on course? If not, why not? What do we need to do to be on course? Can we do it?
4. What do we need to do? When do we need to do it? How will we do it? Who will do it?
5. Is this where we want to be? Where would we like to be? In one year? In five years?
6. What might prevent us from getting there? What might help us get there?
7. Where will we go if we continue as before? Is that where we want to go? How could we get to where we want to go?
8. What is the best course for us to take? What are the potential benefits? What are the risks?

2. What are the most common reasons that cause projects to fail?

_____

_____

_____

_____

PM Quick Check

3. Assumptions should be validated regularly throughout the project life cycle.
   - ☐ True
   - ☐ False
4. The project manager should develop all of the detailed plans for the functional managers to prevent omissions and inconsistency.
   - ☐ True
   - ☐ False
5. Project managers should welcome top management participation, especially at the start of the project.
   - ☐ True
   - ☐ False
6. Why is continuous validation of assumptions critical to project success?

   _____

   _____

   _____

   _____

7. What are the nine major components of the planning stage of a project according to Dr. H. Kerzner?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

Remember

At the project level, planning must include recognition and resolution of group conflict as it relates to goals, assignment and acceptance of responsibilities, increased motivation and commitment to organizational goals, vertical and lateral communications, and coordination of activities between groups.

Life Cycle Phases

An effective approach to planning is to divide the project into specific phases that define the entire project life cycle. Applying a project life cycle approach provides consistency within an organization by defining key phase deliverables and also establishes a greater ability to plan and control the activities in each phase. Analyzing the results or accomplishments of each phase assists the project manager and sponsor in determining if the project should continue on to the succeeding phase. These "end of phase" reviews are commonly referred to as phase exits, stage gates, or go and no-go decision points. End of phase reviews assist in determining the "health" of a project and can prevent an organization from continuing with a project that will not meet financial goals, achieve the desired value, or use resources that could be deployed more effectively and beneficially on other projects.

Key points about project life cycles and project phases

- All projects go through a life cycle that includes specific and describable phases
- Each phase is initiated, planned, executed, monitored, controlled, and brought to closure
- Phases generally have specific deliverables or intended accomplishments that, upon completion, provide the starting point for the next phase. These are referred to as *interim deliverables*.
- Generally, the costs at the start of the project life cycle are low (staffing has just begun, procurement is minimal) and increase throughout the project as work activity and resource usage increases.
- Transitions from one phase to another provide an ideal time to conduct reviews to compare performance with baselines
- Study note: Project phases can overlap to compress the total project schedule if the risks are considered acceptable. This technique is referred to as *fast tracking*.

Commonly used life cycle phases

- Conceptual
- Feasibility
- Preliminary planning
- Detailed planning
- Execution
- Testing and commissioning

Other common phase names: approval, design, build, test, deploy, close

8. The benefits of developing and using a standard project life cycle are _____

_____

_____

_____

9. What factors should be considered when deciding if a project should continue into the next phase of the project life cycle?

_____

_____

_____

PM Quick Check:

10. The purpose of a feasibility study is to
    - a. Determine the total cost of the project and establish a baseline budget.
    - b. Provide technical data and alternatives to the concept and form a basis on which to decide whether to undertake the project.
    - c. Determine the return on investment before initiating the project.
11. Projects are divided into phases for which of the following reasons? (Select all that apply.)
    - a. To improve the ability to control project activities and resources and manage deliverables more effectively
    - b. To establish gates for project reviews
    - c. To provide consistency for managing projects within an enterprise

Remember

Providing interim deliverables on projects that may have long life cycles will provide indications of progress and give the customer and sponsor a sense that work is being accomplished. Interim deliverables may indicate a series of successes that can assist in maintaining team focus and commitment toward the project. Interim deliverables are associated with each phase of the project.

■ Project Manager and Functional Manager Roles

12. The responsibilities of the project manager and the functional managers assigned to the project are specific and unique. Match each of the following roles with either the project manager or the functional manager.

Responsibility	Project Manager	Functional Manager
a. Set project goals and objectives	_____	_____
b. Develop detailed task descriptions	_____	_____
c. Communicate/Establish major milestones	_____	_____
d. Set high-level requirements	_____	_____

Responsibility	Project Manager	Functional Manager
e. Provide detailed schedules	_____	_____
f. Identify areas of risk, uncertainty, and conflict	_____	_____
g. Establish ground rules and provide assumptions	_____	_____
h. Define project constraints	_____	_____
i. Provide summary status reports for the sponsor	_____	_____

■ Project Planning: The Importance of Objectives

Planning starts with an understanding of the objectives of the project. The sponsor, the project manager, and the project team should all have the same understanding about what must be accomplished. There may be several levels of objectives depending on the complexity of the project, but all objectives should be interrelated and support the overall goals and acceptance criteria of the project.

13. The commonly accepted criteria for project objectives are expressed in the word "SMART." Fill in the blanks with the correct description of each letter of the word SMART as it relates to writing objectives:

S _____

M _____

A _____

R _____

T _____

14. Review each of the problems that are generally associated with developing and documenting objectives. Explain the reason or root cause of the problem and provide a possible solution or action to prevent the problem from occurring.

Problem	Error/Cause	Recommended Solution
a. Objectives are not agreeable to all stakeholders.		
b. Project objectives are too rigid in a project subject to changing priorities.		
c. Objectives are not adequately quantified.		
d. Objectives are not documented clearly.		
e. Objectives are too complex.		

(Continued)

Problem	Error/Cause	Recommended Solution
f. Objectives are too numerous.		
g. Performance and behavior of the team are below the established expectation.		

Exam Tip

A high-level set of project objectives is stated in the Project Charter (PMBOK® Guide Integration Management) and further defined and finalized in the Project Scope Statement (PMBOK® Guide Scope Management).

■ The Statement of Work (SOW)

The statement of work is generally defined as the narrative description of the work to be performed under contract. It provides the potential contractor or bidder with specific information about the work that must be performed and provides a basis for the contractor to decide if their organization can perform the work. In some organizations the statement of work may become the actual signed contract after negotiation. The statement of work is not a plan and should not be confused with the scope, project scope, or project scope statement documents. (See the glossary for definitions.)

15. What's wrong with the following statement of work?

The contractor agrees to conduct approximately 15 individual tests of the product before it is released to the client for evaluation. The tests will require supervision by the client to ensure that appropriate procedures are utilized during the tests. Test results should be provided to the client shortly after the tests are completed. The client will review the test results and provide feedback before acceptance.

_____

_____

_____

_____

_____

■ Proposal Preparation

Project planning begins after the proposal process has been completed. It is strongly recommended that the project manager is assigned early and becomes involved in the proposal process. This will provide a strong foundation for project planning and a clear understanding of risks, obstacles, and project opportunities

Remember

Common causes of misinterpretations of the statement of work

Mixing tasks, specifications, approvals, and special instructions
Using imprecise language (e.g., nearly, approximately)
No pattern, structure, or chronological order
Wide variation in size of tasks and details
Failing to obtain a "third-party review"

Milestone Schedules

In the early stages of project planning, before project details are identified, some project scheduling constraints or timing requirements may be defined in association with contractual agreements. These specific dates or milestones include:

- The project start date
- The project end date
- Other milestones such as phase completions or a requirement for a completion of a deliverable
- Reports or data items
- Certifications and approvals
- A point where future work is restrained

16. **PM Quick Check:** A milestone can best be described as:
    a. A significant event in the project schedule
    b. An activity in the project that consumes a large amount of project resources and time
    c. The activities included in the close of a phase or the project

The Business Case and the Project Charter

The business case provides the organization's decision makers with the necessary information to determine whether the expected outcomes of the project justify the investment.

Typical information that may be included as part of a business case:

- The business need: the gap that currently exists and the rationale
- The connection to strategic business objectives
- The value/benefits that may be realized: cost savings, additional profits, or new opportunities
- Assumptions that justify the project
- Financial analysis including benefit-to-cost ratio, cash flow considerations, strategic options, opportunity costs, return on investment, net present value
- Project risks: business, legal, technical, financial

- Resources required: human and nonhuman resources needed (materials, equipment, machinery)
- Legal issues and potential liabilities

The project charter is the document that formally authorizes a project. This means that the project manager, usually assigned at the time of the approval of the charter, is authorized to apply organizational resources to project activities. The charter is initiated and approved, generally, by a project initiator or sponsor external to the organization that will plan and implement the project.

17. Match the following reasons why a project would be chartered by an organization with the appropriate example.

Reason	Example
a. Market demand _____	1. Authorizing a project to meet safety regulations
b. Business need _____	2. A requirement from a client to build a new location to manage expansion
c. A customer request _____	3. A requirement to create a new product to increase revenue
d. A technological advance _____	4. Refurbish a public park in the local community
e. A legal requirement _____	5. A new project to produce a faster and more portable handheld computer
f. A social need _____	6. Building a fuel-efficient car in response to increasing fuel costs and consumer concerns

18. List the key items that would generally be included in a project charter.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

19. What is the main reason for the development of a business case?

_____

_____

_____

Remember

All projects should support the organization's strategic goals and business plans. The strategic goals and business plans should be a major factor in the project selection process.

Requirements

Collecting requirements is the process of gathering, documenting, and determining the needs of project stakeholders to achieve the functionality that will meet project objectives. There are several techniques that may be used to collect requirements:

- Brainstorming
- Focus groups
- Interviews
- Questionnaires
- Benchmarking
- Prototypes

The "collect requirements" process will result in documentation about how the identified requirements will meet the business needs of the project. Requirements may be classified as:

- Business requirements
- Functional requirements: data interactions
- Nonfunctional requirements: safety, reliability, performance, supportability

The Project Scope Statement

The project scope statement is a definition of the project and what must be accomplished. It describes in detail the project deliverables and the work required to achieve those deliverables. In some organizations a preliminary scope statement is developed that addresses the characteristics, boundaries, and constraints of the project, including the deliverables, products, services, and the methods by which the scope will be controlled, verified, and accepted. The final scope statement may include the following items:

- Project and product objectives
- Service requirement and product characteristics
- Product acceptance criteria
- Constraints and assumptions
- Schedule milestones
- Initial defined risks
- A high level or order of magnitude cost estimate
- Configuration management requirements
- Approval requirements

The content and detail of the scope statement will vary by organization but the general intent of the scope statement is to provide the project stakeholders, especially the project team, with the information necessary to plan the project in more detail. The project scope statement is developed by answering the basic questions: Who? What? When? Where? Why? How? How much? And how many?

PM Quick Check

20. What is the difference between a project charter and a project scope statement?

_____

_____

_____

21. What is the difference between "scope" and a project scope statement?

_____

_____

_____

22. Who generally prepares and issues the project charter?

_____

23. What are the main objectives of a project kick-off meeting?

_____

_____

_____

24. What are the major roles of the project manager, functional manager, and senior management (sponsor) during the planning process?

Project manager: _____

_____

_____

_____

_____

Functional manager: _____

_____

_____

_____

_____

Senior management (sponsor): _____

_____

_____

_____

_____

25. Why is it important to validate project assumptions?

_____

_____

_____

■ Decomposition and the Work Breakdown Structure

The work breakdown structure (WBS) is a deliverable-oriented grouping of project tasks and activities shown in a hierarchal arrangement and in descending levels of detail. The WBS displays the complexity of the project and defines the total scope of the project. The purpose of the WBS is to subdivide the project into smaller, more manageable parts and to provide the appropriate level of detail for further planning. The lowest levels of the branches of the WBS are referred to as work packages. The work packages contain the specific activities that must be performed by the project team or assigned resources. These activities are defined at a detail to meet the needs of the project, estimated in terms of duration and resource requirements, schedules, their costs estimated, and their progress monitored and controlled.

Exam Tip

The work package is a deliverable at the lowest level of the WBS where work is to be controlled. The activities in the work package must be performed to produce the deliverable. Work packages are generally associated with a cost account to track the actual costs of the work performed.

The process of breaking the project down into smaller, more manageable parts is known as *decomposition*. This process continues until the appropriate level of detail for planning purposes has been achieved. A common practice is to create a WBS template from a similar project to save time and accelerate the planning process. In some cases, where tasks are scheduled to be completed much later in the project, decomposition may not be possible. In these cases a technique referred to as "rolling wave" planning may be used. In this process, the details are added progressively throughout the project, generally phase by phase.

Remember

The work breakdown structure is considered to be the "cornerstone of project planning." It provides the basis for time estimates, cost estimates, risk identification and analysis, and project control. The WBS is also useful for communicating information about the project and building teamwork by including all functional managers associated with the project in the development of the WBS.

■ WBS Format

The WBS can be developed using several methods. A common approach is to display the WBS in a diagram that resembles an organizational structure. The diagram starts at the highest level, referred to as the project level, and is then broken down into smaller and smaller components and grouped in phases or by deliverables. Another approach is to create an indented format. This format starts with the project name and as each lower level is added, the levels are indented to display the grouping arrangement. Each indentation represents a successively lower level detail of the WBS. Special note: A WBS is *not* a list of tasks. It is a purposely designed *grouping* of tasks and activities. The lowest level deliverable in a branch of a WBS is referred to as a work package. Within the work package are the activities that will be assigned to resources who will perform the work required to produce the deliverable. Even though work can be broken down within the work packages, the lowest level of cost accumulation is usually the work package level.

WBS indentation example

1.0 Project Name
- 1.1 Major project deliverable or subsystem
  - 1.1.1 Task 1
    - 1.1.1.1 Subtask 1
    - 1.1.1.2 Subtask 2
  - 1.1.2 Task 2
    - 1.1.2.1 Subtask 1
    - 1.1.2.2 Subtask 2
      - 1.1.2.2.1 Work Package 1
        - 1.1.2.2.2.1

Organization Type WBS

WBS Practice

26. Using either the indentation technique or the organizational diagram technique, create a WBS for the following project:

Project: Home office addition

Deliverables or subsystems:

- Rough framing and carpentry
- Electrical system
- Plumbing
- Heating and AC
- Painting
- Decorating and furniture placement

Tasks:

- Obtain permits
- Purchase material
- Frame structure
- Run wire
- Install pipes
- Install heating system
- Select paint
- Select furniture

27. Describe how the work should be structured in the WBS to achieve the proper level of planning and control:

_____

_____

_____

_____

_____

28. When using the indented structure to develop the WBS, levels are divided into two major categories, the _____ and _____ levels.

29. The six typical levels within the indented structure are:

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

Remember

The WBS dictionary is used to provide clarity and additional detail to elements of the WBS and may include a code of account identifier.

■ Project Selection and Planning: The Role of the Executive

Before a project is chartered it must be reviewed by the appropriate organization decision makers (executives or steering committee), who will determine if the project should be undertaken. These selection methods may include an analysis of return on investment, payback period, breakeven analysis, net present value, or internal rate of return. These methods are referred to as *benefit selection methods*. Mathematical models such as decision trees may also be used to determine which projects should be selected. The project executive or executive steering committee generally establishes the selection criteria for projects. Feasibility studies may be required to determine if the organization has the capability to perform the project work and a benefit to cost analysis may be required to determine if the project should be selected based on economic measures and return on the investment. In some cases, due to technological issues, competition, compliance requirements, or government regulations, the generally accepted selection process and criteria may not apply. The steering committee may also establish a cancellation criteria so that we know when to cancel a project such that resources are not squandered. The cancellation criteria can change from project to project.

30. Identify five items senior executives consider during the project selection process:

_____

_____

_____

31. During project planning and execution the project manager is expected to provide the project executive with information about the project. What information is typically provided to the project executive or sponsor?

_____

_____

_____

_____

32. What is the role of the project executive or sponsor during the project-planning process?

_____

_____

_____

PM Quick Check

33. The benefits associated with a project may be either tangible or intangible.

- ☐ True
- ☐ False

34. Projects are usually prioritized by executives and the connection of the project to the organization's strategic plan.

- ☐ True
- ☐ False

35. A WBS displays all project tasks in a logical sequence.

- ☐ True
- ☐ False

36. The WBS provides the project manager and team with the ability to develop more reliable cost and schedule estimates.

- ☐ True
- ☐ False

37. The product scope is the work that must be accomplished to deliver the service or result with all specified features and functions.

- ☐ True
- ☐ False

38. The scope statement is the document that provides a common understanding of the scope among all project stakeholders.

- ☐ True
- ☐ False

■ Why Projects and Plans Fail

Projects may fail for a number of reasons. Many failures can be prevented if the appropriate level of planning is applied.

39. For each of the following reasons for failure, provide a possible solution or preventive measure.

a. Corporate goals are not understood at the lower or organizational levels or functional units.

_____

_____

_____

_____

b. Plans are too complex and require too much in too little time.

_____

_____

_____

_____

c. Financial estimates are significantly inaccurate.

_____

_____

_____

_____

d. Plans are based on insufficient data.

_____

_____

_____

_____

_____

e. Planning is performed by a planning group.

f. No one knows the ultimate objective of the project.

g. Staffing requirements are not clearly understood.

h. The project personnel lack the required skills.

i. The project team is not working toward the same specifications.

j. The project team is constantly being shuffled in and out of the project.

40. Projects are sometimes canceled. The termination of the project can occur in any project phase. What are the typical reasons that a project may be canceled by executive management?

_____

_____

_____

_____

_____

41. What are performance measurement baselines (PMBs) and why are they important?

_____

_____

_____

_____

_____

_____

■ Management Control and Configuration Control

After the project has been planned and the plans have been approved by the key stakeholders, a monitoring and control process should be utilized to prevent unauthorized work from being performed, scope creep from developing, and variances to the baselines from exceeding established thresholds. Project control is concerned with:

- Comparing actual project performance to the planned baselines
- Assessing performance to determine if corrective action is necessary
- Identifying, tracking, and responding to risks
- Providing status to key stakeholders
- Providing updated cost and schedule forecasts
- Managing changes through a specified process

A project methodology and a system for storing project information (Project Management Information System, or PMIS) provide the project manager and team with useful information to assist in maintaining control and providing information to stakeholders. Upper management or the project sponsor may establish guidelines regarding control to meet organizational requirements or conform to established policies.

Configuration management is a form of change control. It is a process or technique that manages changes to the features, functions, or physical characteristics of the deliverables of the project or the final product. A configuration control board (CCB) or

committee reviews requested changes to determine if a change should be approved and to prevent unwanted or unnecessary changes from taking place.

42. If you were a member of a configuration control board, what questions would you ask before determining whether or not a change should be approved?

_____

_____

_____

_____

_____

_____

■ Project Phase-Outs, Transfer, and Closing

Projects have a specific end date (at least by definition), and therefore, transfer of project deliverables to the customer or intended user and the closeout of the project should be planned. The closeout of the project is actually a project in itself and a very important phase of the project. Projects are generally closed based on the following reasons:

- Completion of all project objectives
- Achieving the desired value:
- Achieving agreed-upon contractual terms and conditions
- Preparing for the transition to the operational phase of the project's product
- Analysis and documentation of overall project performance
- Identification of possible follow-on business
- The project is no longer associated with organizational goals, will not achieve its targeted value, or has reached a point where it is no longer perceived as financially beneficial.

43. What activities should be included in the closeout or transfer of the project deliverable to the operational environment? Make a list of activities that should be included in the closeout phase.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

h. _____

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The topic "planning" is related to all of the knowledge areas of the *PMBOK® Guide*. Planning involves the integration of all project knowledge areas. Specific references about this chapter are mainly located in the knowledge areas: Project Integration Management and Project Scope Management.

The PMP® exam will include many questions that are arranged in the form of scenarios. A suggested study strategy is to apply the principles, tools, and techniques described in this chapter to your actual projects. Experience in using the tools and techniques will assist in improving your understanding about a concept and how the tools and techniques can improve the probability of achieving desired results.

Remember the differences between the definitions of project scope statement, statement of work, and scope of the project.

The charter authorizes the existence of the project and usually names/assigns the project manager. The charter is not a plan and is much less detailed than the scope statement. The charter authorizes the project manager to use organizational resources to complete project objectives. It is an input to scope planning.

Additional tips and practice items for the PMP® exam are included in each chapter of *Project Management: A Systems Approach* (12th edition), and in Chapter 22, "PMP® and CAPM® Exam Review."

The WBS is a key part of total project planning and provides a basis for estimating activity costs, activity durations, resource requirements (e.g., headcount and skill levels), and for identifying project risks. It is not a list; it is a grouping of tasks and activities and facilitates project planning. The WBS is often referred to as the "cornerstone of project planning."

▶ Answers to Questions and Exercises

1. **a.** 1
b. 5
c. 7
d. 6
e. 2
f. 8
g. 4
h. 3

2. Corporate goals are not understood at the lower organizational levels.

Plans encompass too much in too little time.

Financial estimates are poor.

Plans are based on insufficient data.

No attempt is made to systematize the planning process.

Planning is performed by a planning group.

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No one knows the ultimate objective.

No one knows the staffing requirements.

3. True
4. False
5. True
6. Assumptions are not based on fact and faulty or unverified assumptions can lead to faulty conclusions, unsatisfactory results, dissatisfied clients, and significant risk events.
7. Objective, program, schedule, budget, forecast, organization, policy, procedure, standard.
8. Increased manageability, standardization, and more effective control.
9. Additional cost, new risks, organizational capability, continued alignment with strategic goals, changes in technology, market conditions, and competitor advancements.
10. b
11. a, b, and c
12. a. Project manager
    b. Functional manager
    c. Project manager
    d. Project manager
    e. Functional manager
    f. Functional manager
    g. Project manager
    h. Project manager
    i. Project manager
13. Specific, measurable, attainable or action oriented, realistic, time based
14.

Problem	Error/Cause	Recommended Solution
a. Objectives are not agreeable to all stakeholders.	Failure to obtain input from the stakeholders	Identify all stakeholders and obtain requirements.
b. Project objectives are too rigid in a project subject to changing priorities.	Lack of flexibility in planning to accommodate potential changes and uncertainty	Set objectives based on the "SMART" concept.
c. Objectives are not adequately quantified.	No method of measurement	Establish specific metrics for each objective.
d. Objectives are not documented clearly.	Failure to obtain feedback from stakeholders and the project team	Communicate, obtain feedback, and refine objectives to ensure full understanding.

(*Continued*)

Problem	Error/Cause	Recommended Solution
e. Objectives are too complex.	Failure to define objectives at the appropriate level of detail and establish realistic expectations	Review objectives and break down into more manageable elements.
f. Objectives are too numerous.	Too many objectives can cause concerns about span of control and could overwhelm the project team or cause mismanagement of resources.	Reduce objectives to an acceptable number (5–10). Break higher-level objectives into smaller elements and assign to functional managers or units.
g. Performance and behavior of the team are below the established expectation.	Failure to establish expectations early in the project. Unclear objectives. Poor communication to the team. No performance appraisal process.	Establish expectations at the project kickoff and ensure that all objectives are communicated clearly; achieve buy-in. Establish a process for regular performance reviews.

15. Use of the word "approximately," no description of the term "supervision," no explanation of "appropriate procedures." Use of the word "shortly." No explanation of how the client will review the test results or acceptance criteria.

16. a

17. **a.** 6

b. 3

c. 2

d. 5

e. 1

f. 4

18. Business need

Project purpose or justification

The assigned project manager

Summary milestones

Stakeholder influences—who will be affected

Assumptions

Functional groups that will be involved

High-level or summary budget

Sponsor name

19. The business case provides the organization's decision makers with the necessary information to determine whether the expected outcomes of the project justify the investment.

20. A charter authorizes the project. The scope statement defines the project in detail and includes the specific objectives.

21. Scope is the sum of all products and services to be delivered as a project. The project scope statement is a narrative description of the project scope and includes the major deliverables, objectives, assumptions, and constraints of the project.

22. The sponsor or project initiator.

23. Introduce the project manager to the team, assemble the subject matter experts, explain project success criteria, communicate project objectives, define team roles and responsibilities, explain constraints and assumptions, begin the detailed planning process.

24. Project manager will define: goals and objectives, major milestones, initial requirements. The project manager will also facilitate the establishment of team ground rules and the documentation of assumptions. The project manager will communicate information about time, cost, and performance constraints, operating procedures, administrative policy and reporting requirements.

Functional manager or line manager will define: Detailed task descriptions to implement objectives requirements, and milestones; detailed schedules and manpower allocations to support budget and schedule; and identification of areas of risk, uncertainty, and conflict.

Senior management (project sponsor) will: Act as the negotiator for disagreements between project and line management; provide clarification of critical issues; provide communication link with customers and senior management.

Special note: Successful planning requires that project, functional, and senior management are in agreement with the plan.

25. Assumptions are generally not grounded in fact and failure to validate an assumption could lead to significant risk situations.

26. 1.0 Home office addition

1.1 Rough framing and carpentry

1.1.1 Obtain permits

1.1.2 Purchase material

1.1.2.1 Determine lumber requirements

1.2 Electrical system

1.3 Plumbing

1.4 Heating and AC

27. The project work is structured into small elements that are:

- Manageable, in that specific authority and responsibility can be assigned
- Independent, or with minimum interfacing with and dependence on other ongoing elements
- Integrated so that the total package can be seen
- Measurable in terms of progress

28. Managerial, technical

29. **a.** Program

b. Project

c. Task

d. Subtask

e. Work package

f. Level of effort

30. Capital requirements, competitive issues and reaction, return on investment, payout time (breakeven point), Wall Street impact (market impact)

31. Project variances in cost and schedule, achievement of milestones, major delays or changes in project plans, risk situations, customer satisfaction issues

32. Select the project manager, define high-level project requirements, provide resources, and communicate organizational strategies, liaison to other business units or functional groups.

33. True

34. True

35. False

36. True

37. False: The project scope is the work that is required to produce the product or service.

38. True

39. **a.** Review corporate goals with the sponsor and then communicate to the project team. Provide an opportunity for feedback to ensure understanding

b. Review the project objectives and consider breaking into smaller separate projects introduced in phases

c. Establish reliable and consistent estimating practices. Use lessons learned and previous projects for comparison.

d. Conduct feasibility studies and cost benefit analysis. Conduct risk assessment. Obtain expert knowledge.

e. Arrange to have plans developed by the functional units that will perform the work.

f. Establish clear roles and responsibilities at project kickoff. Prepare and communicate a project scope statement.

g. Create a WBS; use a scope statement and the project charter to determine staffing and resource needs.

h. Establish a screening process for staffing or schedule training for team members.

i. Define project specifications and requirements early in the project. Document and distribute specifications. Conduct reviews.

j. Establish formal signed agreements from functional units when obtaining project staff. Arrange for contingencies or back-up personnel. Cross-train. Escalate to the project sponsor.

40. Poor planning, market forecasts, new and better alternative discovered, change in company strategy, allocated budget and schedule exceeded, loss of key personnel, complexity of the project becomes too great for organizations capability.

41. They are the reference points for measuring project performance. The PMB serves as the metric benchmark against which performance is measured in terms of time, cost, and scope. It is also used as the basis for business value tracking. The principal reasons for establishing PMBs are to ensure achievement of project objectives, manage and monitor progress during project execution, ensure accurate information on the accomplishment of the deliverables and requirements, and establish performance measurement criteria

42. Why is the change necessary? How much will it cost? Who will do it? How will the change affect the schedule, scope, or budget? What are the risks?

43. a. Prepare all documents and project records.

b. Conduct post-project reviews.

c. Obtain acceptance from the client and the sponsor.

d. Verify compliance with contract requirements.

e. Release resources.

f. Prepare performance appraisals.

g. Close out all open work orders.

h. Prepare final project financial reports and close financial accounts.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER TWELVE

Network Scheduling Techniques

Network scheduling is an extremely important part of the total integrated project-planning process. As plans are developed, the project scope statement and work breakdown structure (WBS) provide the project manager and team with the foundation for more detailed planning. The scope statement and WBS answer the "what" "when," "where," "why," and "who" questions and provide the project team with information about the complexity of the project. Additional planning is required to determine project cost, develop the schedule, and ensure that project risks have been considered and cared for. The tasks and activities of the project, defined in the WBS, must be arranged in an appropriate and logical sequence to meet predefined schedule requirements, mandatory dependencies, resource constraints, and other factors defined by the sponsor, key stakeholders, or contractual agreements.

Network scheduling is actually a continuation of the project-planning process and allows the project team to determine the best approach to organizing, managing and controlling project activities. The process of network scheduling provides an opportunity to display the logical relationships and dependencies between project activities. It defines the project critical path, and will identify where the schedule has flexibility, commonly known as float or slack. Network scheduling will also identify opportunities for rearranging the sequence of activities to optimize the schedule and ensure the most efficient use of resources and time. Network scheduling requires input from the entire project team and may require several iterations before the project schedule is finalized and approved.

Remember

The WBS is generally considered to be the "cornerstone of project planning" and provides the basis for network scheduling and the development of network diagrams. The project team collaborates to identify the project components, major tasks, and work package activities and uses a process known as decomposition to develop the WBS. When completed, the WBS will clearly display the project and its complexity. Network

(*Continued*)

scheduling generally follows the development of the WBS, but need not be at the same level of detail as is the WBS. The activities defined in the WBS, at the work package level, are placed in a logical sequence using the precedence diagramming method. This method utilizes input from the project team and will display the predecessor and successor relationships between the activities of the project. The PDM method uses four possible logical relationships: finish to start, start to start, finish to finish, and start to finish. More than one relationship can appear in a PDM schedule.

The major advantage of using network scheduling is that it provides the project team with a visual display of the project's work flow dependencies and the logical relationships between activities. This information will assist in optimizing resource usage, especially when resource availability presents scheduling challenges.

Study note: Gantt charts, milestone charts, and the WBS are useful for planning and control as well as status reporting but are not intended to display activity logical relationships. Today's project software has been designed to show the relationships between activities on the Gantt chart but these relationships are often obscured if the project has a large number of activities. For study purposes, the Gantt chart is generally used to display progress, the WBS is used to display project details in a hierarchical arrangement, and milestone charts provide a high level visual view of major project events.

► Glossary of Terms

Activity An element of work performed during the course of a project. Each project activity generally has a defined duration, an estimated cost, and specific resource requirements. Activities are usually shown as components of the work package.

Activity-on-node Commonly referred to as precedence diagram method (PDM). The activity is depicted as the node or box. Each activity in the diagram is connected using arrows to indicate dependencies and logic relationships. This technique utilizes four logical relationships: finish to start, start to start, finish to finish, and start to finish. PDM is generally used in most of today's project scheduling software.

Arrow diagram method (ADM) A network diagramming technique in which activities are represented by arrows. Activities are connected at points called nodes to illustrate the sequence in which activities are expected to be performed. This is also known as activity-on-arrow (AOA). This technique utilizes one logical relationship: finish to start and dummy activities to display other logic relationships. This technique has been replaced by the PDM, or activity-on-node, method.

Backward pass A process in the critical path method that uses the completion date of the project as the starting point. From the project end date, the process involves a backward motion through each path of the network diagram to calculate the late finish and late start dates of each project activity. The backward pass will enable the calculation of activity float.

Baseline The original approved plan. There are generally three main project baselines: the scope baseline, schedule baseline, and budget or cost baseline. The baseline provides the benchmark for comparing actual results with planned results. The difference between the actual result and the planned result is referred to as variance.

Crashing A technique for schedule compression where the total project duration is reduced by identifying activities that can be reduced in duration by adding additional resources or using overtime. Crashing usually results in increased project costs and may increase the risk in meeting the project's constraints. Crashing focuses on seeking opportunities for compressing the project schedule by targeting activities that will provide the greatest duration reduction at the lowest cost without significantly increasing the risk. Crashing generally is applied to the critical path where there is minimal flexibility and, in most cases, no slack or float.

Critical activity An activity on a critical path.

Critical path The longest path through a network that determines the earliest completion date of the project. The critical path is usually defined as the path through a network where the activities have zero float or slack. It is important to note that the critical path is not necessarily the path with the greatest overall risk. Secondary or tertiary paths may have greater risk.

Critical path method (CPM) A network analysis technique used to determine the early start, early finish, late start, and late finish dates for activities on the various logical paths of a network. Early dates are calculated using a forward pass; late dates are calculated using a backward pass. The critical path is identified during this process.

Dummy activity An activity of zero duration used to show a logical relationship. Dummy activities are used in the arrow diagramming method (activity on the arrow) when special logical relationships are required and must be displayed. Dummy activities are shown graphically as a dashed or dotted line headed by an arrow and connecting two nodes. Dummy activities may be a factor in calculating the critical path. The activity on the arrow method has been replaced by the PDM or activity-on-node method.

Duration The number of calendar work periods, commonly expressed in days and weeks, required to complete an activity or other project element. Duration is generally estimated by the functional manager responsible for the activity.

Effort The number of labor units required to complete an activity or other project element. Effort is associated with skill level, resource competency, and number of resources available. Effort is related to the determination of activity duration. Example: an activity may be estimated to have a 3-day duration but may require 2 resources working 8 hours a day to complete the work, or 48 hours of effort. Effort can also include part-time assignments.

Fast-tracking Compressing the project schedule by overlapping activities that would normally be done in sequence. Risk must be considered when utilizing fast-tracking.

Float The amount of time that an activity may be delayed from its early start without delaying the project finish date. (Also referred to as slack.)

Forward pass The calculation of the early start and early finish dates for activities in a network diagram. The forward path begins at the start milestone and follows each path in the network to the project end milestone. The longest path through the network is identified when the forward pass process is complete.

Free float The amount of time an activity can be delayed without delaying the early start of any immediately succeeding activities.

Hammock A group of related activities aggregated to a summary level. Also known as a summary activity.

Lag A modification of a logical relationship that places a delay between the predecessor and successor activity. Example: After concrete is poured (the activity is complete), there is a waiting period to allow the concrete to cure. This may take several days. The next succeeding activity cannot start until the curing time is satisfied. The curing time or elapsed time is known as lag.

Lead A modification of a logical relationship that allows an accelerated start of the successor task. A time period that has been determined to start a successor task before its predecessor has completed. Example: Task B depends on the completion of task A in a finish-to-start relationship. The team determines that task B can start two days before the end of task A. The start if task B has been accelerated by two days, or the lead time for task B is two days.

Level of effort (LOE) A support type activity that does not readily lend itself to measurement of discrete accomplishment. Level of effort is considered when determining the duration of an activity. Example: The level of effort for an expert to perform an activity would be much less than the level of effort of a newly trained employee. A project manager provides a supporting effort to achieve project objectives. The level of effort is a factor in determining the duration of an activity. Example: An activity may be scheduled for a duration of one day (8 hours) but may require three resources to complete the work. The effort is considered to be 3 person days or 24 hours of effort.

Master schedule A summary level schedule that identifies the major activities and milestones associated with a project.

Milestone A significant event in the project. Examples: end of a phase, end of the project or even a short customer interface meetings. Milestones do not consume resources and generally do not have duration. A milestone is a specific and significant point in time.

Precedence diagram method (PDM) A network diagramming technique in which activities are represented by nodes. Activities are linked by precedence relationships to show the sequence in which the activities are to be performed. There are four logical relationships in the PDM: finish to start, finish to finish, start to start, start to finish.

Program evaluation and review technique (PERT) An event-oriented network analysis technique used to estimate project duration when there is a high degree of uncertainty with the individual activity duration estimates. This technique is associated with the formula: (O + 4m + P) / 6. (The sum of the optimistic estimate plus four times the

most likely estimate, plus the pessimistic estimate divided by six.) This is referred to as the PERT weighted average formula.

Project network diagram A schematic display of the logical relationships of project activities.

Resource breakdown structure Hierarchal structure of the identified resources by resource category and resource type.

Rolling wave planning A technique in which more details are added as the project progresses. It is a form of progressive elaboration and addresses the issue that information about some project activities may not be immediately available. It is a process of project planning in waves as the project proceeds and later details become available. As the project progresses, the risks, assumptions, and milestones originally identified become more defined and reliable.

Slack Generally considered to have the same meaning as float. The amount of flexibility an activity has in relation to the project end date.

Total float The amount of time that a scheduled activity may be delayed from its early start date without delaying the project finish date. Total float is associated with the entire path in the network. The path owns the float, not the individual activities.

► Time Management Processes: A Brief Review

The following processes are generally associated with the knowledge area project time management. Network scheduling is directly associated with the time management process of activity sequencing and is an essential element of the integrated planning process.

The PMBOK® Guide—Sixth Edition includes the following project time management processes:

- Plan schedule management: establishing the processes and procedures for planning, developing, and controlling the project schedule
- Define activities: further developing the WBS at the work package level to identify specific actions that must be taken to complete project deliverables
- Sequence activities: identifying the specific logical relationships of project activities; identifying predecessor and successor relationships
- Estimate activity duration: determining the number of work periods required to complete project activities
- Develop schedule: analyzing project resources, activity sequences, activity durations, and project constraints to determine the project schedule
- Control schedule: monitoring the project schedule to identify variances, managing project changes and updating the project schedule as required

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Define Activities

The process of identifying and documenting the specific activities that must be performed to produce the various project deliverables identified in the WBS. This is a continuation of the process of decomposition. The activities are defined to the detail that will allow project objectives to be met.

Inputs

- Project management plan, enterprise environmental factors, and organizational process assets. Other inputs may be considered, including WBS, project scope statement, WBS dictionary, historical information, constraints, and assumptions

Tools and techniques

- Decomposition: involves subdividing project elements into smaller, more manageable components
- Expert judgment: the use of functional managers and technical experts
- Rolling wave planning: continuous process of planning near-term tasks in detail and maintaining some focus on future tasks
- Meetings

Outputs

- Activity list, milestone list, activity attributes, change requests, and project plan updates

Sequence Activities

The process of identifying and documenting activity dependencies and relationships. There are three common types of dependencies:

1. Mandatory, also known as hard logic. Tasks must be completed in a specific sequence due to physical necessity.
2. Discretionary, also known as soft logic (discretionary dependencies are associated with best practices)
3. External: dependency associated with another project or other item outside of the project and generally affecting the critical path

Inputs

- Project management plan, project documents, enterprise environmental factors, and organizational process assets. Other inputs may include approved changes, product description, identified dependencies, constraints, and assumptions

Tools and techniques

- Precedence diagramming method (activity-on-node), dependency determination and integration, leads and lags, project management information system, arrow diagramming method (activity-on-arrow), conditional diagramming methods such as GERT (Graphical Evaluation Review Technique)

Outputs

- Project schedule network diagram, project document updates, activity list updates, activity attribute updates, and requested changes (The sequencing activity may generate a need to change an activity or refine the schedule.)

Estimate Activity Duration

This is the process of estimating schedule activity durations using information from the scope statement, identified resource types, number of resources available, calendars, ramp-up and ramp-down time (the effect of non-contiguous work assignments)

Inputs

- Project management plan, project documents, enterprise environmental factors, organizational process assets.

Tools and techniques

- Expert judgment, analogous estimating, parametric estimating, three-point estimates, bottom-up estimating, data analysis, decision-making techniques, meetings.

Three-point estimates are based on determining the optimistic, most likely, and pessimistic durations of an activity. The weighted average estimate or estimated time is calculated by the formula

(O + 4m + P)/6 (The sum of the optimistic estimate plus four times the most likely estimate plus the pessimistic estimate divided by six)

The triangular distribution estimate is similar to the weighted average three-point estimate but the there are no weighted values. This estimate is basically an average of the three points.

Analogous estimating uses actual duration figures from similar activities or projects. Also referred to as a top-down type of estimating. This type of estimating is generally used early in a project. Estimates are refined as more project data is obtained.

Parametric estimating calculates duration estimates by using mathematical algorithms such as multiplying the quantity of work in work periods by the cost rate of a resource. This type of estimate works best for standardized and often repetitive activities. This is also a top-down type of estimating. Example: Multiplying the cost per square foot by the desired number of square feet of living space will produce a parametric estimate of the cost of building a home.

Outputs

- Duration estimates, basis of estimates, project documents updates

Develop Schedule

An iterative process to determine planned start and end dates for project activities. Schedule development involves the combined input of the project team and includes negotiation, agreement about contingencies, availability of critical resources, and contractual agreements.

Inputs

- Project management plan, project documents, agreements, organizational process assets, enterprise environmental factors

Tools and techniques

- Schedule network analysis, critical path method, resource optimization methods, data analysis, leads and lags, schedule compression (crashing and fast tracking), project management information system, agile release planning

Outputs

- Schedule baseline, project schedule, schedule data, project calendar, change requests, project management plan updates, project document updates

Control Schedule

This process is used by the project team to determine the status of the project schedule, identifies factors that can change or impact the project schedule, provides a process to determine if variances to the schedule or a change in the schedule has occurred, and manages actual changes upon approval. Schedule control is an element of integrated change control.

Inputs

- Project management plan, project documents, work performance data, organizational process assets, reports from earned value management or variance analysis, approved change requests

Tools and techniques

- Data analysis, critical path method, project management information system, resource optimization techniques, leads and lags, schedule compression

Outputs

- Work performance information, schedule forecasts, change requests, project management plan updates, project document updates

▶ Activities, Questions, and Exercises

Refer to Chapter 12 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information and assistance in completing each exercise.

The following questions and exercises are most closely associated with the knowledge area of the *PMBOK® Guide*—Sixth Edition: Project Time Management. It is important to remember that although each knowledge area is presented separately in the *PMBOK® Guide* for learning purposes, many processes are performed concurrently and all processes are associated with project integration management. The five major process groups—initiating, planning, executing, monitoring and controlling, and closing—assist in the integration of all subprocesses associated with planning and managing a project.

Review each of the following questions or exercises and provide the answers in the space provided. Some questions and situations will have more than one appropriate answer or response. Project managers are aware that many issues they face on a daily basis may have several possible solutions. These exercises are designed to encourage you to think about alternatives before taking action.

■ Activity Planning: From WBS to Project Network Diagram

After the project has been defined in the scope statement and by developing a work breakdown structure, the next step in the planning process is to perform the steps required to develop the project schedule. This process includes identifying activities, determining resource requirements, estimating activity durations, establishing the sequence or activities, and managing within project constraints.

1. **PM Quick Check:** The process of activity definition is an extension of the development of the _____.
2. **PM Quick Check:** After the major project deliverables have been defined using the process of decomposition, the activities necessary to produce the lower-level project deliverables are included in the _____.
3. Review the list of items and indicate whether each item is an input, a tool or technique, or an output.
   a. Enterprise environmental factors _____
   b. Decomposition _____
   c. Activity list _____
   d. Organizational process assets _____
   e. Rolling wave planning _____
   f. Project management plan _____
   g. Expert judgment _____
   h. Activity attributes _____
   i. Milestone list _____

j. Meetings _____

k. Project management plan updates _____

■ Sequencing Activities and Network Diagrams

The next process-following activity definition involves arranging the activities from the activity list into a specific sequence based on dependencies identified by the project team. Some activities depend on input from another activity before they can begin or are constrained by time, resources, or other factors. The sequencing process identifies all relationships between activities and ensures that there are no "dangling activities." A dangling activity is one that does not have clearly defined relationships and is not completely connected to the network.

Exam Tip

Precedence Diagramming Method: Study Note

The precedence diagramming method (PDM) is used to display project activities using nodes that are linked together using one or more types of logical relationships. The logical relationships are shown using arrows to connect the nodes. PDM uses four types of logical relationships: finish to start (the most common relationship), finish to finish, start to start, and start to finish.

4. What are the major advantages of using network scheduling techniques?

_____

_____

_____

_____

5. Create a network diagram using the PDM and the information in the table below: (Hint: A common practice in the development of network diagrams is to use Post–It™ notes or other similar products that allow the team to move activities around until they are satisfied that the diagram correctly displays the project network.) Establishing a start and an end milestone will assist in making sure there are no "danglers" and will provide a means to ensure that the network is complete.

Activity	Predecessor
Start	none
A	Start
B	A
C	A

Activity	Predecessor
D	B
E	C
F	D
G	E, F
End	G

Remember

The PDM is the most common method used today to display a project network. The PDM uses nodes that represent activities. They are connected by arrows that represent logical relationships or dependencies.

Review the three network diagrams labeled Problem 1, Problem 2, and Problem 3. Complete a forward and backward pass, and answer the associated questions.

Problem #1 (Time in weeks)

6. Which activities are on the critical path and what is the length of the critical path?
7. What is the impact on the end date if Activity B slips by 12 weeks?
8. What is the impact on the end date if Activity E slips by 1 week?
9. What is the impact on the end date if Activity D slips by 10 weeks?

Problem #2 (Time in weeks)

10. Which activities make up the critical path and what is the length?

11. What is the impact on the end date if Activity F slips by 2 weeks?

12. What is the impact on the end date if Activity E finishes early by 1 week?

13. By how many weeks can Activity B slip before it becomes a second critical path?

Problem #3 (Time in weeks)

14. Which activities are on the critical path and what is the length?

15. What is the impact on the end date if Activity I slips by 6 weeks?

16. What is the impact on the end date if Activity F slips by 5 weeks?

17. What is the impact on the end date if Activity B cannot start until a month from now because of late delivery of raw materials?

Remember

A network diagram using PDM will generally show the following information:

- **Early start:** The earliest date the activity can start or begin
- **Duration**: The calendar duration of the activity
- **Early finish:** The earliest date the activity can finish
- **Late start**: The latest date the activity can start
- **Late finish**: The latest date the activity can finish
- **Slack or float:** Difference between the early start and the late start dates

18. Network match-up: Match each of the terms provided with its definition.

Term	Definition
a. Event ____	1. Longest path through a network
b. Activity ____	2. Total time
c. Duration ____	3. Milestone
d. Effort ____	4. Element of work
e. Critical path ____	5. Amount of work

Exam Tip

A normal distribution is an arrangement of a data set in which most values cluster in the middle of the range and the rest taper off symmetrically toward either extreme. A graphical representation of a normal distribution is sometimes called a bell curve because of its flared shape. The precise shape can vary according to the distribution of the population but the peak is always in the middle and the curve is always symmetrical.

Example of normal distribution: Most people are of average height; the numbers of people that are taller and shorter than average are fairly equal and a very small number of people are either extremely tall or extremely short.

In normal distribution the following information is important to remember:

- 68.3% of the data points fall within one standard deviation from the mean.
- 95.5% of the data points fall with two standard deviations from the mean.
- 99.7% of the data points fall within three standard deviations from the mean.

Basic formula for standard deviation:
(pessimistic value minus the optimistic value) divided by 6 or (P – O) / 6

Note: This is a short formula generally accepted for calculating standard deviation.

Definitions to remember:

Mean: The average of all data points

Median: The midpoint of a frequency distribution. Example: In the series 1,2,3,4,5,6,7, the median is 4.

Mode: The most frequent data point value. Example: In 1,1,1,2,2,2, 2,3,4,4,5,6, the mode is the number 2.

Range: The difference between the highest value data point and the lowest value data point. Example: 10, 20, 40, 50, 70, 80, 100 the ranges = 100 - 10 or 90

PM Quick Check

19. List the four types of logical relationships that may be utilized in the precedence diagram method.

a. _____

b. _____

c. _____

d. _____

20. The most common logical relationship in a PDM diagram is _____

21. A mandatory relationship is also referred to as _____

_____

Study Notes

Activity duration estimating is used to determine the number of work periods required to complete a schedule activity. Duration is determined by analyzing several factors, including the number of resources required, the competency of the resources, and the availability of the resources. Work periods may be represented in several ways, including days, weeks, or hours based on the preference of the project team and stakeholders. The process of activity duration estimate may follow activity definition, but in many cases the estimates are provided concurrently.

A PERT chart is a type of network diagram that uses probabilistic estimates to determine the project duration. PERT is the abbreviation for program evaluation review technique. Network diagrams are commonly referred to as PERT charts, but a PERT chart is actually a network diagram that is constructed using the critical path method (CPM) and a weighted average formula. The formula is expressed as:

$$\frac{a+4m+b}{6}$$

where: a = optimistic, b = pessimistic, and m = most likely. The standard deviation may be calculated using the formula:

$$b - a/6$$

This formula will provide an acceptable value for the standard deviation. Standard deviation is a measure that is used to quantify the amount of variation or dispersion of a set of data values. Calculating the standard deviation provides a basis for establishing a confidence level for completion of activities and for completing a project in the estimated time frame. Using normal distribution, statistics indicate that there is a 68% probability of completing an activity on the project within one standard deviation from the mean, 95% within two standard deviations, and 99.73% within three standard deviations from the mean.

A GERT chart or graphic evaluation review technique is a diagram that allows looping, branching, and multiple end points. A PERT chart does not allow feedback loops and conditional branching.

Types of dependencies. There are three basic types of dependencies:

- Mandatory dependencies or hard logic. This type of dependency is inherent in the nature of the work. They often involve physical limitations. The work must be performed in a specific order. Example: Install walls before adding the roof, dig trench before placing pipeline.
- Discretionary or soft logic. Generally, the dependency is determined by the project manager or team and is associated with best practices.

Example: "There are several possible ways to complete this work and we have decided that it is best to do it this way."

- External dependencies are those that are associated with factors that are outside of the project or outside the control of the project manager and team but may impact the critical path. Example: A local government decision or change in regulations may cause a project to be delayed.

Determining Probability Using Normal Distribution

Remember that the mean is the 50% point. This is interpreted as the point where the probability of reaching this value is 50%. Example: If the mean is 10 weeks, the project has a 50% probability of completing in 10 weeks or less. There is a 68% probability of completing a task within 1 standard deviation.

The standard deviation includes the (-) and (+) side of the mean. Example: If the mean is 20 weeks and the standard deviation is 2, the range of 1 standard deviation is 20 +2 or 22 and 20 -2 or 18.

This means there is a 68% probability the task will be completed between 18 and 22 weeks. The 68% spans the + and – side of the mean. The probability of completing the task in 22 weeks is calculated as 50% (the mean) plus ½ of 68 or 34. 50% + 34% = 84%. There is an 84% chance the task will be completed in 22 weeks or less.

Forward Pass

The forward pass is used to determine the earliest start and earliest finish dates of each activity on the network diagram. The process begins with the first activity on the network (usually a milestone) and continues from left to right, analyzing each path, and adding activity duration to the start time of the activity. During the process, at any point where two or more activities converge on another activity the higher value of the early finish is used to determine the early start of the succeeding activity. This process continues through each path in the network to determine the total duration of the project and the critical path.

22. Using the information provided in the following table, create a network diagram using the precedence diagram method and determine the duration of the project and the critical path.

Activity	Predecessor	Duration
Start		
A	None	5
B	A	2
C	A	3

(*Continued*)

Activity	Predecessor	Duration
D	B	7
E	C	4
F	D	1
G	E,F	2
End	G	

Project Duration _____

Critical Path _____

■ Backward Pass

The backward pass is used to determine the latest start and latest finish of each activity. In diagrams where all relationships are finish to start, the difference between the latest finish and the earliest finish will determine the float or slack for the activity. There is generally no float or slack on the critical path. The backward pass is performed on the network diagram from the end milestone and proceeding back through the network to the starting point. At points of convergence the smaller number is used to determine the latest finish of a preceding task.

23. Referring to the diagram developed in question 6, perform a backward pass to determine the late start and late finish of each activity.

a. Identify the activities that have float or slack.

_____

Activity	Predecessor	Duration	Float / Slack
Start			
A	None	5	
B	A	2	
C	A	3	
D	B	7	
E	C	4	
F	D	1	
G	E,F	2	
End	G		

b. What is the early start of Activity C? _____

c. What is the late start of Activity E? _____

24. **PM Quick Check:** In network diagrams, activities with zero float are referred to as:

a. critical activities

b. noncritical activities

c. events

d. dummy activities

25. **PM Quick Check:** In the precedence diagramming method, the most common logical relationship is:

a. start to finish

b. finish to start

c. finish to finish

d. start to start

26. During the project scheduling process or during actual execution of the project, it may become necessary to shorten the duration of the project. "Crashing the schedule" generally means to reduce duration by using additional resources or overtime.

a. Review the information in the table. Determine which activities should be crashed. (Hint: Determine the critical path first.)

_____

Activity	Predecessor	Normal time required in weeks	Crash time in weeks	Normal cost	Crash cost	Crash? Yes/No
A	None	4	2	10,000	14,000	
B	A	6	5	30,000	42,500	
C	A	2	1	8,000	9,500	
D	B	2	1	12,000	18,000	
E	B, C	7	5	40,000	52,000	
F	D, E	8	3	20,000	29,000	

b. What is the critical path? _____

c. What is the cost to crash the schedule to 23 weeks?

_____

_____

_____

_____

■ Lead and Lag Time

During project planning it may be necessary to adjust the project schedule to include *lag time*, a delay of the succeeding activity, or *lead time*, an acceleration of a succeeding activity. A common example of lag time is the elapsed time after the activity of pouring concrete. The concrete must cure for a period of time. Lag is built into the network to allow for the curing time. An example of lead time is to indicate that a succeeding activity may start after 70% of a preceding activity has been completed.

27. In the following diagram, if the early start of activity A is 10 days, what is the early finish time for activity C? _____

28. Network scheduling practice: Using the PDM, draw the network diagram, identify the critical path, and calculate the early start and early finish times for each activity.

Activity	Dependency	Activity duration (weeks)	Early start	Early finish
A	None	4		
B	None	6		
C	A,B	7		
D	B	8		
E	B	5		
F	C	5		
G	D	7		
H	D,E	8		
I	F,G,H	4		

29. Fun with PERT. What is the estimated time (Te) for each activity? Using the Te for each activity, what is the critical path?

Activity	Initial node	Final node	Optimistic time	Pessimistic time	Most likely time	Te
A	1	2	1	3	2	
B	1	4	4	6	5	
C	1	3	4	6	5	
D	2	6	2	4	3	
E	2	4	1	3	2	
F	3	4	2	4	3	
G	3	5	8	15	10	
H	4	6	4	6	5	
I	4	7	6	14	10	
J	4	5	1	3	2	
K	5	7	2	4	3	
L	6	7	6	14	10	

30. **PM Quick Check:** The critical path is the:
    a. Shortest path through the network diagram
    b. Longest path through the project network that determines the earliest time the project can be completed
    c. Path with the greatest number of resources assigned
31. You have received the following information from a project team member: the estimated pessimistic duration to complete an activity is 45 days, the optimistic time is 15 days, and the most likely time is 25 days. What will you post as the duration for this activity using the PERT weighted average technique? _____
32. Using the same information from the previous question, calculate the standard deviation using the short formula. _____
33. Using normal distribution, what is the probability of completing the activity referred to in questions 12 and 13 within 21.67 days and 31.67 days?

    _____
34. What is the probability of completing the activity in 31.67 days or less?

    _____

■ Another Crashing Exercise

The table below shows data for the diagram shown above, Problem 1. The column labeled "Crashing Time" is the smallest duration of the activity after compression. For example, Activity A can be compressed from 6 weeks to 5 weeks.

Activity	Normal Time, weeks	Normal Cost, $	Crashing Time, weeks	Crashing Cost, $	Crashing Cost/Week
A	6 weeks	$6,000	5 weeks	$8,000	
B	4 weeks	$14,000	3 weeks	$15,000	
C	14 weeks	$23,000	11 weeks	$30,500	
D	9 weeks	$26,000	7 weeks	$29,000	
E	5 weeks	$8,000	3 weeks	$12,400	

35. Complete the column in the table for the crashing cost/week.
36. The client wants the project completed in 24 weeks. What is least amount of additional cost to achieve a 24-week project?

    _____

    _____
37. The client wants the project completed by 23 weeks. What is the least amount of additional cost for a 23-week project?

    _____

    _____

38. Rather than incur the crashing cost yourself for a 23-week project, you ask the client to pay for your crashing costs. The client offers you a $3,000 bonus for compression to a 23-week project. Is this acceptable?

■ Understanding Standard Deviation

You are managing a project where the critical path includes the three activities below. Your managers have provided you with optimistic, most likely and pessimistic estimates (in weeks) as provided below.

Activity	Optimistic Time	Most Likely Time	Pessimistic Time
A	2	4	12
F	4	6	8
G	3	7	17

39. Calculate the expected time for each activity on the critical path.

A:_____; F:_____; G_____

40. What is the length of the critical path? _____

41. What is the standard deviation for the activities on the critical path? _____

42. How much time should be allowed if management wants to be 95% sure of the project completion date? _____

Exam Tip

The PMP® exam will test your knowledge of the forward pass, backward pass process. Practice the critical path method often and remember the rules: During the forward pass, at points where activities converge, the larger early finish value is used to determine the early start of the successor activity. During the backward pass, use the activity with the lowest value of the late start to determine the late finish of the activity where the paths converge.

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The topic of network scheduling techniques is most closely related to the following areas in the *PMBOK® Guide*—Sixth Edition: Project Time Management.

Review the inputs, tools and techniques, and outputs of the time management processes: plan schedule management, define activities, sequence activities, estimate activity durations, develop schedule, and control schedule.

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It is important to become familiar with how inputs, tools and techniques, and outputs relate to project planning and control. Consider the logic of each process. Example: It is necessary to define the activities that must be performed before determining the sequence of the activities.

PDM has four possible logical relationships:

1. **Finish to start (the most common dependency type):** The successor activity's start depends on the completion of the successor activity.
2. **Finish to finish:** The completion of the successor activity depends on the completion of the predecessor activity.
3. **Start to start:** The start of the successor activity depends on the start of the predecessor activity.
4. **Start to finish:** The completion of the successor activity depends on the start of the predecessor activity.

Become familiar with different types of scheduling charts: Gantt, milestone, and schedule networks and what they are used for Gantt charts are generally used to display progress, network diagrams display dependencies, and milestone charts provide high-level summary information and significant points in time.

Be prepared to explain the critical path method and how to determine critical path.

Understand the difference between the schedule compression techniques of crashing, fast tracking, and managing slack or float.

Remember the formula for calculating activity durations using PERT—Optimistic Value + 4 times the Most Likely Value + Pessimistic Value divided by 6:

$$[O + (4 \times ML) + P]/6$$

Practice forward pass and backward pass calculations to determine which activities have float or slack.

Develop network diagrams and practice calculating early start, early finish, late start, and late finish.

Remember: Float refers to the amount a time an activity can slip before it affects the project completion date. Free float is the amount of time an activity can slip before it affects the immediate successor activities.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. WBS
2. Work Package
3. a. Inputs
   b. Tools and techniques
   c. Outputs

d. Inputs

e. Tools and techniques

f. Inputs

g. Tools and techniques

h. Inputs

i. Outputs

j. Tools and techniques

k. Outputs

4. They provide the basis for planning and predicting, visibility of the project components and relationships, opportunities to evaluate alternatives, facts for decision making, and they reveal dependencies and interdependencies.

5.

Activity	Early Start	Early Finish	Latest Start	Latest Finish
A	1	7	1	7
B	1	5	17	21
C	7	21	7	21
D	7	16	17	26
E	21	26	21	26

6. Activities A, C, and E; critical path is 26 weeks.

7. There is no impact on the end date.

8. The critical path will slip by 1 week.

9. A second critical path will be formed 25 weeks in length.

Problem 2.

Activity	Early Start	Early Finish	Latest Start	Latest Finish
A	1	8	1	8
B	8	11	11	14
C	8	13	8	13
D	11	19	14	22
E	13	18	24	29

Activity	Early Start	Early Finish	Latest Start	Latest Finish
F	13	22	13	22
G	22	29	22	29
H	13	17	25	29

10. Critical path is 29 weeks; Activities A, C, F, and G.

11. The project is lengthened by 2 weeks.

12. The project is completed 1 week early.

13. 3 weeks

Problem 3.

Activity	Early Start	Early Finish	Latest Start	Latest Finish
A	1	6	1	6
B	1	3	7	9
C	1	7	5	11
D	6	15	6	15
E	6	12	9	15
F	7	11	11	15
G	15	20	18	23
H	15	23	15	23
I	11	14	21	24
J	23	26	23	26
K	23	25	24	26

14. Critical path is 26 weeks; Activities A, D, H, and J

15. No impact

16. A new critical path is formed.

17. No impact

18. **a.** 3

b. 4

c. 2

d. 5

e. 1

19. **a.** Finish to start

b. Finish to finish

c. Start to start

d. Start to finish

20. Finish to start

21. Soft logic

22. Project duration = 17; Critical path = ABDFG

23. **a.** C and E have float /slack (3 units each)

b. 5

c. 11

24. a

25. b

26. **a.** Tasks A, B, E, and F could be considered for crashing. Always look for the least cost to achieve the desired crashing effect and watch out for new critical paths that may appear.

b. A B E F

c. Crash task A, which will reduce the project duration by two weeks at a cost of $4000. Task A has the lowest crash cost and is on the critical path.

27. 32 days

28. a

Activity	Dependency	Activity duration (weeks)	Early start	Early finish
A	None	4	0	4
B	None	6	0	6
C	A, B	7	6	13
D	B	8	6	14
E	B	5	6	11
F	C	5	13	18
G	D	7	14	21
H	D, E	8	14	22
I	F, G, H	4	22	27

29.

Activity	Initial node	Final Node	Optimistic time	Pessimistic time	Most likely time	Te
A	1	2	1	3	2	2
B	1	4	4	6	5	5
C	1	3	4	6	5	5
D	2	6	2	4	3	3
E	2	4	1	3	2	2
F	3	4	2	4	3	3

Activity	Initial node	Final Node	Optimistic time	Pessimistic time	Most likely time	Te
G	3	5	8	15	10	10.5
H	4	6	4	6	5	5
I	4	7	6	14	10	10
J	4	5	1	3	2	2
K	5	7	2	4	3	3
L	6	7	6	14	10	10

Critical path is CFHL
Duration is 23
Standard deviation of G = 1.17

30. b

31. 26.67 days

32. The standard deviation is 5 (45 – 15) / 6.

33. The probability associated with 1 standard deviation in normal distribution is 68.3%. In this example one standard deviation below the mean is 26.67 – 5 = 21.67. 26.67 + 5 = 31.67.

34. The probability of finishing the activity in 31.67 days or less is 84%. The mean is 50% plus 68% /2 = 34%. 31.67 is one standard deviation from the mean. Add the mean plus ½ of the 68% = 84%.

35. Activity A: $2000/week

Activity B: $1000/week

Activity C: $2500/week

Activity D $1500/week

Activity E: $2200/week

36. To compress the schedule, you must compress the activities on the critical path even though the activities not on the critical path are cheaper. Therefore, crash Activity A for one week at an additional cost of $2,000.

37. Crash activity A for 1 week and Activity E for 1 week; additional cost is $4,200.

38. $3,000 does not cover the additional cost of $4,200. The exception would be if you need the resources to be available earlier for another project.

39. A: 5 weeks; F: 6 weeks; G: 8 weeks

40. 19 weeks

41. The standard deviation of the activities on the critical path is 2.94 weeks

42. A 95% completion is the critical path plus two standard deviations, or approximately 25 weeks.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER THIRTEEN

Pricing and Estimating

The total integrated process of project planning includes several activities that require collaboration between the project manager, the project team, and many of the project stakeholders. Estimating the likely costs of material, human resources, equipment, and work effort required to complete the project is a significant part of the planning process.

There are several common techniques available for use in estimating project costs, activity duration, and project completion date, and the project manager may use a combination of these techniques to develop the initial project schedule and budget. Companies today have estimating databases that can be useful. These techniques may also be used later in the project life cycle depending on the extent of changes introduced to the project plan and on overall project performance. The application of these techniques will vary depending on project complexity and organizational project management maturity, but the objective of the estimating process is to determine, within a desired or expressed degree of reliability and risk, the total cost to produce a product or project deliverable and the time frame for completion. The difficulty experienced in estimating project costs and schedules depends on the type of project, the experience level of the project manager and project team, the number and type of resources to be used, and the availability of historical estimating data. Use of previous projects for comparison purposes, lessons learned, and established organizational processes will affect the reliability of an estimate. Estimating is basically the process of producing a guess or an approximation of project costs or time durations. It should include risk assessments and an appropriate management and contingency reserve to address estimating uncertainty.

Pricing is generally the process of determining the appropriate amount to bill or charge a client, customer, or receiver of a product or service. Pricing is considered to be a business decision and is associated with profitability (or margin), the relationship with clients, the general target market, and what the market will bear. Availability of materials, difficulty of production, level of quality to be included, competition, and risk factors are also associated with pricing.

It is important to emphasize that one of the most crucial inputs in the pricing decision is the cost estimate or cost baseline of the proposed project. The process of estimating actually begins before the proposal development process. It starts with

customer requirements, defining the tasks and subtasks, and in many cases a top-down estimate that is further refined during the planning process. The further refinement is generally associated with the process of progressive elaboration, moving forward in increments and adding detail as planning progresses.

There are three major types of estimating techniques that may be used during project planning:

- Analogous: Using previous similar projects as a basis for the estimate and adjusting the estimate for the degree of difficulty
- Parametric: Using mathematical algorithms, usually based upon a statistical approximation, such as the cost of square footage
- Bottom-up or grass roots estimating: The use of a WBS and an aggregation of costs and or durations to determine the project cost and schedule

It is important to note that, in most cases, estimates are more reliable when they are developed by the functional organizations or specific resources that have been assigned responsibility for completing the work package or activity. This is based on the actual hands-on experience and lessons learned from functional groups or personnel who will perform the work or who have performed similar work in the past.

Remember

Reliable estimates are not based on luck. They are the result of a combination of available information, expert judgment, best practices, and in many cases, a model that is based on previously collected and validated data.

► Glossary of Terms

Analogous estimate Preparing an estimate by comparing projects that may be similar and then adjusted based upon a degree of difficulty. This type of estimate is considered to be a top-down estimate and has a low degree of reliability. Analogous estimates are in most cases refined to improve the accuracy over time.

Bottom-up estimating A technique that uses well-defined project information from a WBS. The estimate is produced by aggregating information from the work package level, through each higher-level component of the WBS, to the total or project level. This process will produce a definitive estimate that has a generally accepted range of accuracy of plus or minus 10%, but may require a great deal of time to produce the estimate.

Cost baseline The approved total estimated cost of the project. The cost baseline is the output of the cost-budgeting process. The cost baseline is a time-phased budget that is used as a basis for measuring and controlling project costs through each phase of the project life cycle. The cost baseline will exclude profits, contingency reserves and the management reserve. If contingency and management reserve funding is to be used, the cost baseline is then updated.

Cost budgeting The aggregation of all project costs to produce the project cost baseline.

Cost estimating relationships The output of cost models. Typical cost estimating relationships (CERs) include:

- Mathematical equations based on regression analysis
- Cost-quantity relationships such as learning curves
- Cost to cost relationships
- Cost–non-cost relationships based on physical characteristics, technical parameters, or performance characteristics. There may be some relationships and interfaces that will not incur additional cost and will not affect the estimating process. Examples: internal transfer of documents, use of support resources that are not billed back to the project.

Direct cost A funding amount or price of something that can be completely attributed to the production of specific goods or services. Examples: supplies, equipment, and man-hours to produce the deliverable.

Estimating The process of calculating the likely cost of a project, product or service. It may be a formal or informal process. The act of determining the likely cost of construction works on behalf of either clients or contractors. Determining the probable cost of future work and/or possible scope changes.

Estimating groups These are people or departments that estimate the cost of new work without soliciting input from the functional managers. The success of this group is based upon the quality of the estimating database.

Estimating teams On some projects, the initial group of people assigned to the project are functional subject matter experts with knowledge of functional estimating standards. Once the estimating team completes their tasks, they may be replaced by other functional employees who will be doing the actual work.

Feasibility study A process to determine if a business idea is capable of being achieved by an organization. A study of the applicability or ability to develop and deliver a proposed action or plan.

Forward pricing rates These are long-term forecasts on the salary of the workers two or three years ahead. This is for estimating on long-term projects. Forward pricing rates are also used on overhead costs and material costs.

Fully loaded or fully burdened rate The total cost of a resource including salary and all overhead costs such as benefits. The total of all costs associated with maintaining a resource. Many organizations establish reference tables that provide the fully burdened rates of its employees for use in project cost estimating. The estimate may be based upon a department or pay grade fully loaded rate.

Indirect cost Costs that are not directly associated with a single activity, event, or other cost object. These costs are frequently aggregated into an overhead cost pool and allocated to various activities

Examples of indirect costs are:

- Management salaries and related benefits
- Quality assurance staff wages and related benefits
- Equipment maintenance
- Depreciation on factory equipment
- Facility rent
- Utilities

Management reserve (as related to pricing) This is a sum of money or a percent of the estimated cost that is added into the price for possible inaccuracies in the estimating process. Generally the management reserve is held in an account separate from the project budget and is released after careful analysis of the project performance data and forecast information.

Opportunity cost The loss of potential gain from other alternatives when one alternative is chosen. Something given up when a decision is made.

Parametric estimating A process of estimating that utilizes mathematical models to determine an approximate outcome. An example is the use of a standard cost per unit multiplied by the number of units required. Example: House construction may use a standard cost per square foot of living space multiplied by the desired amount of living space. This method is often referred to as a top-down estimate, but in practice overtime will produce highly reliable estimates.

Pricing The process of applying prices to purchases and sales orders based on several factors: fixed amount, quantity, promotion or sales campaign, specific vendor quote. Pricing is the process of determining the correct amount to bill or charge for a product or service. Pricing includes the cost of developing and building or fabrication of a product, investment risks, and fair profit margin.

Regression analysis A method for determining the association between a dependent variable and one or more independent variables. The statistical technique of finding a straight line that approximates the information in a group of data points. A statistical method to estimate any trend that might exist among important factors.

Sunk cost This is a cost that has been incurred and will not be affected by any future decision. It is basically money spent. Sunk costs are not considered when making decisions about whether to continue with a project or terminate the project. This is a cost that has been incurred and cannot be recovered.

Top-down estimating This is an estimating process at the top one or two levels of the WBS. Estimating can be done quickly but the accuracy of the estimates may be risky unless the company has a good estimating database.

▶ Activities, Questions, and Exercises

Refer to Chapter 13 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Cost Management and Project Time Management. There is also a relationship to Project Risk Management.

Remember

The reliability of estimating types is a key factor in the planning process. The type of project, especially where new technology is involved or where a new product is being developed, may require several adjustments to the prepared estimates as the project proceeds. This is accomplished through progressive elaboration.

1. Review each of the following estimating methods and match with the appropriate descriptions and characteristics for each.

Estimating Method	Generic Type	WBS Relationship	Accuracy
a. Parametric (or ROM)	_____	_____	_____
b. Analogy (analogous or budgetary)	_____	_____	_____
c. Engineering or grass roots (also bottom up or definitive)	_____	_____	_____

Generic types:	*WBS relationships:*	*Accuracy:*
ROM (rough order of magnitude)	Top down	–25% to +75%
Budget	Bottom up	–10% to +25%
Definitive		– 5% to +10%

2. **PM Quick Check:** Which of the following will provide the project team and project manager with the most useful information to develop a well-prepared and definitive project cost estimate?
   a. The project charter
   b. The preliminary scope statement
   c. The WBS
   d. The statement of work

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3. **PM Quick Check:** The ROM or rough order of magnitude estimating type is associated with which of the following estimating methods?
   a. Engineering or grass roots
   b. Parametric
   c. Analogous
   d. Definitive
4. **PM Quick Check:** Reliability of estimates is a critical factor in the project-planning process. To ensure greatest reliability of activity estimates they should be developed by:
   a. The project sponsor
   b. The project manager
   c. The functional manager
   d. The customer

Remember

The WBS is considered the cornerstone of project planning and in addition to displaying the project tasks, activities, and project complexity is used by the project team to increase the probability of producing reliable cost estimates and activity duration estimates. It will also provide useful information during the risk identification and risk assessment process.

5. Explain how the WBS is used by the project manager and project team to develop a reliable bottom-up estimate.

_____

_____

_____

_____

6. What is the difference between a "sunk cost" and an "opportunity cost"?

_____

_____

_____

_____

_____

7. Review the list of project costs and identify each item as a direct cost or an indirect cost.

Project Cost	Direct Cost	Indirect Cost
a. Project manager travel expenses	_____	_____
b. Project team labor rates	_____	_____
c. Equipment costs	_____	_____
d. Taxes	_____	_____
e. Maintenance and janitorial services	_____	_____
f. Reward and recognition of the project team	_____	_____
g. Company benefits	_____	_____
h. Materials	_____	_____
i. Accounting services	_____	_____
j. Utilities	_____	_____

Remember

Variable costs and fixed costs should be considered when planning the project budget. Variable costs are costs that may change during the project life cycle, including material costs, supplies, and salaries. Maintain an awareness of the use of collective bargaining units or resources that may be associated with contractual salary or wage increases at points in time during the project life cycle. Fixed costs generally do not change and may be associated with nonrecurring or recurring activities. Fixed costs may include rentals, one-time setup, or leases.

8. **PM Quick Check:** Using the technique of analogous estimating is also associated with the technique known as:
   - **a.** Scope decomposition
   - **b.** Scope definition
   - **c.** Feasibility analysis
   - **d.** Expert judgment
9. **PM Quick Check:** Before developing the project cost estimates for resources the project manager should consider the following organizational expense items: building maintenance, fringe benefits, group insurance, office supplies, clerical support, postage, retirement plans, sick leave, vacation pay. These items are generally associated with:
   - **a.** Contractor direct costs
   - **b.** Overhead rates or costs
   - **c.** Variable costs
   - **d.** External costs

10. There is generally a sequence of steps taken to determine the estimated cost of a project deliverable. Review the following list and number each to create the appropriate sequence for completing the estimating process.

a. Develop the WBS. _____
b. Provide a complete definition of the work requirements. _____
c. Estimate the costs (cost out) of the WBS. _____
d. Establish a logic network. _____
e. Establish reasonable costs for each WBS element. _____
f. Decide on the basic course of action. _____
g. Review WBS costs with functional managers. _____
h. Develop the RAM. _____
i. Negotiate with functional managers for qualified personnel. _____
j. Review base case costs with upper management or sponsor. _____
k. Document the results in the project plan. _____
l. Establish cost summary reports. _____
m. Develop the final detailed network diagram and CPM schedules. _____

11. **PM Quick Check:** Sunk costs are used as a major factor in the decision to approve the continuation of a project into the next phase.

☐ True
☐ False

Remember

In some cases the customer may wish to audit the cost proposal before it is approved. The project manager should prepare supporting data about cost estimates for reference during audits.

12. For each of the following estimating pitfalls and problems provide a possible preventive measure or solution.

a. Misinterpretation of the statement of work. _____

_____

_____

_____

b. Omissions or improperly defined scope _____

_____

_____

_____

c. Poorly defined or overly optimistic schedule _____

_____

_____

_____

d. Inaccurate or incomplete WBS _____

_____

_____

_____

e. Applying improper skill levels to project activities _____

_____

_____

_____

f. Failure to account for risks _____

_____

_____

_____

g. Failure to understand or account for cost escalation and inflation _____

_____

_____

_____

h. Failure to use the correct estimating technique _____

_____

_____

_____

i. Failure to use forward pricing rates for overhead, general administrative, and indirect costs _____

_____

_____

_____

_____

13. Review the following common risks that may be encountered when planning a project. These items may significantly impact the project cost and schedule and the activity duration and cost estimates and ultimately affect the final project results. For each risk identified, provide a possible preventive action or response.

a. Poorly defined requirements _____

_____

_____

b. Lack of qualified resources _____

_____

_____

c. Lack of management support _____

_____

_____

d. Inexperienced project manager _____

_____

_____

e. Unreliable estimates from functional managers _____

_____

_____

f. New technology or work that has not been performed previously _____

_____

_____

g. Unreliable subcontractors _____

_____

_____

14. Which of the following costs are generally associated with the project life cycle, and which costs are associated with the total life cycle of the product (or both)?

a. R&D costs	Project life cycle _____	Product life cycle _____
b. Production costs	Project life cycle _____	Product life cycle _____
c. Construction costs	Project life cycle _____	Product life cycle _____
d. Operation and maintenance	Project life cycle _____	Product life cycle _____
e. Product retirement	Project life cycle _____	Product life cycle _____

Remember

Life cycle cost analysis is the systematic analytical process of evaluating various alternative courses of action early in the project with the objective of choosing the best way to employ scarce resources and lower the cost of the total life cycle of the product or the project.

Study Note

Successful application of the life-cycle costing process will:

- Provide downstream resource impact visibility (a forecast of potential future costs and impact to the project
- Provide more effective life cycle cost control
- Influence/improve/enhance R&D decision making
- Support downstream strategic planning and budgeting

Estimating methods may be classified as follows:

Informal

- Expert judgment or experience
- Analogy
- SWAG (slang term, basically a guess with no actual reliable basis)
- ROM (Rough Order of Magnitude)

Formal

- Engineering/Detailed from standards
- Parametric
- Organizational process standards and assets
- Bottom-up, engineering estimate

15. Explain the advantages and disadvantages of each estimating type listed in the table.

Estimating Type	Advantages	Disadvantages
Engineering or grass roots (bottom-up estimating)		
Parametric		
Analogous (analogy)		

Study Notes

Economic project selection methods

- **Payback period:** The time required to recover or pay back an initial investment. The payback method generally does not take into consideration the time value of money. Example: A project requires an initial investment of $10,000. The project team estimates a cash inflow in year one of $5000, and a cash inflow of $5000 by end of year two. Recovery of the initial investment is two years. Therefore payback period is two years. If this is acceptable to the organization decision makers, the project may be approved. Shorter-term payback periods are preferred when assessing projects during the project selection process.
- **Discounted cash flow (DCF):** Determining the present value of potential future earnings of an investment. The yield of the investment is calculated in terms of the present value. Example: If an investment yields $1,000 one year from now and the cost of money is 10%, the value in today's dollars would be $909. This is determined by the formula for present value:

$$PV = FV/(1 + r)^n$$

Where

PV = Present value
FV = Future value
r = Rate or cost of money
n = Number of years

The future value of an investment is determined by the formula $FV = PV(1 + r)^n$.

- **Breakeven analysis**: The point at which the cash outflow and the cash inflow meet. The cash outflows are projected along with the cash inflows. The date where the two curves intersect is the breakeven point. If the breakeven point is acceptable to the organization, the project will be approved.
- **Net present value (NPV)**: Net present value is determined by calculating the present values for the cash flows for each year of the project. The sum of the present values is determined and the net present value is calculated by subtracting the initial investment from the sum of the present values. Generally, a net present value greater than zero would indicate an acceptable project.
- **Internal rate of return (IRR)**: A sophisticated capital-budgeting process involving a series of trial and error or iterative calculations to determine at what interest rate or cost of capital rate would result in a net

present value of zero. This requires several calculations at increasing cost of capital rates to determine the actual internal rate of return.

- **Depreciation**: The reduction in the balance sheet of a company asset to reflect its loss of value through age and wear. The decline in the value of a capital asset. Depreciation represents a cost of ownership and the consumption of an asset's useful life. Generally deductible for tax purposes.

PM Quick Check

16. What is the future value of $5,000 invested at 10% interest for 3 years?

_____

17. What is the present value of a project that will yield $100,000 two years from now if the cost of capital is 15%?

_____

18. What is the net present value of the following project? The discount rate is 5%. The initial investment is $10,000 and the project has a 5-year duration.

Year	Cash Inflows	Present Value
1	$1,000	
2	$2,000	
3	$2,000	
4	$5,000	
5	$2,000	
	Sum of present values	=
	Initial investment (–)	
	Net present value (NPV)	=

A Problem to Consider: Estimating Person Days

Companies usually estimate work based upon man-months (person-months). If the work must be estimated in person-weeks, the person-month is then converted to person-weeks. The problem is in the determination of how many person-hours per month are actually available for actual direct labor work.

Your company has received a request for proposal (RFP) from one of your customers and management has decided to submit a bid. Only one department in your company will be required to perform the work and the department manager estimates that 3,000 hours of *direct* labor will be required.

Your first step is to calculate the number of hours available in a typical person-month. The human resources department provides you with the following *yearly* history for the average employee in the company:

- Vacation (3 weeks)
- Sick days (4 days)
- Paid holidays (10 days)
- Jury duty (1 day)

How many direct labor hours are available per month per person?

	2,080	hours available per year
–	120	for vacation
–	32	for sick days
–	80	for paid holidays
–	8	for jury duty
=	1,840	hours per year or 153 per month

If only one employee can be assigned to the project, what will be the duration of the effort, in months?

3,000 hrs/(153 hrs per month) = 19.6 months (This assumes only one person)

If the customer wants the job completed within one year, how many employees should be assigned?

3,000 hrs/(1,840 hrs/person) = 1.6 people

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Cost Management and Project Time Management.

Remember the three types of estimating methods: analogous, parametric, and bottom-up estimating (sometimes referred to as a grassroots or engineering estimate).

Analogous and parametric estimating are generally considered top-down estimating techniques. The parametric estimate may become very reliable over time based on repetitive type of work.

Pricing is a business decision and is determined after project costs have been estimated and validated. Pricing determines the margin or profit associated with a project and is usually decided by managerial staff.

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The cost baseline is the aggregate of all cost estimates and is provided to the sponsor for review and approval.

The cost baseline is developed after all costs have been aggregated. The project cost is allocated across each phase of the project and is managed as a time phased budget that allows the project costs to be monitored as the project progresses through each phase.

Sunk costs are those costs that have been incurred and are generally not considered when making decisions about the future of the project.

Opportunity cost is generally considered the loss of revenue that is experienced when one project is selected over another or when funds are held for one project that could have been used to generate revenue in another area or on another more favorable project.

Remember to consider overhead and indirect costs when developing a project budget.

Life-cycle costing includes all costs from R&D to salvage. Project costing is generally associated with the costs to deliver the project and does not include operations, maintenance, and salvage.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. **a.** ROM; top down; – 25% to +75%
   b. Budget; top down; –10% to +25%
   c. Definitive; bottom up; – 5% to +10%
2. c
3. b
4. c
5. The WBS provides the details of the project activities and allows the team to determine the resource requirements and other cost factors to produce a more accurate estimate.
6. A sunk cost is an expenditure that has been incurred while working on a project and cannot be recovered. It is not considered when making decisions about the future disposition of the project. Opportunity cost is associated with the loss of revenue that could have been attained from one project by holding funds for another project.
7. **a.** Direct cost
   b. Direct cost
   c. Direct cost
   d. Indirect cost
   e. Indirect cost
   f. Direct cost
   g. Indirect cost
   h. Direct cost
   i. Indirect cost
   j. Indirect cost
8. d
9. b

10. a. 3
    b. 1
    c. 4
    d. 2
    e. 7
    f. 6
    g. 5
    h. 10
    i. 9
    j. 8
    k. 13
    l. 12
    m. 11
11. False
12. a. Ensure the SOW is free of imprecise language. Have the SOW reviewed by a third party.
    b. Verify the scope statement and project scope. Use a template or check list to define the scope. Obtain support from functional groups.
    c. Ensure that functional groups are involved in the planning, consider risks associated with scheduling, validate assumptions.
    d. Use functional manager knowledge, use templates from previous projects, review WBS with scope statement and statement of work.
    e. Identify the appropriate skill levels required, provide training as needed, and verify competency levels.
    f. Prepare a risk management plan and conduct risk analysis.
    g. Review lessons learned, obtain support from accounting groups, and ensure that estimates include forecasts of economic conditions.
    h. Review standard practices, review expectations with project sponsors and executives.
    i. Consider the time value of money, plan for inflation and changing market prices for material, identify overhead (rent, telecom costs, support services, benefits), consider contractual raises bargained for by employees, obtain templates to assist in estimating, obtain a third-party review of estimates.
13. a. Develop a plan to identify requirements early in the project. Verify statement of work and scope statement. Validate requirements before developing project plans.
    b. Define resource requirements. Review WBS to identify resource needs. Negotiate with functional managers for qualified resources. Communicate resource requirements prior to project kickoff.
    c. Connect the project to strategic goals. Review the project objectives and scope statement with management. Verify that the project was selected using the appropriate selection process.
    d. Request a more experienced project manager. Establish a mentor relationship with a more experienced project manager. Define required skills before selection of a project manager.

e. Obtain records and historical data from previous projects. Request supporting data for all estimates.

f. Prepare rolling wave estimates. Reassess estimates at the completion of each phase.

g. Establish contractor selection criteria. Establish expectations and performance measurement criteria. Negotiate penalty clauses and other controlling processes in the contract.

14. a. Product life cycle

b. Project life cycle and product life cycle

c. Project life cycle and product life cycle

d. Product life cycle

e. Product life cycle

15.

Estimating Type	Advantages	Disadvantages
Engineering or grass Roots (bottom-up estimating)	Detailed information Very accurate Provides best estimating base for future project change estimates	Requires significant amount of time to complete May be costly
Parametric	Generally a simple process Statistical database can provide expected values and prediction intervals	Requires the establishment of parametric cost relationships to be established (need a basis for the estimates) Considered top down and low in accuracy
Analogous (analogy)	Low cost Quick Simple to generate Accurate when very similar projects are compared	Generally low in accuracy except when projects are very similar Limited to stable technology

16–18.

Year	Cash Inflows	Present Value
1	$1,000	952
2	$2,000	1,814
3	$2,000	1,728
4	$5,000	4,113
5	$2,000	1,567
	Sum of present values	= 10,174
	Initial investment (–)	10,000
	Net present value (NPV)	= 174

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER FOURTEEN

Cost Control

Project cost control includes the processes of monitoring project work activities, assessing project performance in terms of the variance between planned costs and actual costs, determining the cause of the variances whether good or bad, tracking and recording of project data, and taking corrective action as necessary to return project performance to acceptable levels.

Key point: Monitoring is tracking performance and control is taking the necessary steps to correct unfavorable situations. Project managers must do both monitoring and control.

Cost control processes, which are often company standardized, are part of integrated change control and should be introduced to the project team at the start of the project and especially during the kickoff meeting. The control processes should be agreed to by all project personnel who are responsible for incurring costs during the project life cycle.

Generally, cost control includes managing costs after the project budget has been approved, cost accounting (managing cash inflows and outflows), and identifying and correcting unacceptable variances.

The project budget, prepared by the project manager and project team, includes the estimated cost of all project deliverables, including the materials, equipment, resources, and all activities required to produce the deliverables. The budget also includes any overhead costs, indirect costs, and reserves have been included to address potential project risk events.

Typically, the project manager is held accountable for the successful management and control of project costs and must be prepared to act quickly when project costs appear to be approaching an unacceptable variance from the plan. Continuous monitoring of project performance, analysis of variances, and identification of possible solutions and alternatives that may be utilized to correct variances are all included in the list of project manager responsibilities.

The project manager's main objectives regarding cost control are to maximize the probability of completing the project within the approved budget by keeping actual costs at or below planned levels, to minimize the use of available contingency reserves, and to maximize company profits, or to minimize overall expenses (depending on the type of project).

It is important for the project manager to understand that cost management is directly related to schedule management and scope management. Cost, scope, and schedule are the three elements associated with what has been referred to as the triple constraint, which was intended to illustrate the interrelationships between these elements. In the project environment, a change in scope can affect cost and schedule. A change in schedule can affect cost and scope.

Exam Tip

Some key components and activities of cost control:

- Awareness of factors that may cause changes to the cost baseline
- Following the process of obtaining approval of change requests that will affect project cost and impact the cost baseline
- Managing changes through a change control process to ensure that risks have been identified and that an impact analysis has been conducted to prevent additional negative cost-related issues from occurring; also intended to manage or minimize the impact to other projects or ongoing company operations
- Monitoring cost performance on a regular basis through project reviews
- Recording and documenting all authorized project changes that impact the cost baseline
- Preventing incorrect, unauthorized, or inappropriate changes
- Informing project stakeholders of approved changes
- Taking corrective action to resolve identified cost overruns

Cost control also includes the use of effective risk management techniques that address the opportunities as well as the potential negative events that may be experienced during project execution.

Remember

Any cost control system is only as good as the original plan against which performance will be measured. Effective planning and the use of reliable sources of estimates are key factors in managing project costs.

► Glossary of Terms

Here are key terms and definitions to review and remember.

Actual cost (AC) Amount expended (in terms of direct labor or direct cost) of work that has been completed within a given time period. Also known as ACWP, or actual cost of work performed.

Actual cost of work performed (ACWP) Amount expended (in terms of fully burdened direct labor or direct cost) on work that has been completed within a given time period. Also known as AC, or actual cost.

Baseline The original approved plan for a project. There are three major baselines associated with a project: the scope baseline, the schedule baseline, and the cost baseline or project budget.

Benefit-cost ratio (BCR) An indicator, used in the formal discipline of cost-benefit analysis, that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Budget at completion (BAC) The sum of the total work authorized budgets for a project. Sum of the budgets for each phase of a project.

Budgeted cost of work performed (BCWP) Amount budgeted or planned to be expended for work that has been completed. Also known as earned value. The amount that had been planned to be spent for the work that has been completed. The earned value is compared with the actual cost. The difference between earned value and actual cost is the cost variance.

Budgeted cost of work scheduled (BCWS) The budgeted amount of work that has been scheduled to be completed at the time of measurement. Also known as planned value. This is the amount that was planned to be paid for the work that was scheduled to be completed by the time of the actual measurement.

Contingency The planned allotment of time and cost for unforeseeable elements that may be associated with project planning. A planned reaction or response established to address an event that may or may not happen.

Contract cost The summation of the cost baseline and the management reserve.

Contract Price The summation of the contract cost and the profit anticipated.

Corrective action Changes made to bring expected future performance of the project in line with the plan. Actions taken to return project performance to the planned level or performance or to an acceptable level.

Cost baseline The summation of the distributed (or time-phased) budget and the undistributed budget. The total project cost including reserves allocated across the project life cycle.

Cost control The process of controlling variances to the planned costs of a project. Managing to remain within a predetermined project budget throughout its various stages or phases.

Cost performance index The cost efficiency ratio of earned value to actual costs, expressed as the formula CPI = BCWP/ACWP or CPI = EV/AC. It is often used to predict the magnitude of a possible cost overrun using the formula BAC/CPI = projected cost at completion or EAC.

Cost variance Any difference between the budgeted cost of an activity and the actual cost of that activity. In earned value, BCWP – ACWP or EV – AC = CV (cost variance). *Special note:* CV and SV (cost variance and schedule variance) can be expressed in hours, $$, %, or all three. The reason is that, for example, CV in dollars can be unfavorable while CV in hours can be favorable. In other words, you are spending more money that you thought but you are using fewer hours. This is normally indicative of having people assigned that are at a higher pay grade than you budgeted for. They are more expensive but can get the job done in less time.

Distributed or time-phased budget The sum of money that is released using the work authorization forms (usually associated with the allocation of project funds to each project phase).

Earned value (EV) A measure of the physical work accomplished considering the original approved cost estimate or authorized budget for this work. The sum of the approved cost estimates (may include overhead allocation) for activities (or portions of activities) completed during a given period (usually measured to a specific point in time). Also known as budgeted cost of work performed, or BCWP. This is the amount that was planned to be paid for the work that has been completed.

Earned value management A method for integrating scope, schedule, and resources, and for measuring project performance. It compares the amount of work that was planned with the work that was actually completed or "earned" with the units of cost expended (actually spent) to determine if cost and schedule performance are in line with the project plan. Also expressed as BCWP or EV.

Effort The number of labor units required to complete an activity or other project element. Usually expressed as staff hours, staff days, or staff weeks.

Estimate An assessment of the likely quantitative result. Usually applied to project costs and durations and should always include some indication of a range of accuracy such as plus or minus a given percent.

Estimate at completion (EAC) The expected total cost of an activity, a group of activities, or the project when the defined scope of work has been completed.

Estimate to complete (ETC) The expected remaining costs to complete an activity, a group of activities, or the project.

Management reserve A sum of money or a percent of the estimated cost that is added into the cost baseline for possible inaccuracies in the estimating process. Generally the management reserve is held in an account separate from the project budget and is released after careful analysis of the project performance data and forecast information. The management reserve is not considered part of the cost baseline because you do not plan on spending this money unless the situation dictates this as an action.

Planned value (PV) The physical work scheduled plus the authorized budget to accomplish the scheduled work. Also known as BCWS, or budgeted cost of work scheduled.

Schedule performance index (SPI) The schedule efficiency ratio or earned value accomplished against the planned value. The SPI describes what portion of the planned schedule was actually accomplished. SPI = BCWP/BCWS or EV/PV.

Schedule variance Any difference between the scheduled completion of an activity and the actual completion of the activity. In earned value, BCWP – BCWS or EV – PV.

Scope creep The uncontrolled and unauthorized changes to the project scope. Usually results in greater cost, lower quality, and unfavorable performance variances.

Undistributed budget A sum of money that you intend to spend but that hasn't been allocated yet to the work breakdown structure elements or possibly to work authorization forms. Undistributed budgets and distributed budgets make up the cost baseline.

Variance Any deviation from the plan, whether favorable or unfavorable.

Work breakdown structure (WBS) A deliverable-oriented grouping of project elements that organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of the project work.

Work package A deliverable at the lowest level of the work breakdown structure.

■ Study Notes: EVM Formulas: A Brief Review and Study Tool

Remember: PMI refers to earned value (BCWP) as EV, planned value (BCWS) as PV, and actual cost (ACWP) as AC.

Formulas to remember:

CV or cost variance =	BCWP – ACWP	or EV – AC
SV or schedule variance =	BCWP – BCWS	or EV – PV
CPI or cost performance index =	BCWP/ACWP	or EV/AC
SPI or schedule performance index =	BCWP/BCWS	or EV/PV
CV % or cost variance percent =	CV/BCWP	or CV/EV
SV % or schedule variance percent =	SV/BCWS	or SV/PV

EAC or estimate at completion = ACWP + ETC or AC + ETC where ETC is the estimate to complete. This formula is used when the original estimates appear to be questionable or are no longer relevant due to changes in the project. (ETC refers to work that has not been performed and is therefore an estimate of cost.)

EAC = AC (cumulative) + BAC – EV (cumulative) where BAC is the Budget at Completion. This formula is used when the variances experienced are atypical and similar variances are not expected to occur as work proceeds.

EAC = AC (cumulative) + [BAC – EV (cumulative)] divided by CPI (cost performance index). This formula is used when variance experiences are typical and will continue to be observed as the project continues.

VAC or variance at completion =	BAC – EAC
Project cost at completion =	BAC/CPI (also referred to as EAC)

Cost–benefit ratio is the total saving or realized benefits in dollars (converted to present value) divided by the initial cost. Example: A program that cost $54,000 to develop and deliver resulted in a $430,000 saving the first year. 430,000 / 54,000 = 7.96. For every dollar spent on this investment there was a return of 7.96 dollars. This would be considered to be a very beneficial investment.

■ Attack of the Acronyms!

Review these acronyms and learn to recognize their meanings. These are the "language" of earned value. Learn to speak it fluently.

AC	Actual cost
ACWP	Actual cost of work performed
BAC	Budget at completion
BCWP	Budgeted cost of work performed
BCWS	Budgeted cost of work scheduled
CPI	Cost performance index
CV	Cost variance
CV %	Cost variance percent
EAC	Estimate at completion
ETC	Estimate to complete
EV	Earned value
EVM	Earned value management
PMBOK®	Project Management Body of Knowledge
PV	Planned value
SPI	Schedule performance index
SV	Schedule variance
SV %	Schedule variance percent
VAC	Variance at completion
WBS	Work breakdown structure

Remember

The WBS is a key input in the cost management process. The WBS provides a basis for estimating the resources required, the duration of each activity, and for managing changes to the project plan. Project plans can be expected to change through the project life cycle, but a well-planned project will generally have minimal scope changes. Ensure that the entire project team is involved in the development of the WBS. This will assist in developing a more complete project plan and improve how the team performs together. The WBS also allows the team to determine responsibility for each major task when it is associated with the responsibility assignment matrix (RAM).

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▶ Activities, Questions, and Exercises

Refer to Chapter 14 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Cost Management and Integrated Change Control.

Remember

The estimating process is the key to cost management. Make sure that your estimates have been obtained from reliable sources. Generally, estimates should be provided by the functional managers or subject matter experts that will perform the work. Remember that estimates are actually guesses or approximations and many factors can impact the accuracy of an estimate. Risk should always be considered when developing estimates.

1. Select one and only one of the listed acronyms to answer each question.

PV	EV
AC	BAC
SV	CV
EAC	ETC

a. What is the revised estimate for the final cost at the completion of the project? _____

b. How much money was expended thus far? _____

c. How much physical work was actually accomplished thus far? _____

d. How much money was originally budgeted? _____

e. From where we are today, how much money is needed to complete the work? _____

f. By how much have we deviated from the schedule baseline, favorably or unfavorably? _____

g. By how much have we deviated from the cost baseline, favorably or unfavorably? _____

h. What is the planned cost or value of the work accomplished thus far? _____

2. There are basically two types of reserves that project managers should become familiar with: management reserves, generally associated with unknown unknowns (issues that cannot be anticipated or planned for), and contingency reserves, generally associated with known unknowns (issues and risks about which some data for

planning exists). For each of the two reserves, select *all* of the appropriate possibilities from the list that are associated with the type of reserve.

a. Management reserve: _____

b. Contingency reserve: _____

1. Labor rate escalations
2. Estimating errors
3. Overhead escalations
4. Material price escalations
5. Scope changes
6. Workmanship errors
7. Flood, natural disaster
8. Previously documented schedule delays

3. Executives want the answers to two questions, at a minimum, during briefings. Match the questions with each of the following terms. (i.e., for each of the terms below, which question will be satisfied using the term?). Select all that apply.

1. PV
2. EV
3. AC
4. EAC
5. ETC
6. VAC
7. SPI
8. CPI

a. Where are we today? _____

b. Where will we end up? _____

4. Shown below are three types of performance reports. Select the terms from the list that appear in each report. Select all that apply.

1. PV
2. EV
3. AC
4. EAC
5. ETC
6. SPI
7. CPI
8. SV
9. CV

Progress report: _____

Status report: _____

Forecast report: _____

5. The 50-50 Rule

Using the 50-50 Rule and the figure below, determine the value for PV, EV, and BAC.

PV = _____ EV = _____ AC = _____

6. A customer (homeowner) hires a contractor to tile five identical rooms in his home. The customer purchased the tiles and the contractor will be reimbursed for labor only. Because the tiles are difficult to work with, the contractor assumes two days per room at eight hours per day and at $100 per hour. The planned cost is $8,000 but overtime will also be paid, if necessary, at the same rate of $100 per hour.

The first room was completed in three days because of difficulty in workmanship and getting an understanding of how to use these special tiles. This included two hours of overtime. The second room was completed in two days. Using EVMS, the following information would be presented to the homeowner at the end of the first week:

PV = 5 × 800 = $4,000

EV = 4 × 800 = $3,200

AC = 42 × 100 = $4,200

BAC = $8,000

SV = EV – PV = –$800

CV = EV – AC = –$1,000

EAC = (AC/EV) × BAC = $10,500

VAC = BAC – EAC = –$2,500

ETC = EAC – BAC = $6,300

Percent complete = EV/BAC = 40%

SPI = EV/PV = 0.8

CPI = EV/AC = 0.76

Now it is your turn. Having tiled the floors, you now hire a contractor to wallpaper all of the walls in each of the five rooms. Once again, you purchase the wallpaper and will reimburse the contractor just for labor. The contractor works at $100 per hour and estimates eight hours of work per room, for a total of five days.

At the end of the first week, working eight hours per day, the contractor completed only three rooms. The EVMS status is:

a. PV = _____

b. EV = _____

c. AC = _____

d. BAC = _____

e. SV = _____

f. CV = _____

g. EAC = _____

h. VAC = _____

i. ETC = _____

j. Percent complete = _____

k. SPI = _____

l. CPI = _____

7. By mistake, someone left spaces unfilled in the status report below. Please complete the report by filling in the missing data.

Activity	PV	EV	AC	SV	CV
a.	100	100	150	?	?
b.	?	200	?	90	0
c.	350	?	?	–100	?
d.	400	300	?	?	–50
e.	175	?	150	25	?
Totals	?	?	1,000	?	?

8. The WBS below shows the code of accounts and costs for a given project. Every place a question mark exists, data is missing. Complete the chart.

9. Below are three S curves. For each of the curves, determine whether the project is under budget, over budget, ahead of schedule, behind schedule, or cannot be determined.

10. In the figure below, the project manager released $10 million to the functional areas to do the job. This was the released budget but the project manager also had, as part of the contract, $6 million for an undistributed budget that had not

been planned out yet. The contract also has a $2 million profit included as well as a management reserve of $1 million. Using the figure, answer the following questions:

a. The dollar value of the cost baseline is: _____

b. The contracted cost is: _____

c. The contract price is: _____

11. If the cost variance is +$100, the activity is over budget.

☐ True
☐ False

12. CPI and SPI are used for trend analysis.

☐ True
☐ False

13. If SV = –$200, the project is over budget.

☐ True
☐ False

14. Management reserve is an example of an undistributed budget.

☐ True
☐ False

15. The most difficult part of EVMS is to determine EV or % complete.

☐ True
☐ False

16. EAC can be greater or less than BAC

☐ True
☐ False

17. The 50-50 rule is used to determine AC.

☐ True
☐ False

18. Excluding management reserve and undistributed budgets, the summation of all of the PV for each work package should equal BAC.

☐ True
☐ False

19. Variances are usually expressed in percent as well as hours or dollars.

☐ True
☐ False

20. Scope changes should be paid for out of the management reserve.

☐ True
☐ False

21. Elements normally plotted in S curves are PV, EV, and AC.

☐ True
☐ False

22. As you progress through the life cycle phases of a project, the accuracy of the estimates usually improves.

☐ True
☐ False

23. An earned value drill to help you remember those formulas! Calculate the CV, SV, CPI, and SPI.

Case #	BCWS or PV	ACWP or AC	BCWP or EV	CV	SV	CPI	SPI
1	800	800	800				
2	800	600	400				
3	800	400	600				
4	800	600	600				
5	800	800	600				
6	800	800	1,000				
7	800	1,000	1,000				
8	800	600	800				
9	800	1,000	800				
10	800	1,000	600				
11	800	600	1,000				
12	800	1,200	1,000				
13	800	1,200	1,200				

24. Review the earned value analysis for case number 3 from the table in question 22. What is your assessment of this project?

_____

_____

_____

25. Review the earned value analysis for case number 12 from the table. What is your assessment of this project? What are some of the causes for this situation?

_____

_____

_____

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the areas of the *PMBOK® Guide*—Sixth Edition: Project Cost Management, Project Time Management, and Project Scope Management.

- Earned value: Practice the earned value formulas and whenever possible, apply the technique to your actual projects. Review the technique with your project teams and explain how the process applies to your project.
- Remember that PMI uses the acronyms PV, AC, and EV. Many organizations continue to use the traditional acronyms BCWS, ACWP, and BCWP. Learn to use them interchangeably.
- Earned value analysis is closely connected to communications management. The information calculated through earned value analysis is used to provide project stakeholders with useful information about a project's performance in the form of S curves, charts, and status reports.
- Cost control is a subset of integrated change control.
- Cost control is a subsystem of the management cost and control system (MCCS).
- Cost management is associated with cost estimating, cost accounting, direct costs, indirect costs, overhead, and many internal and external environmental factors.
- Cost estimating should generally be performed by the functional groups or experts who will actually do the work.
- Many projects require adjustments to the estimates as the project is progressively elaborated.
- Practice developing S curve charts to analyze project performance.
- Project performance should be monitored on a regular basis.
- Corrective action should be taken after alternatives have been identified. Select the best, most cost-efficient trade-off.
- Remember the relationships of the triple constraint and the competing demands associated with project management: time, cost, scope, quality, risk, and resources.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

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▶ Answers to Questions and Exercises

1. **a.** EAC **b.** AC **c.** EV **d.** BAC **e.** ETC **f.** SV **g.** CV **h.** PV
2. **a.** 1, 2, 3, 4, 6, 7
   b. 5, 8
3. **a.** 1, 2, 3
   b. 4, 5, 6, 7, 8
4. Progress report: 1, 2, 3
   Status report: 8, 9
   Forecast report: 4, 5, 6, 7
5. PV = $34,000, EV = $33,000, BAC = $52,000
6. **a.** $4,000 **b.** $2,400 **c.** $4,000 **d.** $4,000 **e.** –$1,600 **f.** –$1,600 **g.** $6,667 **h.** –$2,667 **i.** $2,667 **j.** 60% **k.** 0.60 **l.** 0.60
7.

Activity	PV	EV	AC	SV	CV
a.	100	100	150	0	–50
b.	110	200	200	90	0
c.	350	250	150	–100	100
e.	400	300	350	–100	–50
f.	175	200	150	25	50
Totals	1,135	1,050	1,000	–85	50

8.

9. a. Behind schedule
   b. Under budget
   c. Cannot be determined
10. a. Cost baseline is $16 million
    b. Contracted cost is $17 million
    c. Contract price is $19 million
11. False
12. True
13. False
14. False
15. True
16. True
17. False
18. True
19. True
20. False
21. True
22. True
23.

Case #	BCWS or PV	ACWP or AC	BCWP or EV	CV	SV	CPI	SPI
1	800	800	800	0	0	1	1
2	800	600	400	–200	–400	.66	.50
3	800	400	600	200	–200	1.5	.75
4	800	600	600	0	–200	1	.75
5	800	800	600	–200	–200	.75	.75
6	800	800	1,000	200	200	1.25	1.25
7	800	1,000	1,000	200	0	1	1.25
8	800	600	800	200	0	1.33	1
9	800	1,000	800	200	0	.80	1
10	800	1,000	600	–400	–200	.60	.75
11	800	600	1,000	400	200	1.66	1.25
12	800	1,200	1,000	–200	200	.83	1.25
13	800	1,200	1,200	0	400	1	1.50

24. It's good news and bad news. The work is being performed efficiently (under budget), but the project is behind schedule.
25. The work is being done efficiently (ahead of schedule), but there is a cost overrun. Additional resources may have been used or overtime may have been used. There are several possible causes for this situation.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in enhancing your skills, or for preparing to take the PMP® or CAPM® exams.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER FIFTEEN

Metrics

Today, almost every company uses project management, and the differentiation is whether they are simply good at project management or whether they truly excel at project management. Studies have indicated that companies using project management effectively have included a formal process for measuring, tracking results, and reporting performance through metrics. A business metric is a quantifiable measure that is used to track and assess the status of a specific business process. This definition also applies to project management. When determining which metrics to use, it is important to note that they should be intended to address the decision-making needs of key stakeholders involved in the project. These stakeholders may include investors, customers, sponsors, executive committees, and different types of employees. Every area of a business has specific set performance metrics that should be monitored – marketers track marketing and social media metrics, such as campaign and program statistics, sales teams monitor sales performance metrics such as new opportunities and leads, and executives look at big picture financial metrics. Every area of project management, such as cost, time, quality, and risk, should also have a set of performance metrics.

Advances in measurement techniques and available performance tracking software have given companies the opportunity to look at new metrics, including benefits expected, value created, safety, risk, customer satisfaction, image, reputation, and many others. With these new techniques and tools, executives, sponsors, and project managers are now able to make informed decisions based upon evidence rather than merely upon guesses about the health of the projects.

Many organizations, especially those with project management offices in place, utilize a project management information system (PMIS) to gather, store, analyze, and disseminate project performance data. The PMIS can provide significant benefits if designed properly. These benefits include:

- Relatively quick access to project performance information: activities completed, activities in progress, activities that are late, cost and schedule information, earned value data
- Satisfying the information needs for the various stakeholders in a timely manner

- Providing the correct information to sponsors and senior executives for informed decision making
- Customizing information for specific stakeholders
- Lowering the cost of collecting the required information
- Providing information about how the project interacts with various initiatives that are part of the ongoing business
- Providing information about how one project interacts with other projects being supported by functional managers
- Providing information that can be translated into value to the company

Effective use of a well-designed PMIS can also prevent projects from failing, by identifying early warnings signs of trouble and communicating project information that indicates where problem areas are beginning to develop. A PMIS can also make it easier for team members and functional managers to input information necessary for required and status reporting.

► The Value of Metrics

The use of metrics can provide an organization with a number of benefits. These benefits can be translated into tangible and intangible or financial and nonfinancial benefits. Many organizations focus on the financial outcomes of projects such as net present value and internal rate of return. Some effort should also be focused on less tangible items such as customer satisfaction and community relations. These items can be assessed in terms of value that could lead to financial gain and better competitive positioning. Advantages of metrics:

- Metrics tell us if we are hitting the targets/milestones.
- Metrics provide early identification of issues.
- Good metrics lead to informed decision making.
- Good metrics will allow teams to assess performance accurately.
- Metrics allow for proactive management.
- Metrics can improve future estimating.
- Metrics can be used to improve future performance.
- Metrics make it easier to validate baselines and maintain the baselines with minimal disruptions.
- Metrics can be used to more accurately assess project success and failure.
- Metrics can be used to change strategies and improve client satisfaction.
- Metrics are a means of assessing the project's health.
- Metrics track the ability to meet the project's critical success factors.

▶ The Ground Rules for Metrics

There are certain ground rules that should be established as part of the metric selection process:

- Make sure that the metrics are worth collecting.
- Make sure that we use what we collect.
- Make sure that the metrics are informative.
- Train the team in the use and value of metrics.

▶ Glossary of Terms

Balanced score card The balanced scorecard is a strategic planning and management system used extensively in business and industry, government, and nonprofit organizations worldwide to align business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals.

Critical success factor A management term for an element that is necessary for an organization or project to achieve its mission. Examples: market share, customer satisfaction, leadership capability

Dashboard A management tool used to provide an overview of enterprise health or project health. A tool for displaying complex sets of indicators.

Key performance indicator A measurable value that demonstrates how effectively a company is achieving key business objectives. Organizations use KPIs at multiple levels to evaluate their success at reaching targets. High-level KPIs may focus on the overall performance of the enterprise, while low-level KPIs may focus on processes in departments such as sales, marketing, or a call center.

Measurement A value made meaningful by quantifying into specific units. Measurements act as labels that make those values more useful in terms of details.

Metric A quantifiable measure used to track, monitor, and assess the success or failure of various processes, projects, and business activities. The main goal of using metrics is to communicate a company's progression toward certain long- and short-term objectives

Project management information system A system or combination of systems that is designed to allow an organization to gather, store, analyze, and distribute information about projects, programs, and or operations.

Value The importance, worth, or usefulness of something. A fair return in goods, services, or money for something exchanged. Business value is an informal term that includes all forms of value used to determine the health and well-being of an

organization in the short and long term. Business value reaches beyond economic value (profit, shareholder value) to include other forms of value such as employee value, customer value, supplier value, channel partner value, alliance partner value, managerial value, and societal value.

▶ Activities, Questions, and Exercises

Refer to Chapter 15 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Schedule Management, Project Cost Management and Integrated Change Control. The control processes of each knowledge area are also related to metrics, for example: control cost, control, quality, and control procurements.

■ Metrics Questions

1. Metrics are designed to:
   - a. Keep stakeholders informed
   - b. Portray a clear and truthful representation of the project
   - c. Provide information for informed decision making
   - d. All of the above
2. The benefits of an effective EVMS include:
   - a. Accurate display of project status
   - b. Reasonable determination of the project's health
   - c. A basis for course corrections
   - d. All of the above
3. Which of the following drove the need for better metrics?
   - a. The desire for paperless project management
   - b. The growth in more complex projects
   - c. New definitions of project success and failure
   - d. All of the above
4. Which of the following is true:
   - a. Metrics should not be allowed to change as the project progresses.
   - b. Good metrics can provide precise predictions of performance rather than a close estimate.
   - c. Metrics do not provide any real value unless they can be measured.
   - d. All of above are true.

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5. Even with good metrics, metric management can fail because of:
   a. Poor stakeholder governance
   b. Overly optimistic planning
   c. Slow decision-making processes
   d. All of the above
6. Which of the following is not a requirement for a metric?
   a. A need or purpose
   b. A metric owner
   c. A means of measurement
   d. A reporting structure
7. Which of the following stakeholder actions can lead to metric management failure?
   a. Mistrust among the stakeholders
   b. Failing to understanding the metrics
   c. Failing to agree on how to measure the metrics
   d. All of the above
8. When determining the best possible metrics for a project, it may be necessary for the PMO to perform metric benchmarking.
   ☐ True
   ☐ False
9. Promising stakeholders certain metrics without knowing how to perform the measurement is an example of a metric trap.
   ☐ True
   ☐ False

■ Key Performance Indicators Questions

10. Metrics focus on the future whereas KPIs focus more so on the here and now.
    ☐ True
    ☐ False
11. The rule of inversion states:
    a. Only metrics that are difficult to measure should be selected as KPIs.
    b. Risk KPIs are essential for tracking performance.
    c. Only core metrics should be tracked.
    d. Only the easy metrics, such as time and cost, should be selected.
12. The project manager must explain to the dashboard viewers what is or is not a leading indicator, and how the metric/KPI should be interpreted.
    ☐ True
    ☐ False

13. Some metrics and KPIs may not be measured until well into the future because the measurement is based upon the beneficial use of the deliverable.

- ☐ True
- ☐ False

14. Which of the following is true?

a. KPIs in one industry may not be transferable to another industry.

b. KPIs in one company may not be transferable to another company even if they are both in the same industry.

c. KPIs in one part of a business may not be transferable to another part of the business within the same company.

d. All of the above

15. Stakeholders should be asked to buy into the KPI measurement techniques.

- ☐ True
- ☐ False

16. According to David Parmenter, what percent of the metrics selected should be treated as KPIs?

a. 10%

b. 20%

c. 80%

d. 90%

17. Which of the following is not one of the six characteristics of a KPI?

a. Predicts the present and the future

b. Can be displayed with more than one icon

c. Relevant to the success and failure of the project

d. Few in number

18. Which of the following can influence the selection of KPIs?

a. Size and number of dashboards

b. Type of audience and audience requirements

c. Audience project management maturity level

d. All of the above

19. It is important that the number of metrics be limited so that everyone is focused on the same KPIs and understands them.

- ☐ True
- ☐ False

20. Which of the following is true?

a. We can always get the customers and stakeholders to agree on the KPIs.

b. KPI data is always available through an EPM system.

c. Once the KPI is selected, the cost, complexity, and timing to obtain the data are generally low.

d. The risks of changes to the information system and data collection techniques must be considered.

21. Sophisticated measurement techniques will eliminate uncertainties and provide us with complete information for project decision making.

☐ True
☐ False

22. KPI measurements can lead to project failure if:

a. Employees believe the results will be used against them during performance reviews.

b. The measurements are controlled by management.

c. They are used to allocate blame for performance problems.

d. All of the above

23. The true health of a project can be determined from a single metric or KPI.

☐ True
☐ False

■ Value-Based Project Management Metrics Questions

24. Stakeholders view value as:

a. Something worth paying for

b. Low cost

c. Quality

d. Longevity

25. The project manager's definition of value includes:

a. Accomplishment of objectives

b. Demonstration of creativity

c. Demonstration of innovation

d. All of the above

26. The three broad categories of metrics are traditional metrics, KPIs and:

a. Value-based or value reflective metrics

b. Quality metrics

c. Service metrics

d. Operational metrics

27. Once accepted, companies will most likely use value-based metrics on all projects.

☐ True
☐ False

28. Which of the following benefits are easy to measure and convert into value?

a. Work force stability

b. Profitability

c. Unused capacity

d. All of the above

29. Which of the following benefits are hard to convert into value?

a. Image and reputation

b. Technology transfer

c. Development of new technology

d. Penetrating new markets

30. Which of the following are generally considered as shortcoming when converting benefits to value?

a. Making too many assumptions

b. Doing measurements at too high of a level

c. Not validating the assumptions

d. All of the above

■ Dashboard Questions

31. The ultimate goal of a dashboard is to go to paperless project management while providing data for informed decision making.

☐ True
☐ False

32. The ultimate purpose of a dashboard is to:

a. Display all required information on a single screen

b. Provide the information clearly

c. Provide information necessary for informed decision making

d. All of the above

33. Which of the following can lead to information overload on a dashboard?

a. Company branding

b. Company logos

c. Marketing and sales data

d. All of the above

34. Even though the colors red, yellow, and green are traditionally used for traffic light reporting on dashboards, the colors may be interpreted differently by each viewer.

☐ True
☐ False

35. Which of the following is part of a continuous improvement effort?

a. Measure performance and turn data into knowledge

b. Turn knowledge into action

c. Turn action into improvements

d. All of the above

36. Perhaps the best way to provide supporting data to a dashboard is by using:

a. Texting buttons

b. Drill-down buttons

c. Crisis buttons

d. Written reports

37. Dashboard designers should take time to learn what contextual information users require in order for metrics to be meaningful for them and to facilitate decisions and actions.

☐ True
☐ False

38. While we teach that all information should appear on a single dashboard screen, typical users require a suite of dashboards.

☐ True
☐ False

39. Which of the following is a common pitfall with using dashboards?

a. Users will accept the technology.

b. The more information, the better the acceptance.

c. High quality data is not necessary.

d. All of the above

40. The purpose of a metric library is to record which metrics have been used successfully.

☐ True
☐ False

41. You can never have too many metrics in the metric library.

☐ True
☐ False

► Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

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Project metrics are necessary before, during, and after the project is completed. The set of metrics defined before the project is started may change during execution and as the project reaches conclusion, the metrics used to determine success may also change. Project management parameters such schedule time to complete, budget, project specifications, and acceptance criteria will generally require a metrics and measurement process.

Project metrics enable project managers to:

- Assess performance projects in progress in terms of schedule, cost, profitability, and value.
- Anticipate potential risk situations.
- Identify problems before they escalate.
- Identify trends and keep a project within budget.
- Assess the productivity of the team.
- Assess the quality of the product or service to be delivered.

Metric definition: Standard of measurement by which efficiency, progress, performance, productivity, quality, of a deliverable, process, project, or product can be assessed.

Project management metrics: Schedule, effort, and cost variance

Goal: Measure the performance as well as progress of the project against defined baselines. The EVM (earned value management) concept, as defined in the 6th edition of the *PMBOK® Guide*, is the commonly used method to track these metrics. It integrates project scope, cost, and schedule measures to help the project manager assess and measure project performance and progress. The principles of EVM can be applied to all projects, in any industry. EVM includes three key elements of the project work:

Planned value (PV): Planned value is the amount planned to be spent for the work to be accomplished; that is, it is the authorized budget assigned to the work to be accomplished for an activity or work breakdown structure component. The total or cumulative PV is actually project budget and is referred to as the budget at completion (BAC). PV at any stage = (Planned % Complete) X (BAC)

Earned value (EV): Earned value is the value of work performed expressed in terms of the approved budget assigned to that work for an activity or work breakdown structure component. It is the authorized work that has been completed, against the authorized budget. EV is can be defined as how much was planned to be spent for the work that was accomplished. Earned value is also known as the budgeted cost of work performed (BCWP).

Actual cost (AC): Actual cost is the total cost actually incurred and recorded for the work that has been performed for an activity or work breakdown structure com-

ponent. It is the total cost incurred in accomplishing the work. Specifically, it is the amount spent for the work actually completed. Actual cost is also known as the actual cost of work performed (ACWP).

Using these three variables, project schedule variance and cost variance metrics can be derived that will indicate if the project is performing over or under budget, and performing behind or ahead of schedule,

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

▶ Answers to Questions and Exercises

Metrics Questions

1. d
2. d
3. d
4. c
5. d
6. b
7. d
8. True
9. True

Key Performance Indicators Questions

10. False
11. d
12. True
13. True
14. d
15. True
16. a
17. b
18. d
19. True
20. d
21. False
22. d
23. False

Value-Based Project Management Metrics Questions

24. a
25. d
26. a
27. True
28. d
29. a
30. d

Dashboard Questions

31. True
32. d
33. d
34. True
35. d
36. b
37. True
38. True
39. d
40. True
41. False

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in enhancing your skills, or for preparing to take the PMP® or CAPM® exams.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER SIXTEEN

Trade-off Analysis in a Project Environment

Ideally, a project manager will create an environment that will lead to the completion of a project on time, within budget, and according to scope and quality requirements, and will achieve a level of customer satisfaction that can generate additional business. In a perfect project environment, this would be relatively easy to achieve if the requirements were well defined at the start, a well-thought-out plan was in place, the team was fully trained on the technology involved, the team was ready to handle any possible change, and risk events were minimal. In actual practice projects seldom progress exactly as planned. Customers and other stakeholders request changes; the business, economic, and political environments do not always provide favorable conditions; people make mistakes; estimates are often flawed; work items are omitted or overlooked; conflicts occur; and team members are changed more frequently than we would like (churn or turnover of project teams can create rework, impede progress, and create conflicts).

This more realistic project environment drives the project manager and team to continually assess project performance throughout the life of the project to determine where significant variances to the plan may be occurring. The project team must also work within a number of constraints that are generally inflexible. This creates a necessity to determine where trade-offs (the giving up of one item to satisfy another need) must be considered. Project managers must be willing to analyze situations and decide on actions in a give-and-take project environment. Today we refer to these trade-off factors as competing demands. Competing demands may include time, cost, quality, risk, scope, resources, safety, aesthetics, social acceptance, and the values expressed by the client and organization performing the project work.

The time, cost, performance triangle, known as the triple constraint, was considered to be the "magic combination" that provided the basis for project trade-off decisions and kept the project manager continuously pursuing a balance of these elements to achieve project success. In the current project management environment, business value is the key factor in determining success. Completing a project on time, within budget, and according to scope does not necessarily indicate success. Customers are expecting long-term value for their business investments. This is generally associated with return on

investment, follow-on business, better positioning in the market, and efficiencies in the use of time and resources. Trade-off analysis is used in project decisions and in business decisions to determine what can be given up or reduced in one area to allow an increase in another area for the purpose of achieving a desired outcome.

Remember

Although time, cost, and scope (or performance specifications) provide a basic platform for success criteria, it is important to note that there are many other factors that must be considered in the quest to achieve project success and customer satisfaction. Don't forget:

- Providing what the customer needs means fulfilling requirements.
- Ensuring that the product is used means it is perceived to have value.
- The project should not interfere with normal business operations.
- The project team sees personal value in completing the project.
- Perform at a level ensures the customer will want your organization to manage future projects.
- The project should be perceived as being aligned with and supportive of organizational strategic objectives.
- Ensure that the desired value and business benefits are achieved.

▶ Glossary of Terms

Competing trade-offs Basically, more of one output requires less of another, or less of one requires more of another. Example: A reduction in the schedule duration without changing the scope of work will require an increase in cost to accommodate the use of more resources or overtime. Physical limitations may affect the viability of trade-off possibilities. These are also known as competing demands.

Complementary trade-offs Multiple outputs that can be achieved independently.

Constraint A limitation or restriction. Examples of project schedule constraints: must start no later than, must finish no later than, must complete no earlier than, funding limits, resource availability.

Trade-off A management decision to reduce one item in favor of another. A situation that requires a decision to give up one thing to obtain something else. An exchange that occurs as a compromise. A decision that implies that the decision maker fully comprehends both the positive (upside) and the negative (downside) of a particular choice.

Trade-off analysis A method to improve the quality of decisions by making the decision process more explicit, rational, and efficient. Generally a political process that can be structured in a systematic way to improve reliability and validity of the decision. Determining the effect of decreasing one or more key factors and simultaneously increasing one or more other key factors in a decision, design, or project.

Triple constraint The three major baselines of a project that are interrelated. The triple constraint implies that any change to one of these elements will generally have an impact on one or both of the other elements. Usually depicted as a triangle, the triple constraint has generally been replaced with a broader emphasis on a combination of competing demands that include but are not limited to time, cost, quality, scope, risk, resources, and safety.

▶ Activities, Questions, and Exercises

Refer to Chapter 16 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: all knowledge areas, particularly Scope Management, Schedule Management, Cost Management, Quality Management, and Risk Management.

Remember

There are two major elements of the trade-off analysis process:

- Identifying and displaying how alternatives perform or affect a situation or defined criteria
- Assisting stakeholders in articulating and applying their personal values to a problem in a rational way to achieve mutual agreement and a decision

Study notes: There are some generally accepted approaches in the trade-off analysis process:

Trade-off analysis is a systemic approach to managing the competing demands of time, cost, quality, risk, resources, and performance (scope or specifications). During the project life cycle, information from cost reviews, schedule reports, and other forms of project reviews are compared to the original plan to identify variances and potential problems or opportunities. This information can be used to support the following generally accepted activities associated with making trade-off decisions.

- Engage the project team in a process-oriented approach to analyze situations and lead to consensus.
- Utilize mathematical models and optimization calculations to determine the best available plan of action.
- Include key stakeholders in the decision process to maintain engagement and support.
- Recognize potential conflicts that may develop between stakeholders and determining the possible effects on the project.

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- Review and prioritize project objectives.
- Analyze the project environment and status of the project.
- Identify alternative courses of action.
- Analyze and selecting the best alternative.
- Obtain approval to revise the project plan.

Reaching agreement among project stakeholders about trade-off decisions may be difficult. There are several factors that impact the decision process:

- Projects may be very complex with numerous system relationships.
- There is inherent uncertainty in many project environments.
- Project team and stakeholders may have different opinions and perspectives.
- Objectives may be unclear or conflicting.
- There may be different priorities among functional groups.

During the trade-off analysis and decision process the project manager must be prepared to provide detailed information, offer alternatives, and provide recommendations for project sponsors and decision makers to consider.

People make trade-off decisions every day. Consider the process of purchasing a new car. What are the trade-offs that would be considered?

Trade-off examples

- Price
- Safety
- Maintenance costs
- Warranties
- Size
- Reliability
- Ease of use
- Serviceability
- Sound system
- Security system
- Domestic or foreign
- Fuel efficiency
- Resale value
- Durability
- Aesthetics

In the business environment, trade-offs may be associated with project funding or enhancing operations, supporting project work versus daily activities and long-term programs, the use of critical resources for operations or projects, funding one project over another, quality versus productivity, or speed over accuracy. Other examples include cost-benefit comparison, performance, response time, functionality, schedule delays, scope reduction, choice of materials, choice of tools, choice of suppliers, and resources.

Trade-off decisions require a method of measurement to effectively assess changes in quantity, quality, and performance and the anticipated impact on a project of one decision over another. Having specific metrics in place will also help to minimize risk and provide supportive information regarding the justification of the decision. Trade-off decisions may involve communication among several stakeholders, including the

project manager, the sponsor, and the customer. Stakeholder bias and level of influence may significantly affect a trade-off decision.

When conducting trade-off analysis, the project manager and other decision makers will assess the incremental cost of the trade-off, determine how it will resolve or mitigate the problem, or improve a situation, and whether an alternative is worth doing. The process also includes ranking alternatives from best to worst using specific criteria for comparison.

1. **PM Quick Check:** Explain the significance of the triple constraint and why it is depicted as a triangle.

_____

_____

_____

_____

_____

_____

2. You are the project manager for a project that is showing a schedule slippage in the status report. The report also shows that the budget is under-running the costs for the work that has been performed. What are the possible actions you may take to correct the schedule slippage? There are several possible answers.

_____

_____

_____

_____

_____

3. The customer for your project insists on adding requirements that will increase the project scope. You are 50% complete with the project when the customer introduces a significant change in the configuration of a major deliverable. What actions may be taken to address this situation and what are the possible trade-offs that could be negotiated?

_____

_____

_____

_____

_____

_____

Remember

Decisions about trade-offs must include consideration about the identified constraints of the project. Trade-off decisions often affect several project factors. When making trade-off decisions, integrated change control should be a factor in the decision process.

4. Every project is unique but most projects often experience similar problems. What are the typical project constraints a project manager and team will be required to work within?

_____

_____

_____

_____

_____

5. **PM Quick Check**: Properly written objectives will help reduce the need for trade-off decisions. A well-written objective is characterized by the acronym: _____.

Remember

Impact analysis is the key to managing trade-off decisions and project changes.

Exam Tip

There is generally a three-step process or methodology in trade-off analysis:

1. Recognize and understand the conflict or issue. Make sure it actually requires attention.
2. Review the project objectives as seen by the stakeholders. An understanding of objectives and priorities will determine the degree of rigidity in the decision process.
3. Analyze the project environment and status, including financial risks, impact on other projects, impact on project results, and effect on customer perception.

6. The project you are assigned to is over budget and behind schedule due to an unforeseen risk event. There is a contract clause that protects you from penalties,

but the customer is pressuring you to deliver on time. From the list provided, select the best options to consider.

a. Fast-track _____
b. Reduce scope _____
c. Crash the schedule _____
d. Negotiate for more time _____
e. Negotiate to phase in the deliverables by priority _____
f. Terminate the contract _____
g. Negotiate for more funding _____
h. Revise the WBS and omit activities _____
i. Shift critical resources to problem areas _____

7. Sometimes trade-off decisions are made based on the type of contract between the buyer and seller. Which of the following contract types below would a project manager be least likely to agree to cost cutting as a trade-off consideration?

a. Cost plus percentage of cost _____
b. Firm fixed _____
c. Cost plus incentive fee _____
d. Time and material _____
e. Cost plus incentive fee _____
f. Cost plus award fee _____
g. Cost plus fixed fee _____

9. Consider the following questions that may be asked by an executive during a project review. How would you respond?

a. How can we get the project done sooner than the scheduled date?

_____

_____

_____

b. How can we complete the project at a lower cost?

_____

_____

_____

c. How can you reduce the amount of overtime you are using?

_____

_____

_____

d. How can we improve quality?

_____

_____

_____

_____

9. Your project schedule indicates that the work assigned to a critical resource will not be completed in time to meet a predetermined release date for the resource to work on another project. What are your options and potential trade-offs?

Possible Action	Trade-off
Example: Increase overtime for the critical resource	Additional cost, possible reduction in quality, burn-out of the resource

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the areas of the *PMBOK® Guide*—Sixth Edition: Project Integration Management, Project Scope Management, Project Time Management, and Project Cost Management.

Trade-off analysis requires the project manager to communicate the issues as well as the potential impacts of a decision to the project stakeholders.

Effective planning, monitoring and controlling will reduce the need to conduct trade-off analysis activities.

Ensure that an effective change control process is in place. Changes are often associated with trade-offs and will generally affect several areas of project performance.

The systems approach to managing projects emphasizes the importance of understanding that a change in one area, even if it is a very small change, can affect the entire project. This is the concept of integrated change control.

Make sure that objectives are clearly written and communicated to all key stakeholders. Remember, objectives should be "SMART" (specific, measurable, attainable, realistic, and time-based).

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Before making decisions about trade-offs, ask questions to determine why the trade-off decision is required and obtain information about the causes of the problem or the need for the trade-off. Consider the risks and potential consequences associated with trade-off decisions.

Document why corrective action is necessary and consider several alternatives before deciding on the action to taken.

Document the rationale behind a trade-off decision and record in a lessons-learned file or historical database.

The triple constraint provides a fundamental model for understanding the effects of trade-off decisions related to schedule, cost, and scope. Changing the value of one element of the triple constraint will cause a change or require some type of trade-off or adjustment to at least one other element

Trade-off analysis involves asking these questions: What must I give up to get more of what I want most? How much must I give up, and from where? What will happen if I make this change?

Remember: Trade-off analysis goes well beyond the factors of the familiar triple constraint. Consider factors such as employee well-being, safety, additional add-on business, political stability, ethics, and social needs.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. The triple constraint generally refers to the relationship of three project baselines: schedule, cost, and quality or performance specifications.
2. The first step would be to determine the severity of the slippage. It may be early in the project and the slippages may not be on the critical path. Overtime could be used or additional resources brought. The best approach is not to jump to conclusions or solutions. Obtain information about causes and then make a decision when you have all of the available data.
3. Start by ensuring that the change control process is followed. Identify and discuss the risks associated with the change request. Alternatives include negotiating for more time and more resources, and recommending the initiation of a new project after the completion of the current project.
4. Resource availability, imposed start and end dates, skill of the resources, contractual milestones, available funding
5. SMART
6. a, d, e, g, i
7. a and d
8. There are many possible responses. Also consider the trade-offs associated with each decision.

a. Add more resources, reduce the project scope, bring in better, more qualified resources.

b. Reduce scope, use less expensive resources, and eliminate defects and poor quality.

c. Add more resources, add better trained and more efficient resources.

d. Provide training, conduct audits, use better materials, and use trained resources.

9.

Possible Action	Trade -off
Example: Increase overtime for the critical resource.	Additional cost, possible reduction in quality, burn-out of the resource
Locate additional qualified resources.	Cost increase, other projects may be affected or delayed
Outsource the work.	Cost, possible quality reduction, increased risk, reduced control of the work
Refuse to release the resource.	Internal conflict with other project managers, escalation to management, potential problem obtaining resources in the future
Reduce scheduled performance tests.	Poor quality, substandard performance
There are many additional possible actions and trade-offs. Consider your project and issues that may require trade-off decisions.	

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER SEVENTEEN

Risk Management

The word "risk" is generally associated with danger, or the possibility of a negative experience. In the financial environment it involves the chance that an investment's actual return will differ from the expected return, and includes the possibility of losing some or all of the original business investment. Risk in the project management environment is associated with both threats (or negative outcomes) and opportunities (or positive outcomes). Risk is actually a measure of uncertainty. During project planning, risk is assessed by considering the probability of and consequences associated with a specific event or occurrence that could result in the failure to achieve a defined project objective or a milestone. Risk is also associated with potential opportunities that may enhance a project outcome.

Risk is often viewed from a negative perspective, and the focus of the project manager and team is commonly directed toward managing the harmful, undesired consequences, and expected losses that may occur. It is important to note that decisions about risk are also associated with the potential to experience beneficial results, such as reduced cost and greater productivity.

Project risk management includes the processes associated with planning for risks, identification of risks, prioritization of risks through analysis, responding to risks, and monitoring and controlling the project to prepare for new risks or mitigate existing risks that may be harmful. The objectives of project risk management are to increase the probability and impact of positive risks (opportunities) and decrease the probability and impact of negative risks (threats).The processes for risk management as described in the *PMBOK® Guide* (Sixth Edition) are:

- Plan risk management
- Identify risks
- Perform qualitative risk analysis
- Perform quantitative risk analysis
- Plan risk responses
- Implement risk responses
- Monitor risk responses

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Risk management is an ongoing process that actually begins during business case development (or even sooner, in the idea generation phase) and is included in contract negotiations and the project selection process. It should also be included in every phase of a project life cycle. The project team, through the guidance and leadership of the project manager, should become actively involved in risk management processes and adopt a "preventive" or proactive approach to managing risk. Project teams should develop a risk management plan in the early stages of the project and continue to emphasize the importance of regular risk reviews and assessments. Other than when a crisis appears, an ideal point for a risk review is at the completion of a phase or major milestone, when lessons learned may be discussed and decisions about the next phase can be considered. This phase-gate approach allows the project manager, sponsor, and decision makers to assess the overall condition and performance level of the project and determine if the project should proceed into the next phase.

It is important to note that early risk management planning may reduce the probability of negative risk events and prepare the team to manage an event if it should occur. However, the project environment contains many uncertainties and therefore continuous emphasis on risk management is necessary, and replanning is likely to be required.

Remember

In the project environment, risk has two primary components: probability and impact. Project risk is associated with the uncertainty of possible events or conditions that, if they occur, may have a positive or negative impact on the project or the objectives of the project. Project risks (potential events or occurrences) may have more than one cause and may result in experiencing more than one consequence. It is important to remember that there will be different risk events in each phase of a project and some risks may occur again. Continued emphasis on the importance of managing project risk and the need to have a plan in place that is reviewed often, to address the uncertainties associated with a project, will increase the probability of successful project completion.

► Glossary of Terms

Brainstorming A group creativity technique designed to generate a large number of ideas for the solution to a problem. Problem solving through spontaneous group discussion.

Business risk The possibility a company will have lower than anticipated profits or experience a loss rather than a profit. Business risk is influenced by several factors, including sales volume, customer response to a product, per-unit price, input costs, competition, the overall economic climate, inflation, recession, and government regulations.

Contingency The planned allotment of time and cost for unforeseeable events that may impact a project. An alternative or response to a realized threat. A reserve in time or funding intended for use in responding to a risk event.

Delphi technique A method of decision making that involves obtaining the opinion of selected experts without bringing them together face to face. The Delphi method utilizes subject matter experts whose identities may remain anonymous to the other experts involved in the research, to minimize bias and influence from other experts. The process includes two or more rounds where the experts provide input, the input is assessed by the initiator, information is returned to the experts for review and revision, and then returned to the initiator for final assessment and decision.

Expected value The product of probability (P) × impact (I) or consequence. A predicted value of a variable, calculated as the sum of all possible values each multiplied by the probability of its occurrence.

Impact The effect resulting from a realized threat or a defined vulnerability.

Insurable risk Also known as "pure" risk. A risk that will only result in loss: fire, theft, personal injury, direct property damage, legal liability.

Maximin criterion Also known as the Wald criterion. The decision maker is concerned about loss and views risk from a pessimistic perspective.

Maximax criterion Also known as the Hurwicz criterion. An optimistic approach to risk whereby the decision maker is optimistic about the results and attempts to maximize the benefits of a decision.

Mitigation The act of making a condition or consequence less severe. The reduction in probability and/or impact of an adverse risk event so that it is within acceptable threshold limits, without changing the objectives of the project.

Monte Carlo simulation A method of generating values from a known distribution. Using random variables to produce failure times. A computerized technique that uses sampling from a random number sequence to simulate characteristics or events or outcomes with multiple possible values. Monte Carlo simulation is used to generate probable outcomes of a project based on available data that is processed many thousands of times to provide probable project results and information for project decision making.

Nominal group technique A group process involving brainstorming for problem identification, solution generation, and decision making. It involves the use of a voting process to ensure that everyone's opinion is taken into account.

Non-risk events Variability: Uncertainty about characteristics of a planned event or activity. Examples: Productivity changes, number of errors found, unseasonable weather.

Ambiguity: A deficit of knowledge about a particular planning item. Very vague information that requires gap analysis to define more clearly the potential risks.

Probability A measure of how likely an event is to occur. A number expressing a ratio of favorable cases to the whole number of cases. Chance, odds, occurrence of uncertain events.

Probability impact matrix A project management tool that uses the combination of probability and impact scores of individual risks, determined by the project team or the specific functional groups associated with the risk management process. The PI matrix is used to rank and prioritize risks for more efficient handling of the risks.

Reserve Something kept back or saved for a special purpose. An amount of assets placed aside to respond to future needs or claims. In project management, reserves are associated with contingencies or additional funding that may be available from a management reserve.

Risk A measure of uncertainty. An exposure to chance of loss, damage, or opportunity.

Risk averse A person or organization that avoids risk, is uncomfortable when risk is present, and is concerned mainly with the possibility of loss or damage.

Risk event A discrete occurrence. The manifestation of risk as a consequence.

Risk management The act or practice of dealing with risk. Planning, identifying, analyzing, responding, and monitoring project risks.

Risk register An organized list of risk events generally arranged by priority. Risk registers may include risk event details, probability, and impact assessments and possible responses.

Risk symptoms Warning signs that a risk event may occur. Also known as risk triggers. Awareness of and response to risk symptoms will reduce the probability of experiencing a risk event.

SWOT analysis A process by which the strengths, weaknesses, opportunities, and threats associated with a project or program or an organization's strategic direction are assessed.

Utility The ability of a stakeholder to accept and manage risk as the intensity and consequence of risk rise. The utility of a risk averter rises at a decreasing rate as risk increases. The utility of a risk seeker increases as risk increases

Workaround A temporary response to an unplanned event.

► Activities, Questions, and Exercises

Refer to Chapter 17 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Risk Management.

Remember

Proper risk management is proactive rather than reactive. The project manager should instill risk management awareness and emphasize risk management practices within the project team at the project kickoff and

during each project phase. Every team member should maintain awareness about project risks and participate in risk management planning.

Risk Management Processes: A Brief Review

The following processes are generally associated with the knowledge area project risk management. These processes are shown as sequential, although in practice many of these process actions can be performed concurrently. It is important to remember that risk management begins with project planning and remains an ongoing process through each phase of the project life cycle. Refer to the *PMBOK® Guide* (Sixth Edition) for more information about the details associated with each process

Plan Risk Management

This is the process of deciding how to approach and conduct risk management activities.

Inputs

- Project management plan
- Project charter
- Project documents
- Enterprise environmental factors
- Organizational process assets

Tools and Techniques

- Data analysis
- Expert judgment
- Meetings

Outputs

- Risk management plan

Identify Risks

This is the process of determining which risk events might occur and affect the project.

Inputs

- Project management plan
- Project documents
- Agreements
- Procurement documentation

- Enterprise environmental factors
- Organizational process assets

Note that risk identification includes input from many of the project knowledge areas, several subsidiary plans, and an assessment of stakeholders. Risk management is a group of integrated processes.

Tools and techniques

- Expert judgement: Use of functional managers and subject matter experts
- Data gathering: Brainstorming, checklists, interviews
- Data analysis: Root cause analysis, assumption and constraint analysis, SWOT analysis, document analysis
- Interpersonal and team skills: Facilitation, negotiation, conflict management
- Prompt list: A predetermined list of risk categories

Other factors to consider during risk identification

- Documentation reviews (Examples: subsidiary plans, contracts, scope statement, statement of work)
- Diagramming techniques
  - Cause and effect diagrams
  - System or process flow charts
  - Influence diagrams

Outputs

- Risk register: List of risks including risk categories, identified risks, risk triggers that indicate that the risk may be happening, probability and impact of the risk, list of potential responses, root causes of risk, person assigned to manage the risk
- Risk report
- Project document updates: Assumption log, issue log, lessons learned register

Perform Qualitative Risk Analysis

This is the process of reviewing and prioritizing risk events and determining their probability and corresponding impact on project objectives. Generally uses lessons learned and expert judgment.

Inputs

- Project management plan that includes the risk management plan as a subsidiary
- Project documents: assumption log and risk register
- Stakeholder register

- Enterprise environmental factors
- Organizational process assets

Tools and Techniques

- Expert judgment
- Data analysis: Risk data quality assessment (determining the reliability of the data source and the accuracy of the data obtained), risk probability and impact assessment
- Interpersonal and team skills
- Risk categorization: Organizing risks by source
- Communication: Probability and impact matrix
- Meetings
- Risk urgency assessment: Determining which risks have the greatest priority based on time frame and must be addressed first

Other factors that may impact the prioritization of risks

- Urgency
- Proximity: Period of time before the risk might have an impact on one or more project objectives
- Dormancy: Period of time that may elapse before the risk impact is discovered
- Manageability
- Controllability
- Detectability
- Connectivity: How the risk is related to other risks
- Strategic impact
- Propinquity: The degree to which a risk is perceived to matter by an individual or a group

Outputs

- Project documents updates: Assumption logs, issues log, risk register, risk report. A specific document that will be updated is the risk register. The relative ranking or priority of the identified risks is provided in the risk register.
- Risk register contents: A list of risks identified by project stakeholders, a risk rating and ranking determined by probability and impact, causes for the risk, possible risk responses, risk owner, risk status, and watch lists for low-priority risks

Perform Quantitative Risk Analysis

This is the process of reviewing and prioritizing risk events that have been identified and prioritized during qualitative analysis but require further consideration and more rigorous analysis.

Inputs

- Project management plan: Specifically the risk management plan
- Scope baseline
- Schedule baseline
- Cost baseline
- Project documents
- Organizational process assets
- Enterprise environmental factors

Tools and Techniques

- Expert judgment
- Data gathering
  - Interviewing
  - Risk probability and impact assessment
  - Probability distributions: Normal, beta, triangular
- Interpersonal and team skills
- Data analysis
  - Sensitivity analysis: Determines which risks have the greatest potential impact on the project from an opportunity and threat perspective
  - Expected monetary value: The average outcome of a future scenario
  - Decision tree analysis: Describes the possible implications of available choices
  - Modeling and simulation: The project is simulated many times to assist in determining possible outcomes. A common technique is Monte Carlo simulation.

Outputs

- Project document updates: Updates to the risk register and risk report

Outputs of this process include a probabilistic analysis of the project, the identified probability of achieving project objectives, and a prioritized list of quantified risks.

Plan Risk Response

This is the process of developing options and approaches to the identified risks.

Inputs

- Project management plan, risk management plan, cost baseline
- project documents: Lessons learned register, project schedule, resource breakdown structure, resource calendars, risk register, risk report, stakeholder register, enterprise environmental factors, organizational process assets

Tools and Techniques

- Expert judgment
- Data gathering
- Interpersonal and team skills
- Strategies for negative risks or threats
  - Avoid: Eliminating the risk
  - Transfer: Shift responsibility to a more qualified or prepared resource or organization
  - Mitigate: Reduce the probability of the occurrence and impact of the risk
- Strategies for the positive impact of risk or opportunities
  - Exploit, share, enhance, acceptance
  - Contingent response strategy
- Strategies for overall project risk
- Decision making: Alternatives analysis, multi-criteria decision analysis, cost-benefit analysis

Outputs

- Change requests
- Project management plan updates: Subsidiary plan updates
- Project document updates: Risk register updates, risk-related contract decisions, cost forecasts, project schedule, assumption log, lessons learned register

Implement Risk Responses

This is the processes of actually executing the responses developed in the plan risk response process.

Inputs

- Project management plan
- Risk management plan
- Project documents
- Organizational process assets

Tools and Techniques

- Expert judgment
- Resource allocation
- Interpersonal and team skills
- Project management information system

Outputs

- Change requests, project document updates

Monitor Risks

This is the process of continually observing, tracking, and analyzing the project for risk triggers, new risks, and reoccurrence of previously identified risks.

Inputs

- Project management plan
- Risk management plan
- Issue log
- Lessons learned register
- Risk register
- Risk report
- Work performance data
- Work performance reports

Tools and Techniques

- Data analysis: Risk reassessment, risk audits (done periodically throughout the project), variance and trend analysis, technical performance measurement (to ensure that results meet specifications), reserve analysis (how the reserves established for the project are being utilized)
- Status meetings to communicate information to stakeholders

Outputs

- Work performance information
- Change requests
- Project management plan updates
- Project document updates
- Updates to organizational process assets

Study note: The *PMBOK Guide*® (Sixth Edition) provides detailed information about the processes of risk management. Refer to Chapter 11 and review the specific breakdown of inputs, tools and techniques, and outputs.

PM Quick Check: Complete the following statements by placing the appropriate letters in the spaces provided:

1. The process of qualitative analysis is _____
2. Quantitative risk analysis is _____
   a. a rapid and cost-effective method of prioritizing identified risks
   b. a method to determine the reliability of project risk data

c. used to develop risk-related decisions using mathematical analysis and simulations that present possible outcomes of risk events

d. used to create a watch list of low-priority risks

Remember

A very effective tool for identifying project risks is the work breakdown structure. The WBS displays the project activities and the complexity of the project and can be used by the project team to identify and then prioritize risks associated with each major deliverable or at the work package level. The work breakdown structure can be used to create a risk breakdown structure that will enable the team to categorize project risks.

3. List the 7 processes of risk management as described by the *PMBOK® Guide*—Sixth Edition.

_____

_____

_____

_____

4. Provide an example of a nonevent risk.

_____

_____

_____

5. Why is the project charter an input to the plan risk management process?

_____

_____

_____

_____

_____

6. According to the *PMBOK Guide* (Sixth Edition), what are the main elements of a risk management plan?

_____

_____

_____

_____

■ A Decision Tree Problem

An author decides to write a workbook about how to pass the PMP® exam on the first try. Historical data indicates that, if the market is strong, gross sales will be $1 million. If the market is weak, the gross sales will be only $50,000. There is a 70% chance of a strong market and a 30% chance of a weak market.

The author must decide whether to use an established publisher for the book or whether to self-publish the book himself. If he self-publishes the book, all of the sales receipts go to the author. But if he uses an external publisher, the publisher pays a 10% royalty on sales.

The decision tree for the problem is shown below. Usually, decision trees are prepared from right to left rather than left to right. In the diagram below, the boxes on the right represent the revenue that comes to the author, whether it be royalties or gross sales.

Now working from right to left, we can fill in the next row of boxes, which indicates the expected value of using the publisher as opposed to self-publishing:

Expected value (publisher):

$$70\% \times \$100{,}000 + 30\% \times \$5{,}000 = \$71{,}500$$

Expected value (self-publish):

$$70\% \times \$1\text{M} + 30\% \times \$50{,}000 = \$715{,}000$$

This is shown in the following figure:

At this point, it certainly looks as if you are better off self-publishing. But suppose your cost of self-publishing (i.e., materials, printing, marketing, advertising, etc.) is $600,000. This is an expense that must be subtracted from your revenue of $715,000. The result is shown in the figure below:

In the box on the left, you see the two options at this point: $70,500 income if you go with the publisher and $115,000 if you self-publish. Therefore, $115,000 will go in the box on the left and, based upon probability theory, the best decision is to self-publish. While mathematically this might appear as the right decision, there is still another consideration. What happens if the author self-publishes and the market is weak? The author will receive $50,000 but may have expenses in the hundreds of thousands of dollars. The author can then lose a considerable sum of money. So, even though the solution says to self-publish, there is still a concern over the author's tolerance for risk.

Decision Tree Analysis

You are considering the decision whether to purchase a machine for internal production or to subcontract the work to an external source. The following information has been provided by your financial managers:

Cost to purchase the machine: $35,000

Cost to subcontract the work: $5,000

Probability of a good market = 70%

Probability of a poor market = 30%

Reward if the prediction occurs:

In the purchase machine decision good market scenario: $80,000; in the poor market scenario: $30,000

In the subcontract decision good market scenario: $50,000; in the poor market scenario: $15,000

7. What is the expected value of the decision to purchase the machine?

_____

8. What is the expected value of the decision to subcontract the machine?

_____

9. What is the most favorable decision based on the data provided by the financial managers?

_____

■ Risk

10. Explain the effect of a project that is experiencing progressively increasing risk on a person or an organization that is considered to be risk averse.

_____

_____

_____

_____

Risk Response

Below are four responses, made by a project manager, to a risk situation. For each of the project manager's responses, from the list below select which response mechanism best fits the project manager's remarks.

- Acceptance
- Avoidance
- Mitigation (or control)
- Transfer

11. "I know we have three different designs we can select from in order to satisfy the customer's requirements. However, I am very reluctant to consider the second option because, if we are wrong, there exists the chance of imminent damage to the project." Response mode: _____
12. "This design has a very high possibility of creating a severe financial problem for us. I have asked the design team to develop an alternative that will minimize our risk exposure." Response mode: _____
13. "I know we can manufacture the product ourselves, but there are a number of potential risks to consider. I would rather award a fixed-price contract to Alpha Company and have them do the manufacturing instead. They have a strong record of success in this area." Response mode: _____
14. "I have set up a management reserve just in case there are escalations in the costs of the raw materials we must purchase." Response mode: _____
15. "There is a strong possibility that one of my team members may leave the project for a better-paying job assignment, so I have added an end-of-project bonus to retain the employee." Response mode _____
16. "I have arranged for an insurance company to handle any direct property damage and any worker injuries during the project." Response mode _____

17. "We have assessed the risk and are aware that it may occur within the next phase of the project. We have developed a contingency to manage the risk if it occurs." Response mode _____

Contractual Risks

Every contract type can be viewed as a sharing of risks between the buyer and the seller. For each type of contract identified below, indicate who has the greater degree of risk: the buyer or the seller.

18. Cost plus percentage of cost: _____

19. Fixed price with economic price adjustments: _____

20. Fixed price incentive fee: _____

21. Cost plus incentive fee: _____

22. Time and materials not to exceed a certain amount: _____

23. Cost plus fixed fee (fee fixed in $, not %): _____

24. Cost plus award fee (fee is a % of a dollar pool): _____

25. Firm fixed price: _____

26. Cost sharing: _____

Risk Identification

For the design and development of a new plane, Boeing identifies four categories of risks, which are listed below (27–30). Options a through d are four possible mitigation strategies for the four categories of risks. Select one and only one of these mitigation strategies from the list for each of the categories of risks.

27. Financial risks: _____

28. Marketing risks: _____

29. Technical risks: _____

30. Manufacturing risks: _____

- **a.** Extensive testing of new parts before they go into a next generation plane; could result in a next-generation plane or a new plane
- **b.** Having firm orders for several planes before manufacturing begins
- **c.** Asking suppliers to share in the development costs for a new plane.
- **d.** Offering a family of planes (i.e., 737, 747, 767, 777, 787, etc.)

31. One of the purposes of risk management is to create an understanding of the potential risks and their effects.

- ☐ True
- ☐ False

32. Risk management is expensive and should be done only on large projects or those of strategic importance.

- ☐ True
- ☐ False

33. Risk management is designed to provide an early warning system that will be useful throughout the project life cycle.

- ☐ True
- ☐ False

34. All risk response mechanisms transfer all or part of the risk to a potential contractor.

- ☐ True
- ☐ False

35. The best way to classify risks is according to their probability of occurrence.

- ☐ True
- ☐ False

36. Risk management is designed to focus only on the potential negative situations and project threats that have been identified by the project team.

- ☐ True
- ☐ False

37. A risk management plan should provide some guidance on how to respond or contain the risk event, if possible.

- ☐ True
- ☐ False

38. A PI (probability impact) matrix can be used for either quantitative or qualitative assessment of risks.

- ☐ True
- ☐ False

39. The Delphi technique is a risk mitigation strategy whereby a group of subject matter experts work closely together in a two-day meeting to identify and solve risk problems.

- ☐ True
- ☐ False

40. Expected value calculations are examples of quantitative risk assessment.

- ☐ True
- ☐ False

41. Planning is based upon history, whereas risk management focuses on the future.

- ☐ True
- ☐ False

42. Risk and knowledge are inversely related.

- ☐ True
- ☐ False

43. The major difference between types of contract is the sharing of risk between the buyer and the seller.

- ☐ True
- ☐ False

44. "Traffic light" or "dashboard" identification of risks is a quantitative risk assessment method.

- ☐ True
- ☐ False

45. Triggers are early warning signs that a potential risk might be materializing.

- ☐ True
- ☐ False

Remember

Project managers must be capable of managing in an uncertain environment. The project environment will change continuously, and a proactive approach to risk management will help to minimize surprises and prepare the project team to respond effectively to risk situations. Remember, risk management is not a one-time event. It is applied through the entire life cycle of the project.

46. Here's an effective tool for the project manager's toolbox. The project plan is actually an integrated plan that includes elements of all 10 knowledge areas of the *PMBOK® Guide*. Create a checklist for managing risk by listing all ten knowledge areas and then, working with the project team, identify the risks that may be encountered in each knowledge area. This technique will help the project team develop a broader understanding of the project and further illustrate how a project actually works as a system.

Knowledge Area	Potential Risks	Response or Preventive Action
Integration		
Scope		
Time		
Cost		
Quality		
Human Resources		
Communications		
Risk		
Procurement		
Stakeholder Management		

47. If you were asked to make a decision about how to respond to a project situation and you needed the opinions of several subject matter experts to review before you made a decision, which of the following techniques would be most effective if you

wanted to keep the identities of each of the subject matter experts confidential, to ensure that there was no possibility of influence or bias from other experts?

a. Nominal group technique

b. Brainstorming

c. Delphi technique

d. SWOT analysis

48. A company with strong assets and a very aggressive approach to risk taking is most likely to be associated with the:

a. Maximin or Wald criterion

b. Maximax or Hurwitz criterion

PM Quick Check

49. Inflation is an example of a business risk.

☐ True
☐ False

50. Bad weather is an example of insurable risk.

☐ True
☐ False

51. Utility is a measurement of risk tolerance.

☐ True
☐ False

52. Probability × Impact = Expected value

☐ True
☐ False

53. What are the typical risk responses for managing negative risks and project threats?

_____

54. Consider the following situation. Your team has assessed the probability of experiencing software errors in the development process as medium, and assigned a numerical value of .8 to the probability. The team has also determined that the impact of these errors will also be high and has assigned a value of .9. What is the risk rating for the software error risk?

_____

55. What is the probability of rolling a one with one die (half a pair of dice)?

_____

56. What is the sum of all probabilities that can occur in a given set of circumstances?

_____

57. You are the project manager for the development of a new product. The following information has been provided to you by your analysts. There is an 80% chance of

finishing on time and a 40% chance of finishing over budget. What is the probability that the project will finish on time and within budget?

58. Consider the following project information provided by a functional manager: Optimistic time for completion of the project is 12 weeks. Pessimistic time is 40 weeks. Most likely time is 25 weeks. Using the weighted average formula, what is the probability that the project will be completed between 14.33 weeks and 33.01 weeks?

59. Why is risk management a key part of overall project management planning?

60. What is the difference between a risk and an issue?

61. What is sensitivity analysis and how is it typically displayed?

62. Complete the following statement: The risk for an event can be defined as

63. Complete the following statements:

a. A risk averter prefers

b. A risk taker prefers

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the area of the *PMBOK® Guide*: Project Risk Management.

Review the seven processes of risk management as described in the *PMBOK® Guide* (Sixth Edition).

1. Plan risk management
2. Identify risks
3. Perform qualitative risk analysis
4. Perform quantitative risk analysis
5. Plan risk responses
6. Implement risk responses
7. Monitor risks

Risk management should be practiced throughout the life cycle of the project.

Maintain an awareness of the risk tolerances of the organization, executive management, the customer, and the project team. A risk-averse organization will attempt to minimize any exposure to potential risk events.

Tools and techniques to identify sources of risk: Use brainstorming, Delphi technique, SWOT analysis, or nominal group technique to identify potential risk situations.

Risks may be categorized to assist the team in identifying risks and also in preparing to respond to risks. An effective method for categorizing risks is to use the knowledge areas of the *PMBOK® Guide* as a basis. Other risk categories include technical, internal, organizational, project management, and external risks. Categories of risk provide the basis for developing a risk breakdown structure.

Risk response for threats and negatives outcomes is generally associated with four types of action: avoidance, transfer, mitigation, and acceptance.

There are two types of acceptance when responding to risk: passive, which means no specific action until the event occurs, and active, which means planning a contingency to be ready if an event occurs.

As risks occur and are managed, it is helpful to document the causes of the risk event to assist with prevention during future project planning. Documenting the rationale behind the corrective action that is taken will provide important information during reviews and assessment of the decision. The documentation can be placed in historical files and shared as lessons learned.

Remember: Risk will continue to appear throughout the project life cycle. Risk reviews and audits should be scheduled on a regular basis, and risk management should be included in your project status meeting agendas.

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In qualitative risk analysis, the risk rating is determined by multiplying the probability of the risk by the impact of the risk. These values are determined using expert judgment, experience, and lessons learned, and are generally subjective.

Remember that the sum of the probabilities of each branch in the chance mode of a decision tree will always be 100%.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

► Answers to Questions and Exercises

1. a
2. c
3. Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk responses, implement risk responses, monitor risks
4. Variability: changes in production; ambiguity: vague or incomplete information requiring gap analysis
5. The project charter provides the project manager and team with a high-level description of the project, including requirements, the reason for the project, the major stakeholders, and the initial high-level list of project risks.
6. Risk strategy, risk methodology, roles and responsibilities, funding, timing, risk categories, stakeholder risk appetite, definitions of probability and impact, reporting formats, tracking
7. $65,000
8. $39,500
9. Subcontract the work
10. The utility or "satisfaction" associated with risk rises at a decreased rate as risk increases. Another way to explain this is that as risk increases, the person or organization becomes more uncomfortable with the environment.
11. Avoidance
12. Assumption/acceptance
13. Transfer
14. Mitigation
15. Mitigation
16. Transfer
17. Assumption/acceptance
18. Buyer
19. Seller
20. Seller

21. Buyer
22. Seller
23. Buyer
24. Buyer
25. Seller
26. Buyer
27. c
28. d
29. a
30. 30.b
31. False
32. True
33. False
34. True
35. False
36. False
37. True
38. True
39. False
40. True
41. True
42. True
43. True
44. False
45. True

46. This table is partially completed to provide examples of how the project team can effectively identify risks in each knowledge area and then develop possible responses to the risk. There are many possible answers and approaches to the risks identified in each knowledge area. Create your own template and use it as you manage your current or next project assignment.

Knowledge Area	Potential Risks	Response or Preventive Action
Integration	Failure to plan from an integrated or systems perspective	Utilize the entire project team developing the plan. Maintain awareness of the triple constraint.
Scope	Omitted deliverables, incomplete scope statement, unclear objectives, scope creep	Clearly define objectives before planning begins, ensure that a complete scope statement has been prepared and has been verified, establish a change control process.
Time	Task date slips. Milestone date is missed.	Include contingency, ensure that the correct resources are assigned to the work, and perform regular status checks and quality reviews.

47. c
48. b
49. True
50. False
51. True
52. True
53. Avoid, mitigate, transfer, accept
54. $.8 \times .9 = .72$

55. 1/6, or 16.7 percent. There are six possible outcomes: 1, 2, 3, 4, 5, 6. The probability of rolling a one is expressed as 1/6 (one of six possible outcomes).

56. 1.0. The sum of all probabilities will equal 1. Using the rolling of one die as an example, there are six possible outcomes: 1/6 + 1/6 +1/6 +1/6 + 1/6 + 1/6 = 1.0

57. 80% × 60% = 48%. There is a 60% chance the project will finish within budget (40% chance of being over budget = 60% of being within budget).

58. Mean = 23.67 (optimistic + 4 times the most likely + pessimistic) / 6

Standard deviation = 4.67 (pessimistic – optimistic) / 6

Probability of completing the project between 14.33 weeks and 33.01 weeks = 95%

Mean of 23.67 minus two standard deviations = 14.33. The mean plus two standard deviations = 33.01. In normal distribution the probability of achieving a result with two standard deviations is 95%.

59. It forces us to focus on the future where uncertainty exists and to develop suitable plans of action to prevent potential issues from becoming problems and adversely impacting the project.

60. A risk has a probability of occurring. An issue has occurred and does not have probability. It is an occurrence that requires attention. Examples: Risk: A fire could occur in an equipment room. Issue: A fire has occurred. Risk: An employee may leave for a new assignment. Issue: An employee has submitted notice of resignation.

61. Sensitivity analysis is a technique used to determine how different values of an independent variable impact a particular dependent variable under a given set of assumptions. It is typically presented in the form of a tornado diagram.

62. The risk for an event can be defined as a function of probability and consequence (impact).

63. **a.** more certain outcome and will demand a premium to accept risk.

b. the more uncertain outcome and may be willing to pay a penalty to take a risk.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER EIGHTEEN

Learning Curves

Learning curves were first introduced into the business world in 1936 by T. P. Wright. Wright described a theory for obtaining estimates based on repetitive production of airplane assemblies. The concept of learning curves has since been used for estimating all types of projects and programs from manufacturing to the space shuttle program. Learning curves are also known as progress functions and experience curves.

The theory of learning curves is based on the concept that repeating the same process or operation many times results in a reduction in the time and effort required to complete the process. Most people experience learning curves when they try a new product for the first time, when a new software application is used, or when a new tool has been introduced to a work process. The first time the tool is used or the process or operation is performed may take a considerable amount of effort to use properly and may produce errors as the learning progresses. The more the process, operation, or tool is used or performed the better the operator becomes at working with it. This reduces overall effort and decreases the actual time to complete the operation. The learning curve theory as written by Wright states that the direct labor hours necessary to complete a unit of production will decrease by a constant percentage each time production quantity is doubled. Learning curves are used to emphasize time, but the principle can be related to cost also. (Information adapted from the National Aeronautics and Space Administration: Cost Estimating Processes.)

Learning curves are most useful when managing projects or operations that involve developing and estimating large quantities of deliverables or units. The cost of producing the first unit may be relatively easy to calculate, but the challenge is to determine the cost of the 100th, 1,000th, or 10,000th unit. The learning curve process is used to determine those costs and becomes a useful estimating tool.

Basically, learning curves are a graphical representation of the familiar principle that as a task is performed repeatedly, the better one gets at it. Learning curves show the rate of improvement in performing a task as a function of time, or the rate of change in average cost (in hours or dollars) as a function of cumulative output. The concept is commonly used in resource requirements planning. Learning curves are also employed in setting incentive rate schemes based on the statistical findings that, as the cumulative output is doubled, the average unit cost declines by a constant percentage. For example, an 80% learning curve means the "per unit" average cumulative cost (in hours or dollars) falls to 80% of the previous per unit average cumulative cost as the cumulative output doubles.

Remember

Learning curves stipulate that manufacturing man-hours (specifically, direct labor) will decline each time a company doubles its output. There are three basic conclusions about the learning curve theory:

- The time required to perform a task decreases as the task is repeated
- The amount of improvement decreases as more units are produced
- The rate of improvement has sufficient consistency to allow its use as a prediction tool

► Glossary of Terms

Cumulative average hours The average hours expended per unit for all units produced through any given unit. When illustrated on a graph by a line drawn through each successive unit, the values for a cumulative average curve.

Cumulative total hours The total hours expended for all units produced through any given unit. The data plotted on a graph with each point connected by a line form a cumulative total curve.

Labor efficiency People learn more each time a task is repeated. As we learn, the time and cost of performing the task should diminish. As the employee learns the task, less managerial supervision is required, waste and inefficiency can be reduced or even eliminated, and productivity increases.

Slope of the curve A percentage figure that represents the steepness (constant rate of improvement) of the curve. Using the unit curve theory, this percentage represents the value (example, hours or cost) at a doubled production quantity in relation to the previous quantity. For example, with an experience curve having an 80% slope, the value of unit two is 80% of the value of unit one. The value of unit four is 80% of the value of unit two. The value of unit 1,000 is 80% of the value of unit 500.

Unit one The first unit or product actually completed during a production run.

Unit jours The total direct labor hours expended to complete any specific unit. When a line is drawn on a graph through the values for each successive unit, the values form a unit curve.

► Project Estimating Using Learning Curves

Learning curves stipulate that the more often you perform a task, the less time (and money) is needed. This concept is very important to companies that have labor-intensive product lines with large volume production. Learning curves allow a company to take advantage of economies of scale and prevent new competitors from entering into the marketplace.

Learning curves have the following properties:

- The time required to perform a task decreases as the task is repeated.
- Manufacturing man-hours will decrease by a fixed percentage each time production is doubled.
- The rate of improvement has sufficient consistency to allow its use as a prediction tool.

The following figure shows a typical learning when plotted in Cartesian coordinates.

Standard Learning Curves

As the number of units produced increases, the time required for each unit decreases. Most companies use hours on the Y-axis rather than cost because cost can change resulting from salary, overhead, and raw material price increases.

Most companies plot learning curves on log-log paper rather than in Cartesian coordinates. When this is done, the curve will appear as a straight line as shown in the following figure.

Standard Learning Curves

If the figure represents an 80% learning curve, then each time production doubles, the rate of learning will be at the same 80%. As an example, if the 100th unit produced required 300 hours, then the 200th unit produced would be 80% times 300 hours, or 240 hours. The 400th unit produced would then be 80% of the time needed for the 200th unit, or 80% × 240 hours, which equals 192 hours.

Learning curves are more appropriate for labor-intensive product lines rather than automated product lines because people can learn, whereas capital equipment does not learn. An 80% learning curve is better than a 90% learning curve.

Learning curves can undergo improvements. In other words, there are activities that can help us go from an 85% learning curve to an 80% learning curve. Some of these activities include:

- Training and educating the workers
- Making improvements in the way the work is performed
- Installing new production processes
- Hiring more skilled labor
- Using higher-quality raw materials that are easier to use
- Redesigning the product so that difficult manufacturing steps can be eliminated or minimized
- Offering workers incentives or disincentives to work better and smarter

There are also factors that can prevent improvements to a learning curve. These include:

- People refuse to learn better ways of doing their job.
- People are not motivated.
- People have no faith in the learning curve concept.
- People will not work better or smarter without incentives.
- People are expected to work in the way that violates health and safety protocols.

The figure below shows what happens when the learning curve improves. This is often called "toe down" learning.

Toe Down Learning Curve

Learning curves work best if there is no break in the learning process. This means no long-term shutdown in the manufacturing process. For example, if the manufacturing process must be shut down for several months, perhaps because of large inventories and fewer customers, the learning curve will not start up at the same point because the workers may need to be reeducated on how to do the job. This is often referred to as a "toe up" learning curve, as shown in the following figure.

Toe Up Learning Curve

Learning cannot continue forever. Sometimes learning becomes "pegged" at a specific level, as shown in the next figure. The pegged level becomes the standard for estimating the time and cost of producing a unit.

Pegged Learning Curve

■ Learning Curve Example

Shown in the table is the data for a 75% learning curve used in a manufacturing company.

Data for Learning Curve Example

Cumulative Units	Cost for This Unit ($)	Cumulative Cost ($)
1	616	616
2	462	1,078
40	134	8,467
100	92	14,932
200	69	22,751
300	58	29,043
400	52	34,513
500	47	39,442
600	44	43,980
700	41	48,217
800	39	52,212

A company manufactures products on a 75% learning curve. The company has already produced 100 units, which had a total cost of $14,932 according to the table.

A. What is the average cost per unit for the first 100 units?

$14,932 / 100 = $149.32 per unit

B. How much did it cost to produce the 100th unit?

From the table, the 100th unit is $92.

C. According to learning curve theory, if production doubles to 200 units, the 200th unit should require only 75% of the 100th unit. Is that correct?

75% × $92 = $69, which matches the entry in the above table.

D. If you have already produced 100 units and you have a customer who wants to purchase another 100 units, what is your average cost per unit for that customer for the next 100 units (i.e., units 101–200)?

($22,751 – $14,932) / 100 = $78.19 per unit

E. Sometimes, companies prefer to use hours rather than dollars. Assume in the above table that the second and third columns represent hours rather than dollars. If the company has 1500 hours of manufacturing available per month to go from 101 to 200 units of production, how many months will be required?

(22,751 hours – 14,932 hours) = 7819 hours
7,819 hours ÷ 1500 hours/month = 5.2 months

F. Whenever hours are used, we need to know the fully burdened employee labor rate to convert to dollars. Assume that the employees are fully burdened at $110 per hour and, using part E above, the company wishes to make a profit of 10% on the sale of units 101–200. Also, assume that 160 hours of management and supervision are need each month in addition to the manufacturing hours, and these hours are also billed at $110. (Disregard any costs for raw materials since this information is not provided.)

Manufacturing hours (from Part E):	=	7,819 hours
Support hours:		
5.2 months × 160 hours per month	=	832 hours
		8,651 hours
8,651 hours × $110 per hour	=	$ 951,610
10% profit	=	95,161
		$1,046,771

G. Learning curves can also be used to price out products. As an example, using the table at the beginning of the problem, assume that the last two columns are costs rather than hours. Your company has produced 400 units thus far, and next year

expects to sell 200 units according to marketing data. If these numbers are correct, and management wants to keep the price fixed for the entire year, using the learning curve for pricing what should be the fixed selling price of the product, assuming a 10% profit margin is desired? This is an example of midpoint pricing.

The cost for the 400th unit is $52 per unit.

The cost for the 600th unit is $44 per unit.

Using midpoint pricing, the selling price = ($52 + $44) ÷ 2 = $48

Adding in a 10% profit, $48 × (1.10) = $52.80

One more example

You have already produced 200 units, and a new customer appears wanting to purchase 600 units. If your material cost is fixed at $60 per unit, a fully burdened hour is $110 and the above table represents labor hours only, how much should you charge the customer if you wish to make a 10% profit (i.e., total cost)? Also assume 1500 hours of manufacturing labor available per month and management support is 160 hours per month for the duration of the project.

Answer: Manufacturing labor hours for 600 units (unit 201 – 800): = (52,212 – 22,751) = 29,461 hours

Support hours = (29,461/1500) × 160	=	3,142 hours
Labor cost = (29,461 + 3,142) × $110	=	$3,586,330
Total material cost = 600 units × $60	=	$ 36,000
		$3,622,330
10% profit	=	362,233
		$3,984,563

Now, let's add a small twist to this problem. Assume that learning is pegged when the 500th unit is produced. In other words, for all units produced after the 500th unit is manufactured, the hours needed for production of each unit will be at the hours needed for the 500th unit. How much time is required to produce units 201 – 800?

Units 201–500 require: 39,442 hours – 22,751 hours = 16,691 hours

From the table, the 500th unit (the pegged point) = 47 hours

Units 501–800 require: 300 units × 47 hours/unit = 14,100 hours.

Therefore, total hours = 16,691 + 14,100 = 30,791 hours.

► Activities, Questions, and Exercises

Refer to Chapter 18 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Time Management and Project Cost Management.

1. You have already produced 200 units, and a new customer appears wanting to purchase 600 units. If your material cost is fixed at $60 per unit and the above table represents labor hours only, and you wish to make a 10% profit, how much should you charge the customer (i.e., total cost)?

Study note: Calculating learning curves—T. P. Wright approach

The process calculates the average unit value of a production lot:

$$Y = AX^b$$

Where:

Y = Cumulative average unit value of the Xth unit
A = The theoretical first unit value (T1)
X = Unit Number
b = Log (slope/Log 2)

Key point: The steeper the curve, the easier the learning.

An example of learning curve in action: It may cost $100 million to build the first copy of a new airplane, $80 million to build the second, $64 million to make the fourth, $51 million to make the eighth, and so on. The planes actually become less expensive to build as the workers and the company learn how to build them more efficiently. As the work is repeated, the workers become faster at completing tasks and they make fewer mistakes while reducing the amount of scrap and wasted material. (From Gary H. Anthes, "The Learning Curve: A Quick Study," in *Computer World,* July 2, 2001.)

The very basic concept of the learning curve is that practice improves performance.

Learning curve limitations

- The learning curve does not continue forever. The percentage decline in hours/dollars diminishes over time.
- The learning curve knowledge gained on one product may not be extendable to other products unless there exist shared experiences.
- Cost data may not be readily available in order to construct a meaningful learning curve. Other problems can occur if overhead costs are included with the direct labor cost, or if the accounting codes cannot separate work packages sufficiently in order to identify those elements that truly demonstrate experience effects.
- Quantity discounts can distort the costs and the perceived benefits of learning curves.
- Inflation must be expressed in constant dollars. Otherwise, the gains realized from experience may be neutralized.

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- Learning curves are most useful on long-term horizons (years). On short-term horizons, benefits perceived may not be the result of the learning curves.
- External influences, such as limitations on materials, patents, or even government regulations, can restrict the benefits of learning curves.
- Constant annual production may have a limiting experience effect after a few years (example: no growth).

2. The learning curve concept suggests that productivity will improve consistently and significantly as work activities are repeated.
   - ☐ True
   - ☐ False
3. The learning curve concept indicates that people will exhibit improvement in performance as a task is repeated a number of times.
   - ☐ True
   - ☐ False
4. The "slope" of the learning curve is related to the rate of learning.
   - ☐ True
   - ☐ False
5. The learning curve does not continue forever. The percentage decline in hours/dollars diminishes over time.
   - ☐ True
   - ☐ False

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the areas of the *PMBOK® Guide*—Sixth Edition: Project Time Management and Project Cost Management.

The basic principles of learning curves are:

1. The time required to perform a task decreases as the task is repeated.
2. The amount of improvement decreases as more units are produced.
3. The rate of improvement has sufficient consistency to allow its use as a prediction tool.

The learning curve theory is based on the principle that practice improves performance.

The consistency of improvement in the learning curve has been found to exist in a constant percentage reduction in time required over successively doubled quantities or units produced.

The constant percentage by which costs of doubled quantities decrease is called the rate of learning.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

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▶ Answers to Questions and Exercises

1. Average labor cost for 600 units (unit 201–800) = ($52,212 – $22,751)/600 = $49.10 per unit

   Total labor for these 600 units = 600 × $49.10 = $29,461

   Total material cost = 600 units × $60 = $36,000

   $65,461

   10 % profit = $ 6,546

   $72,007

2. False
3. True
4. True
5. True

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Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER NINETEEN

Contract Management

Contract and procurement management include the processes associated with determining the products, services, materials, and equipment necessary for project implementation and the negotiations for the actual purchase, lease, or rental of those services and products.

Determining the type of materials, equipment, and resources necessary, and the appropriate quantity or support level of each that must be obtained or acquired to successfully complete project deliverables is a critical and often challenging process. Negotiating the contracts and agreements that guide the buyer and seller through the project life cycle can also be very challenging.

In the contracting and procurement environment, there are two basic viewpoints: the buyer's position and the seller's position. These two views are often opposing in areas such as price, schedule, and quality and require effective negotiation to achieve mutually agreeable terms and conditions.

The project procurement management process includes the activities that will be used to determine what to purchase; how to purchase materials or resources; the preparation of documents that will be used in the process, including requests for proposal (RFPs); selection of the appropriate qualified suppliers; preparing and approving the contract; managing the contract; and closing or terminating the contract.

Contracts create legal obligations for the buyer and seller. Before agreeing to the obligations, each side will usually conduct a risk assessment to identify potential liabilities and attempt to mitigate any unfavorable conditions. The risks for the buyer are generally different than those for the seller and depend on the type of contract and the terms and conditions proposed in the contract. Contract types are generally selected based on the needs of the buyer and seller. Final terms and conditions are determined when the buyer and seller have reviewed the information that is available about the project, the deliverables that must be produced, the environmental factors that may affect the project, and the ability of the supplier to meet the needs of the buyer. A significant amount of negotiating may take place before a contract is finalized and approved. Effective negotiating requires a high level of preparation and skill in areas such as relationship building, problem solving, creativity, business and technical knowledge, and willingness to compromise. The ability to plan and facilitate meetings is also extremely important during the contracting and procurement process.

▶ Major Contract Elements

- **Intention to enter into a legal relationship.** Contracts are generally considered legal relationships and are presumed to include agreements about business, commerce, or other factors that are intended to be legally binding.
- **Contracts include an offer and an acceptance.** The offer is a response to a need and includes details about how work will be performed. The acceptance is the agreement to pay for or in some way provide a reimbursement for the work and is based on the specific details of the offer.
- **Consideration.** Consideration is something of value, usually money that will be exchanged for the service or product provided by the seller.
- **Capacity.** The parties involved in the contract must have the actual capacity to fully understand and carry out the terms and conditions of the contract. A minor (person not of legal age) would be considered to lack the "capacity" to enter into a contract.
- **Genuine consent.** Consent must be given without pressure or misrepresentation. The nature of the contract must be fully understood. If the behavior of the seller is such that a contract is agreed upon that has been misrepresented or forced due to the behavior of the seller, the contract may be subject to be voided.
- **Legality of objects.** The contract must meet certain requirements for actual trade. There cannot be any terms that may actually be in violation of conditions established in the geographic area where the agreement has been negotiated. Restraints of trade must be considered before the contract terms and conditions are agreed upon.

Remember

In general, companies provide services or products based on the invitations for competitive bids issued by clients. One of the most important factors in preparing proposals and estimating the cost and profit of a project is the type of contract expected. There are contract types that may reduce the risk to the buyer, and there are contract types that reduce the risk to the seller. Determining contract type will depend on the specific needs of each party involved in the negotiating process.

▶ Procurement Strategies

There are two basic procurement strategies:

- Corporate procurement: The relationship of specific procurement actions to the corporate strategy. This is generally associated with a centralized procurement process to ensure the greatest benefit to an organization through control and economies of scale.

- Project procurement strategy: The relationship of specific procurement actions to the operating environment of the project. This strategy is focused at the project level and is focused on speed of acquisition and meeting the specific needs of the project.

Procurement planning generally involves the following decisions or objectives:

- Procure all goods and services from a single source.
- Procure all goods and services from multiple sources.
- Procure only a small portion of goods and services.
- Procure none of the goods and services (all production will take place internally).
- Procure goods and services from a sole source. Only one supplier is available and there is no choice but to use that supplier.

Procurement management also includes the make-or-buy decision, the rent-or-lease decision, the selection of suppliers, negotiation of the contract terms, selection of contract type, and the administration of the contract throughout the project life cycle. At project closeout the contract is reviewed to determine if all terms and conditions, including all agreed upon deliverables, have been produced and are accepted.

▶ Glossary of Terms

Acceptance Unconditional agreement to an offer. The agreement creates the contract as solid and binding on both sides. Prior to signing, any party is free to withdraw. Acceptance is also associated with the hand-off of project deliverables. Acceptance criteria for deliverables is usually specified and documented prior to the initiation of work and includes a review functionality, quality, and defined scope,

Arbitration Arbitration is a form of alternative dispute resolution (ADR) and is used for the resolution of disputes outside the courts. The parties involved in a dispute refer the issue to arbitration by one or more persons (the "arbitrators"), and agree to be bound by the arbitration decision.

Contracts may have clauses nominating arbitrators in advance for use if the need arises.

Bidder conference A meeting during which information is shared by the buyer to all sellers who have an interest in presenting a bid or proposal. This is often referred to as a meeting to provide an "equal level playing field."

Collective agreement Term for agreements made between employees and employers. Usually involves trade unions. These are often covered by more than one organization and can be seen as contracts but are not governed by contract law.

Condition A term of fundamental importance to the contract, the breach of which may cause the contract to be terminated.

Consideration In a contractual agreement, each side benefits in some way and they give each other some consideration. This would usually be a price paid by one in exchange for goods supplied by the other. Consideration can be anything of value to the other party and agreed upon as acceptable.

Contract Any legally enforceable promise or set of promises made by one party to another. An oral or written agreement between two or more parties that is enforceable by law.The basic elements of a contract are mutual assent, consideration, capacity, and legality.

Design specification The specific details in terms of physical characteristics that describe, define, and specify what is to be produced. The risk of performance is on the buyer.

Force majeure Exemption from penalties due to nonfulfillment of contractual obligations resulting from conditions beyond the control of the parties involved, such as earthquake, floods, or war.

Functional specification A subset of performance specification. The specific end use of the product. What actions or functions it is intended to do when placed into use.

Indemnity Generally, a restitution, reimbursement, or payment or compensation for damages done. Protection against future loss. An obligation of one party to reimburse another party for losses that have occurred or may occur.

Liquidated damages A sum, usually a fixed amount per day, to be paid as damages to an owner by a contractor due to failure to complete the specified work within the time frame stipulated in the contract. A payment or form of reimbursement the parties designate during the formation of a contract for the injured party to collect as compensation upon a specific breach (e.g., late performance).

Make-or-buy decision The decision to make a product or produce a service internally if capacity and capability is available, or purchase the required item from an external supplier. The decision may be made upon factors other than cost.

Penalty clause A contractual provision that provides for payment of an amount as a forfeiture due to a breach of a contractual provision. The amount is usually unrelated to the actual harm suffered. These clauses are added to prevent future disputes in case of breach of the contractual provisions.

Performance specification The measurable capabilities the product must achieve in terms of operational characteristics. The risk of performance is on the contractor.

Privity Mutual relationship to the same rights of property or contract relationship. The doctrine of privity provides that a contract cannot confer rights or impose obligations arising under it on any person or agent except the parties to the contract.

Procurement The acquisition of goods or services.

Screening system Process to determine if a seller has the minimum qualifications to participate in the bidding process

Severability Severability clauses are intended to enable legal agreements to survive judicial scrutiny if and when a portion of the agreement is deemed to be impermissible. Examples: A section is considered to be illegal, invalid, void, or unenforceable. If any provision of the terms of use shall be deemed unlawful, void, or for any reason unenforceable, then that provision shall be deemed severable from the remaining terms of use and shall not affect the validity and enforceability of any remaining provisions.

Single source One and only one seller is selected out of a group of qualified sellers. A seller/contractor is selected by a buyer to provide all procured goods and services. It is important to consider the risks associated with this decision.

Sole source A seller is the only available source of a particular item that must be procured.

Waiver Voluntary relinquishment or surrender of some right or privilege.

Warranty A statement, either written, expressed, or implied, providing assurance that some specified provision in a contract is true. A protection plan against major repairs and breakdowns.

Project Procurement Management

This chapter refers to the *PMBOK® Guide* chapter "Project Procurement Management."

The major processes of project procurement management are:

Plan procurements Documenting project procurement decisions. This process is concerned with determining what products or services must be acquired from outside the organization and what will be produced internally.

Conduct procurements The processes associated with obtaining seller responses, selecting sellers, and awarding contracts.

Control procurements The processes associated with managing procurement relationships, monitoring contract performance, making changes and corrections to contractual agreements, and closing the procurements.

The procurement management plan is a subsidiary of the project management plan and includes guidance about how procurement will be coordinated, a time table for procurement activities, metrics to be used for managing contracts, stakeholder roles and responsibilities, constraints and assumptions, risk management issues, and direction about the use of prequalified sellers.

► Activities, Questions, and Exercises

Refer to Chapter 19 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Procurement Management and Project Risk Management.

Remember

The objective of the award cycle in contract negotiations is to reach agreement on a contract that will result in reasonable contractor risk and provide the contractor with the greatest incentive for efficient and effective economic performance.

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1. Which of the following are considered to be enterprise environmental factors in the plan procurement process?
   a. Marketplace conditions
   b. Unique local requirements
   c. Contract management systems
   d. Financial accounting and payment systems
2. Match each of the terms below with its correct definition.

   Presales activity

   Contract administration

   Bid proposal preparation

   Contract negotiation and formation

   Bid/no-bid decision making

   a. The process of identifying prospective and current customers, determining customer's needs and plans, and evaluating the competitive environment

   _____

   b. The process of ensuring that each party's performance meets contractual requirements

   _____

   c. The process of evaluating the buyer's solicitation, assessing the competitive environment and risks against the opportunities of a potential business deal, and then deciding whether to proceed

   _____

   d. The process of developing offers in response to a buyer's solicitation or based on perceived buyer needs, for the purpose of persuading the buyer to enter into a contract

   _____

   e. The process of reaching a common understanding of the nature of the project and negotiating the contract terms and conditions for the purpose of developing a set of shared expectations and understandings

   _____
3. What is a procurement statement of work?

   _____

   _____

   _____
4. Place each of the terms below with its correct definition. Design specifications
   - Performance specifications
   - Functional specification

a. This is when the seller describes the end use of the item to stimulate competition among commercial items, at a lower overall cost. This is a subset of the performance specification, and the risk of performance is on the contractor.

_____

b. These detail what is to be done in terms of physical characteristics. The risk of performance is on the buyer.

_____

c. These specify measurable capabilities the end product must achieve in terms of operational characteristics. The risk of performance is on the contractor.

_____

5. For each factor listed, indicate whether it influences the make decision or the buy decision.

Factor:	**Make or Buy Decision?**
a. Less costly	_____
b. Easy integration of operations	_____
c. Utilize skills of suppliers	_____
d. Utilize existing capacity that may be idle	_____
e. Maintain direct control	_____
f. Small volume requirement	_____
g. Having limited capacity or capability	_____
h. Avoid unreliable supplier base	_____
i. Maintain design/production secrecy	_____
j. Augment existing labor force	_____
k. Maintain multiple qualified vendor sources	_____
l. Stabilize existing workforce	_____
m. Indirect control	_____

■ To Rent or to Lease: That Is the Question

The lease/rent decision is a financial endeavor that requires some analysis before making a decision. Leases are usually longer term than renting. Consider the following example. A company is willing to rent you a piece of equipment at a cost of $100 per day. You can lease the equipment for $60 per day plus a one-time cost of $5000. What is the breakeven point, in days, where leasing and renting are the same?

Let X be the number of days.

$$\underset{\text{Renting}}{\$100X} = \underset{\text{Leasing}}{\$5000 + \$60X}$$

Solving, $X = 125$ days

6. Your turn: Consider the following situation: You have the option to rent a piece of equipment for $200 per day. You can also lease the equipment for $70 per day plus a one-time cost of $8,000. You need the equipment for 75 days. Should you rent or lease?
   a. Rent _____ Lease _____
   b. What is the breakeven point in days? _____

Remember

Before accepting the terms of a contract, many organizations conduct a detailed risk assessment using a third party that is not directly connected to the negotiations. This provides a more objective approach to the assessment and may identify significant risks that were not noticed during the negotiations process.

7. To ensure that no contractor has more knowledge about a request for a proposal, the buyer schedules a _____ to provide an opportunity for all potential contractors to ask questions about the proposal and provide the same information to all interested parties.
   a. Seller audit
   b. Bidder's conference
   c. Phase review
   d. Request for bid

Study note

The procurement process may include the use of several different documents:

- Request for information (RFI): A document used to obtain information from potential providers before a formal request for proposal is issued. A document issued by a buyer to find providers or check that service levels of existing providers will meet the needs of the buyer.
- Request for quotation (RFQ): A request for a final price quotation for a precise set of requirements.
- Request for proposal (RFP): The formal mechanism or document by which a company conveys its business requirements to potential contractors/suppliers. An open invitation to potential suppliers to provide a proposal to meet the needs of the buyer.

Negotiation: The primary goal of negotiation should be to achieve a deal that both parties involved will agree to and that will accomplish the objectives established by both sides. Negotiation may require compromising, accommodating, and adjusting of demands before agreement can be reached. In some cases it will be necessary to identify common ground from which negotiations can begin.

Tactics for negotiation:

- Ask open-ended questions: Why? Who? When?
- Probing: Ask questions that will help identify the other party's underlying needs. Example: I am not sure I understand why this point is so important to you. Can you explain your issues and concerns to help me understand?
- Control the documentation: Take notes or minutes to capture the information discussed. This will help keep the results of the negotiation accurate and fair.
- Develop alternatives (BATNA, or best alternative to negotiated agreement): What other steps may be taken to satisfy specific needs? When the original negotiations toward an agreement are not successful, alternatives are introduced that may have a better chance of reaching agreement.
- Awareness of hygiene factors: Location selection for negotiations, type of table (round or rectangular), time of day, size of the room, room set-up, who sits facing the window, number of attendees.
- Set objectives for the minimum that will be accepted by the buyer or the maximum that will be offered by the seller.
- Do not offer your minimum or maximum objectives at the start of negotiations. These are your objectives and will help to measure your success.

Remember

Negotiations should be planned for. The activities associated with negotiations include:

- Developing objectives: What is the minimum that will be accepted? What is the maximum that will be offered?
- Evaluate the other party: Strengths, weaknesses.
- Define your strategy and tactics.
- Gather all the facts you can.
- Perform a complete price/cost analysis: Do your homework!
- Arrange the "hygiene factors" to accommodate the negotiations.

8. **PM Quick Check:** Before negotiations begin, it is a good idea to determine what motivates the other party.

   ☐ True
   ☐ False

9. **PM Quick Check:** A major factor in the negotiations process is the willingness and ability to compromise.

   ☐ True
   ☐ False

Contracts

10. The basic elements of a contract**:** match each term on the left with the number of its explanation on the right:

a. Mutual agreement _____	1. Must be a payment
b. Consideration _____	2. Disputes may be remedied in court
c. Contract capability _____	3. Offer and acceptance
d. Legal purpose _____	4. The agreement constitutes a recognized business or specifically stated reason.
e. Form provided by law _____	5. The contractor has the ability to actually perform the required work.

11. Which of the following items are considered to be hygiene factors when preparing for a contract negotiations meeting?

a. Meeting room size and shape

b. Contract documents

c. Shape of conference table

d. Room temperature

e. Time of day

f. Specific people attending the meeting

g. Seating location of attendees

12. Describe the typical source selection criteria used by a buyer to determine which contractors or sellers will be used.

_____

_____

_____

_____

_____

Contract Forms

Fill in the appropriate contract type (either *definitive, term, completion*, or *letter contract/letter of intent*) for each situation.

13. When a contractor is required to deliver a definitive end product the contract is known as a _____ contract.

14. If a contract specifies a level of effort that must be performed over a period of time and is based on skill sets and person hours the contract is known as a _____ _____ contract.

15. The final contract when agreed upon and signed is known as the _____ contract.

16. If work must begin before the contract has been through the complete approval and acceptance process to avoid late acquisition of resources (i.e., long-lead items) or to avoid potential environmental problems, a _____ contract may be approved to allow work to begin while the formal approval process continues.

Contract Types

For the following questions, indicate "seller," "buyer," or both.

17. Who has the greatest risk in a firm fixed-price or lump sum contract? _____

18. Who has the greatest risk in a cost plus type of contract? _____

19. Who has the potential to benefit from a cost plus incentive fee contract? _____

20. In a cost plus fixed fee contract, who pays for all project costs? _____

21. In the cost reimbursable type contract, who generally has the greatest risk? _____

22. The cost plus percentage of cost contract (CPPC) reduces the motivation of the _____ to complete the contract and may result in enormous cost to the _____

Calculating Project Costs

Review each of the following examples and determine the final price paid by the buyer. In some cases, a buyer and seller may negotiate an incentive-type project that will benefit both sides if the conditions are met. Incentive contracts may be developed to speed up completion of a project or reduce buyer costs.

Example: Cost plus incentive fee contract

Target cost	$100,000
Target fee	$20,000
Target price	$120,000
Sharing ratio	70/30 (70% to buyer, 30% to seller)
Actual cost	$90,000

Additional fee = $100,000 – $90,000 (target cost – actual cost) = $10,000 × .30 = $3,000

Total fee paid = $20,000 (agreed upon fee) plus $3,000 incentive = $23,000

Total project price = $23,000 + $90,000 = $113,000

23. Your turn: Cost plus incentive fee contract

Target cost	$150,000
Target fee	$25,000
Target price	$175,000
Sharing ratio	80/20 (80% to buyer, 20% to seller)
Actual cost	$140,000

Additional fee = _____

Total fee paid = _____

Total project price = _____

24. Fixed-price incentive fee contract

Target cost	$150,000
Target fee	$25,000
Target price	$175,000
Sharing ratio	60/40(60% to buyer, 40% to seller)
Ceiling price	$180,000
Actual cost	$145,000

Additional fee = _____

Total fee paid = _____

Total project price = _____

25. Fixed-price incentive fee contract

Target cost	$150,000
Target fee	$25,000
Target price	$175,000
Sharing ratio	60/40 (60% to buyer, 40% to seller)
Ceiling price	$185,000
Actual cost	$180,000

Additional fee = _____

Total fee paid = _____

Total project price = _____

More Contracts! Cost Plus Incentive Fee Contract (CPIF)

In the CPIF contract, the seller receives a bonus for performing the work below a target cost. As an example, consider the data below provided for a CPIF contract:

Target cost	$200,000
Target fee	$14,000
Sharing ratio	80/20
Profit ceiling	$18,000
Profit floor	$4,000

In this example, the seller has agreed upon a target cost of $200,000 and a target fee of $14,000. If the seller performs the work at a lower cost than the $200,000, then the seller will receive additional profit up to a maximum profit of $18,000. If the seller performs the work for more than the target cost of $200,000, then the seller will receive less profit, but at least the minimum of $4,000.

The sharing ratio represents the amount of the overrun or underrun shared by each party. The first number represents the buyer and the second number represents the seller. If the work is performed below the target cost, the buyer keeps 80% of the underrun and the seller keeps 20% of the underrun as extra profit up to a maximum profit of $18,000. If the contract is overrun, the buyer pays 80% of the overrun and the seller pays 20%, which is subtracted from the target profit as long as the profit is no less than $4,000. This is shown in Figure 1:

Figure 1 Principles of incentive contracts

Consider the following example where the work is performed at $190,000.

Cost saving is $10,000.

Seller keeps 20% × 10,000 = $2,000 in extra profit.

Seller's total profit is therefore $16,000.

Seller will be reimbursed actual cost plus profit, which equals $206,000.

Now let's assume the seller spent $240,000 performing the work.

Cost overrun is $40,000.

Buyer pays 80% or $32,000.

Seller pays 20% of $40,000 or $8,000, which is subtracted from profits, resulting in a total profit of $6,000.

Seller will be reimbursed actual cost plus profit, or $246,000.

26. Now it's your turn. For each of the four situations below, and using the same data from the above problem, calculate the amount of money reimbursed to the seller if the seller's actual cost was:

a. $260,000 _____

b. $230,000 _____

c. $180,000 _____

d. $140,000 _____

An Incentive to Learn! Fixed-Price Incentive Fee Contract (FPIF)

The fixed-price incentive fee contract is very similar to the CPIF contract with the exception that instead of having the floor and ceiling on the profits, there is a ceiling on the final price paid by the seller. Using the data below:

Target cost: $200,000

Target fee: $14,000

Sharing ratio: 80/20

Price ceiling: $250,000

The price ceiling is the point of total assumption, or the maximum amount that the buyer will reimburse the seller. At the point of total assumption, the contract becomes a firm fixed-price contract and the seller incurs all cost overrun from that point forth with no sharing.

Let's use the two examples from the above problem where the actual costs were $190,000 and $240,000. The problem progresses the same way, and we calculate the contract price, which was $206,000 and $246,000, respectively. In both cases, since the contract price did not exceed the price ceiling of $250,000, the seller will receive the full value of the price. If the price were $255,000, the seller would be reimbursed only $250,000.

It is possible that the actual cost can be so large that all of the profit will be lost. However, negative profit cannot exist. The most the seller can lose in profit is the target profit.

27. Now it's your turn. Assume that each of the four choices below is the seller's actual cost for performing the work. How much will the seller receive from the buyer at the completion of the contract?

a. $300,000 _____

b. $260,000 _____

c. $250,000 _____

d. $240,000 _____

Relative Contract Risk

Each type of contract has some degree of risk that is shared between the buyer and the seller. Consider the following nine contract types:

1. Cost plus incentive fee (CPIF)
2. Cost plus award fee (CPAF)
3. Firm fixed price (FFP)
4. Cost plus percentage of cost (CPPC)
5. Cost sharing (CS)
6. Cost only (C)
7. Firm fixed price with economic adjustment (FFE)
8. Fixed price incentive fee (FPIF)
9. Cost plus fixed fee (CPFF)

28. In Figure 2, label each of the nine triangles, which represent each contract type, as to how the risk is shared between the buyer and seller.

Figure 2 Relative contract risk

Procurement Options

There are four basic options available for procurement:

a. Procure all goods/services from a single source.
b. Procure all goods/services from multiple sources.
c. Procure only a small portion of the goods/services.
d. Procure none of the goods/services.

For each of the situations below, select the most likely option that would be chosen:

29. You have the capability to produce a product. If the marketplace likes your product and demand increases sharply, the demand will most likely exceed your manufacturing capability. To minimize future risks, you decide to select one supplier as a backup and give them a small portion of the production contract. In this case, you would most likely be using option _____.

30. The demand for your product has exceeded expectations and you have decided to outsource all of the work. To minimize your dependency (i.e., risk) with using one contractor who might eventually "hold you hostage," you would most likely select option _____.

31. You have performed a make-buy analysis and discovered that it is more economical for you to manufacture the product yourself. The most likely option would be option _____.

32. Your company maintains a list of preferred suppliers, all of whom could individually satisfy your production requirements. However, one supplier has continuously tried to keep costs down for the benefit of both you and the supplier. The most likely option would be option _____.

33. Your company had decided to manufacture all of the goods in-house. However, you have just won a large contract that may necessitate that the remaining portion of the production be outsourced so that manufacturing capability will exist for the new project. The most likely option selected would be option _____.

Make versus Buy

During procurement planning, the project manager must decide whether to produce the goods/services internally or to buy the goods/services externally. For each of the statements below, select whether the most likely option would be to make it or buy it:

34. Some suppliers can do it cheaper than you can.

- ☐ Make
- ☐ Buy

35. Management wants to stabilize the workforce.

- ☐ Make
- ☐ Buy

36. Your needs are one-of-a-kind and low volume.

- ☐ Make
- ☐ Buy

37. You prefer direct control over quality and cost.

- ☐ Make
- ☐ Buy

38. The product has proprietary knowledge in it.

- ☐ Make
- ☐ Buy

39. Your in-house capacity is limited.

- ☐ Make
- ☐ Buy

40. You want to augment the existing labor force.

- ☐ Make
- ☐ Buy

41. The preferred suppliers have superior skills.

- ☐ Make
- ☐ Buy

42. You want indirect control to minimize risks.

- ☐ Make
- ☐ Buy

43. The supplier base is unreliable.

- ☐ Make
- ☐ Buy

Rent versus Lease

Your company has a need for some specialized equipment that can be leased or rented. If you rent the equipment, the cost is $100 per day. If you prefer to lease the equipment, which is usually for a longer period of time, the cost is $2,000 (nonrefundable payment) plus $50 per day. What is the breakeven point where renting and leasing are the same?

Let X = the breakeven number of days

Renting = $\$100X$

Leasing = $\$2{,}000 + \$50X$

Therefore, $\$100X = \$2{,}000 + \$50X$

Solving for X, we find that $X = 40$ days. Therefore, if you plan on using the equipment for less than 40 days, the cost-effective decision is to rent. For more than 40 days of use, the correct decision is to lease.

44. Now it's your turn. A company needs some equipment for 120 days to meet contractual requirements. The rental cost is $200 per day and the leasing cost is $10,000 plus $75 per day. Should the company rent or lease?

Request Seller Response

Below are several statements that affect procurement and contracting. Beside each statement, state whether or not this item would be part of the request seller response process.

45. Name of the project manager.

- ☐ Yes
- ☐ No

46. Bidder conferences (how often and when).

- ☐ Yes
- ☐ No

47. Name of the contract administrator

- ☐ Yes
- ☐ No

48. How payments will be made to the seller.

- ☐ Yes
- ☐ No

49. Specialized documentation (i.e., compliance with OSHA, EEO, EPA, etc.).

- ☐ Yes
- ☐ No

50. Proposal evaluation criteria.

- ☐ Yes
- ☐ No

51. Listing of qualified bidders expected to respond.

- ☐ Yes
- ☐ No

52. The process for change control.

- ☐ Yes
- ☐ No

53. Adverting in a trade journal

- ☐ Yes
- ☐ No

54. Qualified sellers list

- ☐ Yes
- ☐ No

Acquisition Methods

For each of the three methods for acquisitions, select the correct response from among the three options provided.

55. Request for information (RFI) _____

56. Request for quotation (RFQ) _____

57. Request for proposal (RFP) _____

a. Request for a formal response but usually just a cost or price without any supporting information.

b. A request to see if the information is available, and if so, can it be obtained through licensing, leasing, joint venture, or some other way.

c. Request for a formal response including full pricing data, labor justification, backup data, management capability, previous experience, etc.

Contractual Terminology

Listed below are several contractual terms and definitions. Match the term on the left to the correct definition.

58. Arbitration: _____
59. Breach of contract: _____
60. Contract: _____
61. Executed contract: _____
62. Force majeure clause: _____
63. Good faith: _____
64. Infringement: _____
65. Liquidated damages: _____
66. Negligence: _____
67. Noncompete clause: _____
68. Nondisclosure clause: _____
69. Nonconformance: _____
70. Penalty clause: _____
71. Privity of contract: _____
72. Waiver: _____
73. Warranty: _____

a. The relationship that exists between the buyer and the seller
b. A violation of one's legally recognized right
c. The settling of a dispute
d. An intentional relinquishment of a legal right
e. Honesty and fair dealing between all parties
f. To violate or break a legal obligation
g. Restrictions on the disclosure of proprietary knowledge
h. A promise that the facts stated are true
i. An agreement that can be enforced in a court of law
j. Work that does not conform to specifications or requirements
k. Release from liability resulting from acts of God, wars, etc.
l. Reasonable damages resulting from a breach of contract
m. The failure to act in a reasonable manner
n. An agreement, in financial terms, for failure to perform
o. A completed contract
p. Restrictions on working for a competitor within a certain time

Characteristics of Contracts

Following is a list of characteristics of certain types of contracts. For each one, select the letter of the correct contract type from the list.

74. An almost bottomless pit of funds from the buyer whereby the seller is reimbursed for all costs and profits from all money spent _____
75. A sharing formula for costs above and below target as well as a ceiling and floor on profits _____
76. A profit fixed in dollars rather than percent _____
77. A profit based upon how well the buyer likes the end result _____
78. A contract that does not allow for profits and where the seller pays part of the cost _____
79. A contract with a point of total assumption _____
80. A contract where the maximum risk resides with the seller _____

a. Firm fixed price (FFP)
b. Cost plus incentive fee (CPIF)
c. Fixed price incentive fee (FPIF)
d. Cost sharing (CS)
e. Cost plus percentage of costs (CPPC)
f. Cost plus fixed fee (CPFF)
g. Cost plus award fee (CPAF)

The Contract Administrator

For each of the items below, select either Yes or No to indicate whether this item is usually the responsibility of the contract administrator for the buyer.

81. Preparing a report card on the seller.

☐ Yes
☐ No

82. Determining a breach of contract.

☐ Yes
☐ No

83. Selecting the seller's project manager.

☐ Yes
☐ No

84. Selecting the buyer's project manager.

☐ Yes
☐ No

85. Approval of scope changes.

☐ Yes
☐ No

86. Interpretation of specifications.

☐ Yes
☐ No

87. Production surveillance.

☐ Yes
☐ No

88. Issuing of waivers.

☐ Yes
☐ No

89. Resolution of disputes.

☐ Yes
☐ No

90. Project termination.

- ☐ Yes
- ☐ No

91. Payment schedules.

- ☐ Yes
- ☐ No

92. Project closeout.

- ☐ Yes
- ☐ No

93. Validation of a bid protest.

- ☐ Yes
- ☐ No

True-False Exercise

94. Project procurement strategies (as opposed to corporate procurement strategies) most frequently allow for sole source procurement.

- ☐ True
- ☐ False

95. Part of contract negotiations is to prepare a complete price/cost analysis.

- ☐ True
- ☐ False

96. Verbal contracts, based upon mutual agreement, are enforceable in a court of law.

- ☐ True
- ☐ False

97. Contracts are enforceable in a court of law even if the contract was not for a legal purpose.

- ☐ True
- ☐ False

98. Term contracts can be completed without any deliverables being produced.

- ☐ True
- ☐ False

99. Each contract type is a sharing of risk between the buyer and seller.

- ☐ True
- ☐ False

100. The point of total assumption is the point where the buyer pays all additional costs over the target price.

- ☐ True
- ☐ False

101. A letter contract or letter of intent allows the seller to begin work prior to the signing of the final contract and spend a specified amount of the final contract price.

- ☐ True
- ☐ False

102. An order of precedence clause in a contract states which deliverables in the contract must be completed first.

- ☐ True
- ☐ False

103. Back-charging is when the buyer reopens a closed-out contract and pays the seller to perform additional work.

- ☐ True
- ☐ False

Contract Selection Criteria

The buyer usually has criteria from which the final contract type is based. For each of the items below, state whether you agree that this item could be part of the selection criteria.

104. Overall degree of cost and schedule risk.

- ☐ Yes
- ☐ No

105. Type and complexity of requirements.

- ☐ Yes
- ☐ No

106. Extent of price competition.

- ☐ Yes
- ☐ No

107. Cost/price analysis (i.e., validity).

- ☐ Yes
- ☐ No

108. Urgency of requirements.

- ☐ Yes
- ☐ No

109. Performance period.

- ☐ Yes
- ☐ No

110. Contractor's responsibility and risk.

- ☐ Yes
- ☐ No

111. Contractor's ability to perform earned value measurement.

- ☐ Yes
- ☐ No

112. Amount of concurrent contracts that the seller is now working on.

- ☐ Yes
- ☐ No

113. Extent of seller subcontracting required.

- ☐ Yes
- ☐ No

114. Explain the advantages and disadvantages of the decision to use a single source as a supplier.

Advantages:	**Disadvantages:**

115. Under what conditions would a buyer terminate a contract by default?

_____

_____

_____

_____

_____

_____

_____

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the areas of the *PMBOK® Guide*—Sixth Edition: Project Procurement Management.

The project procurement management processes are:

1. Plan procurement management
2. Conduct procurements
3. Control procurements

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Differentiate between enterprise environmental factors and organizational process assets.

The charter is an input of the plan procurement process.

Enterprise environmental factors and organization process assets are inputs to each procurement management process.

Sellers and contractors are selected based on source selection criteria. Examples: capacity, capability, price, technical expertise, schedule, past performance, firm stability.

Bidder conferences provide an equal level of opportunity for all potential contractors.

While studying for the exam it is important to note the logical progression of activities, specifically how inputs, tools and techniques, and outputs are arranged.

Examples

Expert judgment, data gathering, and data analysis, are tools and techniques that are performed or used before a make or buy analysis is completed.

Negotiation is conducted before an agreement is reached.

Negotiations are affected by hygiene factors such as meeting location, conference table shape, seating arrangements, and cultural issues (protocol such as greetings, business card exchange, and recognition of position of authority).

To avoid unfavorable risk situations, the terms and conditions of the contract should be analyzed in detail.

Contract Information

A contract is a legally binding and enforceable agreement.

A contract may be created either by verbal or written agreement or by implication by the conduct or actions of the parties involved.

Remember: The major elements of a contract are offer, acceptance, consideration, capacity, legal form.

Contracts should be reviewed and validated to ensure that the conditions and objectives within the contract will meet the objectives of the organizations involved.

Contracts should be read thoroughly and carefully to make sure that the basic terms are clearly stated and fully understood.

There are several types of contracts. The firm fixed-price contract places the greatest amount of risk on the seller. The cost plus type contracts place the greatest amount of risk on the buyer.

Incentive contracts are negotiated to achieve mutually agreed upon benefits between the buyer and seller. Sharing ratios are established to calculate the actual incentives. Incentive type contracts are designed to accelerate project completion or keep costs as low as possible.

There are certain basic elements of most contracts:

- **Mutual agreement:** There must be an offer and acceptance.
- **Consideration:** There must be a down payment.

- **Contract capability:** The contract is binding only if the contractor has the capability to perform the work.
- **Legal purpose:** The contract must be for a legal purpose.
- **Form provided by law:** The contract must reflect the contractor's legal obligation, or lack of obligation, to deliver end products.

Other key study items

The project management plan is comprised of subsidiary plans. Examples: Procurement management plan, scope management plan, resource management plan, risk management plan.

The objective of the procurement strategy is to determine the project delivery method, the type of agreements or contracts, and how procurement will advance through the project life cycle.

Make-or-buy decisions should be carefully analyzed to obtain the greatest benefits regarding cost, control, and quality.

A letter of intent or letter contract may be used to begin work before the final contract terms and conditions have been officially approved and accepted.

A constructive change is a change that causes the contractor to perform work differently than initially required due to the action or inaction of the customer or other parties. An example of a constructive change would be late or unsuitable customer-furnished property or work environment.

ADR: Alternative dispute resolution. Use of arbitration or mediation. Dispute resolution processes and techniques that act as a means for disagreeing parties to come to an agreement short of litigation.

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

▶ Answers to Questions and Exercises

1. All items listed are enterprise environmental factors.
2. Match the following terms with the correct definition.
   a. Presales activity
   b. Contract administration
   c. Bid/no bid decision making
   d. Bid proposal preparation
   e. Contract negotiation and formation
3. The statement of work (SOW) is a *narrative* description of the work to be accomplished and/or the resources to be supplied.

4. Match the definitions with the correct terms:
   a. Functional specifications
   b. Design specifications
   c. Performance specifications
5. a. Make, buy
   b. Make
   c. Buy
   d. Make
   e. Make
   f. Buy
   g. Make
   h. Make
   i. Make
   j. Buy
   k. Buy
   l. Make
   m. Buy
6. a. Lease
   b. 61.5 days
7. b
8. True
9. True
   C.
10. a. 3
    b. 1
    c. 5
    d. 4
    e. 2
11. a, c, d, e, g
12. Capability and capacity, product cost, product life cycle, technical expertise, proposed approach, staff qualifications, stability of the firm, management experience
13. Completion
14. Term
15. Definitive
16. Letter contract or letter of intent
17. Seller
18. Buyer
19. Seller and buyer
20. Buyer
21. Buyer
22. Seller; buyer

23. Additional fee = $150,000 – $140,000 (target cost – actual cost) = $10,000 × .20 = $2,000

Total fee paid = $25,000 (agreed upon fee) plus 2,000 incentive = $27,000

Total project price $27,000 + $140,000 = $167,000

24. Fixed-Price Incentive Fee Contract

Additional fee = $5,000 × .40 = $2,000

Total fee paid = $25,000 + $2,000 = $27,000

Total project price = $145,000 + $27,000 = $172,000

25. Additional fee = $150,000 – $180,000 = –$30,000 × .40 = –$12,000

Total fee paid = $25,000 – $12,000 = $13,000

Total project price = $180,000 + $13,000 = $193,000, but the ceiling price is $185,000. The total project price paid by the buyer is $185,000.

26. **a.** $264,000

b. $238,000

c. $198,000

d. $158,000

27. **a.** $250,000

b. $250,000

c. $250,000

d. $246,000

28.

Figure 3 Relative contract risk

29. c (a is also possible.)

30. b
31. d
32. a
33. a
34. Buy
35. Make
36. Buy
37. Make
38. Make
39. Buy
40. Make
41. Buy
42. Buy
43. Make
44. The breakeven point is 80 days. Since the company needs the equipment for 120 days, the best choice is to lease.
45. No
46. Yes
47. No
48. Yes
49. Yes
50. Yes
51. Yes
52. Yes
53. Yes
54. Yes
55. b
56. a
57. c
58. c
59. f
60. i
61. o
62. k
63. e
64. b
65. l
66. m
67. p
68. g
69. j
70. n
71. a
72. d
73. h
74. e
75. b
76. f
77. g
78. d
79. c
80. a
81. Yes
82. Yes
83. No
84. No
85. Yes
86. Yes
87. Yes
88. Yes
89. Yes
90. Yes
91. Yes
92. Yes
93. No
94. True
95. True
96. True
97. False
98. True

99. True

100. False

101. True

102. False

103. False

104–113. All are possible selection criteria.

114. There may be several answers for advantages and disadvantages.

Advantages:	**Disadvantages:**
Pricing advantages	No guarantee that pricing is competitive
Consistent level of quality	Potential for the seller/supplier to fail financially
Predicable results	Potential reduction in quality
	No back-up supplier if the contracted supplier cannot perform the work
	Potential delays in completing procured work

115. Contractor fails to make delivery on scheduled date.

Contractor fails to make progress so as to endanger performance of the contract and its terms.

Contractor fails to perform any other provisions of the contract.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER TWENTY

Quality Management

Project Quality Management includes the processes that connect the organization's quality policy with the planning, managing, and controlling of the activities and project deliverables that have been defined to meet the project objectives and satisfy the requirements of the stakeholders. The key to managing quality is to maintain a continuous awareness that quality is defined by the customer. Quality management is a process that should be continuously improving through the use of lessons learned from previous projects, existing products and services, and customer interactions. Lessons learned from quality management experiences can be a key factor when planning for future products and services. They are also useful in developing strategies to retain existing customers, win back lost customers, and attract new customers.

The quality process includes planning for quality, organizing for quality, executing the work using quality guidelines, monitoring the work to identify variance, solving problems by identifying causes of poor quality, replanning as necessary, and establishing preventive measures to reduce defects and poor quality.

There are several approaches and principles to achieving quality. These include:

- Determining the cost of quality; the cost of conformance and nonconformance
- Zero defect programs; Six Sigma
- Total quality management (TQM)
- Reliability engineering

These approaches to achieving high-quality project and product outcomes and others have been established by organizations worldwide and are being implemented for the basic reason that quality is of strategic importance to a company and is a major factor in delivering business value. Quality can be directly linked to profitability and competitive positioning. It is an integral part of strategic planning, and it requires an organization-wide commitment. Every employee in any organization is responsible for quality.

According to the sixth edition of the *PMBOK® Guide*, there are three major quality management processes:

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- Plan quality management: identifying quality requirements and standards
- Manage quality: Defining quality activities to ensure execution of the quality plan
- Control quality: assessing performance, identifying variance and arranging for corrective action as necessary

Project Quality Management is intended to minimize variation from specifications established for products and services and to deliver results that meet predefined requirements. Quality management focuses on the areas of:

- Customer satisfaction: meeting expectations
- Continual improvement: The plan-do-check-act cycle (PDCA), total quality management, and Six Sigma
- Management responsibility: A supportive and involved managerial structure
- Mutually beneficial partnership with suppliers. Cooperation and interdependency. Creating value for both when engaged in a project.

Remember

Organizations generally agree that quality cannot be accurately defined by the organization. Quality is defined by the customer. Quality is associated with products and services that meet or exceed the needs and expectations of the customer at a cost that represents outstanding value.

► Glossary of Terms

Assignable cause A specific or special cause that requires investigation. Example: Data points that are plotted outside of the upper and lower control limits of a control chart are reviewed to determine the assignable cause or reason for the variation.

Attribute sampling A process in which the deliverable is assessed to determine if it either conforms or does not conform to specific acceptance criteria. A pass/fail assessment process.

Availability The probability that the product, when used under given conditions, will perform satisfactorily when called upon.

Control chart A graphic technique for identifying whether an operation or process is in or out of control and tracking the performance of that operation or process against calculated control and warning limits. The dispersion of data points on the chart is used to determine whether the process is performing within prescribed limits and whether variations taking place (plotted and documented) are random or systematic (from an assignable or special cause).

Cost of quality The total cost incurred to prevent errors, appraise and inspect products, repair defects, and resolve nonconformance issues. Cost of quality includes the

cost of conformance—prevention and inspection—and the cost of nonconformance—internal and external failure

DMAIC Six Sigma acronym for define, measure, analyze, improve, and control

Grade A category assigned to products or services having the same functional use but different technical characteristics. High grade generally refers to a greater number of features and functionality. For example, a software application is considered high quality (no defects) but low grade (limited features and functions).

ISO 9000 A series of international standards that provides quality management guidance and identifies quality system elements. ISO 9001 is a voluntary international standard for quality management systems. The ISO 9000 series are based on eight quality management principles. The eight quality management principles are defined in ISO 9000:2005, *Quality Management Systems—Fundamentals and Vocabulary*, and in ISO 9004:2009. They are:

1. Customer focus
2. Leadership
3. Involvement of people
4. Process approach
5. System approach to management
6. Continual improvement
7. Factual approach to decision making
8. Mutually beneficial supplier relationships

Kaizen Continuous incremental improvement of an activity to eliminate waste. From the Japanese term for a process of continuous improvement using problem solving and analysis techniques. A quality improvement process that involves all managers and employees. From *kai*—change, and *zen*—make good.

Maintainability The ability of the product to be retained in or restored to a satisfactory performance level when prescribed maintenance is performed.

Operability The degree to which a product can be operated safely.

Pareto diagram A chart used to graphically summarize and display the relative importance of the differences between groups of data. A bar chart that displays frequency of cause of failure from left to right—greatest frequency to least frequent. Associated with the 80/20 rule—80% of outcomes can be attributed to 20% of all causes for a given event.

Produce-ability The ability to produce the product with available technology and workers and at an acceptable cost.

Quality An essential and distinguishing attribute of something or someone. A degree or grade of excellence or worth. The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

Quality policy The overall intentions and direction of an organization regarding quality as formally expressed by top management. The general practical intention and direction of a company toward quality.

Reliability The probability of the product performing without failure under given conditions and for a set period of time.

Rule of seven The rule of seven states that seven (or more) continuous data points are required to indicate a positive or negative trend or that seven (or more) continuous data points on one side of the process average or mean indicates a run, which may indicate that the system is out of calibration.

Salability The balance between quality and cost.

Sampling The selection of a subset of individual items from within a statistical population to estimate characteristics of the whole population. Two advantages of sampling are that the cost is lower (involves only a portion of the targeted product) and data collection is faster.

Scatter diagram A diagram that shows the relationship between two variables to determine correlation.

Social acceptability The degree of conflict between the product or process and the values of society.

TQM Total quality management. A policy that includes all levels of employees in an organization and involves training, awareness, and overall acceptance of the quality mission and principles of the organization.

Variable sampling A process in which a product is measured on a continuous scale to determine the level of conformity.

▶ Activities, Questions, and Exercises

Refer to Chapter 20 of *Project Management: A Systems Approach to Planning*, *Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

The following questions and exercises are associated with the knowledge areas of the *PMBOK® Guide*—Sixth Edition: Project Quality Management.

Remember

Quality management is approached from many different perspectives. What works well in one organization may not work in another. It is important for an organization to establish a clear quality policy that can be communicated and instilled as part of the company culture.

1. The Shewhart chart, which was adapted by W. Edwards Deming as a basis for illustrating the quality management process, is associated with which of the following flows?
   a. Initiate, plan, execute, control, close
   b. Plan, do, check, act
   c. Prevention, inspection, internal failure, external failure
   d. Execute, analyze, respond, monitor
2. Deming postulated that 85% of all quality problems required:
   a. Employee action
   b. Statistical analysis
   c. Management initiative and action
   d. The use of control charts
3. Match the principles with the appropriate quality guru (Deming, Juran, Crosby, or Taguchi).

Principle	Guru
a. Trilogy of quality improvement, quality planning, and quality control	_____
b. Design of experiments	_____
c. Pioneered statistics and sampling	_____
d. Fitness for use	_____
e. Achieving zero defects is possible.	_____
f. The legal implications of quality	_____
g. Workers can't do their best. They must be shown what constitutes acceptable quality.	_____
j. Conformance to specifications	_____
i. Quality is measured by the cost of nonconformance.	_____
j. Cost to correct problems rises the further the results are from target.	_____
k. Quality comes from prevention.	_____

4. Which of the following are true about Taguchi's approach to quality?
   a. Quality should be designed into the product.
   b. Quality should be inspected into the product.
   c. Senior management must take a visible role in managing defects.
   d. The cost of quality is associated with nonconformance.
   e. Cost of quality is measured as a function of deviation from the standard.

5. Consider the data shown below, which will be used to construct a quality control chart:

Data Point(N)	X	$(X - \bar{X})^2$
1	2.00	0
2	2.01	.0001
3	2.02	.0004
4	1.99	.0001
5	1.99	.0001
6	1.98	.0004
7	1.99	.0001
8	2.01	.0001
9	2.01	.0001
10	2.00	0
	20.00	0.0014

$\bar{X}$ = 20.00/10 data points = 2.00

$$\sigma = \sqrt{\left([X - \bar{X}]^2 / [N - 1]\right)} = 0.01$$

Now let's apply this to a problem. Assume one of your customers wants this product and has given you a specification where the upper specification limit is at 2.05 and the lower specification limit is at 1.95. If you establish your process limits at $X \pm 3\sigma$, then the upper control limit is 2.03 and the lower control limit is 1.97. This is shown in the figure below:

In this figure, the process is said to be "in control" because all of the data points fall within the upper and lower control limits. However, had the upper and lower specification limits been set to 2.015 and 1.985, respectively, the process would be "out of control" because of two of the points.

This example is for teaching purposes only. In most companies, 10 data points may not be a sufficient quantity to analyze the data in a control chart format.

Now it's your turn. Shown below are three control charts that represent special or assignable cause variability. For each of the control charts, select from the first

group the reason why the process is out of control. Then, from the second group, select the cause or causes for the process to be out of control.

Group I:	1.	A "run"
	2.	A point outside of the control limits
	3.	"Hugging" the control limits
Group II:	1.	Operator made a mistake
	2.	Process may be out of alignment; shift in centerline
	3.	Faulty raw material
	4.	Operator pushed the wrong button
	5.	Worn-out tooling

Control Chart A

Control Chart B

Control Chart C

6. Review the list provided and determine which items are associated with quality assurance and which ones are associated with quality control.

   a. Identify objectives and standards. _____
   b. Set standards that provide the basis for decisions regarding corrective action. _____
   c. Establish measurement methods. _____
   d. Multifunctional and prevention oriented _____
   e. Plan for collection of data in a cycle of continuous improvement. _____
   f. Include scheduled reviews and audits. _____
   g. Comparison of actual results with standards _____
   h. Take corrective action. _____
   i. Monitor and calibrate measuring devices. _____

7. The cost of quality is divided into two major sections: the cost of conformance and the cost of nonconformance. Match the list of costs with the appropriate cost of quality element, cost of conformance or cost of nonconformance.

Type of Cost	Cost of Quality Element
a. Internal Failure	_____
b. Prevention	_____
c. Appraisal	_____
d. External failure	_____

8. Match the specific issue or event that may result in additional cost, with the category of quality costs (prevention costs, appraisal costs, internal failure, or external failure).

Issue or Event	Quality Cost
a. Design review	_____
b. Rework	_____
c. Customer complaints	_____
d. Training	_____
e. Quality planning	_____
f. Scrap	_____
g. Process studies	_____
h. Repair	_____
i. Downtime	_____
j. Customer visits to inspect and take corrective action	_____
k. Inspection	_____
l. Lab tests	_____

■ More Guru-Matching Exercises

9. In the left column are the names of three of the pioneers in project quality management. In the right column are their definitions of quality. List the correct definition next to the each name.

a. Deming _____	Conformance to requirements
b. Juran _____	Fitness for use
c. Crosby _____	Continuous improvement

10. Each of the pioneers in the left column had an approach they followed to improve quality. Match the approach on the right to the pioneer.

a. Deming _____	The trilogy
b. Juran _____	The four absolutes
c. Crosby _____	Plan-do-check-act cycle

11. Each of the pioneers in the left column was also known for some other contribution to the quality effort. Match the pioneer with the contribution.

a. Deming _____	Cost of quality
b. Juran _____	85%–15% rule
c. Crosby _____	Quality is free

12. Quality is inspection.

☐ True

☐ False

13. Training to support total quality management begins with the executive levels of management.

☐ True

☐ False

14. Quality is defined by the customer.

☐ True

☐ False

15. Correction to quality problems should be documented.

☐ True

☐ False

16. The alternative to Three Sigma is Six Sigma.

☐ True

☐ False

17. Six Sigma applies to manufacturing only.

☐ True

☐ False

18. Histograms are quality control tools.

☐ True

☐ False

19. Quality circles are executive-level quality control teams.

☐ True

☐ False

20. Pareto charts are used to identify quality problems.

☐ True

☐ False

21. Cause and effect charts are commonly used to identify the source of both quality problems and risks.

☐ True

☐ False

22. If the upper and lower control limits are set at $X \pm 3\sigma$, then 99.73% of the products are expected to fall within these limits.

☐ True

☐ False

23. Project managers have accountability for project success but can delegate to others the project manager's responsibility for quality.

☐ True

☐ False

24. The following table is an example of a

a. Pareto diagram

b. Ishikawa diagram

c. Control chart

d. Check sheet

Defect	Supplier A	Supplier B	Supplier C	Supplier D	Total
Incorrect invoice					
Incorrect inventory					
Damaged material					
Incorrect test Documentation					
Total					

25. **PM Quick Check:** Which of the following charts is most commonly associated with cause-and-effect analysis?

a. Check sheet

b. Pareto diagram

c. Histogram

d. Fishbone or Ishikawa diagram

Remember

Pareto diagrams are associated with the 80/20 rule. This rule states that 80% of problems can be associated with 20% of the identified causes.

PM Quick Check: True or False?

26. The use of a control chart is focused on prevention of defects.

☐ True

☐ False

27. There are two types of control charts—variable charts and attribute charts.

☐ True

☐ False

28. Attribute sampling is focused on a pass/fail or conform/does not conform decision basis.

☐ True

☐ False

29. Six Sigma is a method of quality management that focuses on the control of a process to achieve 3.4 defects per million opportunities of failure.

☐ True

☐ False

30. The project sponsor is ultimately responsible for the quality of the project results.

☐ True

☐ False

31. Total quality management is a program that is targeted specifically for the upper management of an organization.

☐ True

☐ False

32. Match the terms on the left to the correct meaning on the right.

a. Mean _____	Most frequent
b. Mode _____	Middle value
c. Median _____	Average

33. What is meant by the 80/20 rule as it relates to quality management?

_____

_____

_____

34. Provide examples of the cost of quality component "internal failure".

_____

_____

_____

35. Explain the difference between accuracy and precision.

_____

_____

_____

_____

36. The project manager should not be held accountable for the quality of the end result of a deliverable if the work was performed in departments that were not under the project manager's influence or control.

☐ True

☐ False

37. The Pareto diagram displays information by lowest frequency of occurrence to highest frequency.

☐ True

☐ False

38. Which of the following would be the most appropriate tool to display a grouping of potential problems by category after a brainstorming session?

a. Histogram

b. Affinity diagram

c. Ishikawa diagram

d. WBS

39. A control chart indicates that more than 7 consecutive data points appear above the center line of process average. What does this indicate?

_____

_____

_____

40. As part of the management of quality, audits are often scheduled. What is the purpose of a quality audit?

_____

_____

_____

_____

■ Study Note

Quality management is often about statistics and analysis. It is important to become familiar with the terminology of statistical analysis.

- Population: The universe of environment that will be analyzed
- Variable sampling: A process in which products are evaluated on a continuous scale that allows for some deviation from the standard as long as it falls within set parameters
- Attribute sampling: A process that determines acceptance or rejection of a product. There is no flexibility and decisions are either pass/fail or conform/does not conform
- Producer's risk: Known as alpha risk. The risk to a producer that a good lot will be rejected
- Consumer's risk: Known as beta risk. The risk that a consumer may accept a bad lot
- Normal distribution: Associated with the bell-shaped curve, it represents a theoretical frequency distribution of measurements. The normal distribution curve, according to statistics, indicates that there is a probability of 68.26% that the results will fall within one standard deviation from the mean, 95.46% within two standard deviations and 99.73% within three standard deviations from the mean. The normal distribution curve provides a probability confidence factor.

▶ Kerzner "Quick Tips" for the Project Management Institute PMP® and CAPM® Exams

The subjects in this chapter are most closely associated with the areas of the *PMBOK® Guide*—Sixth Edition: Project Quality Management.

Project quality management includes three major processes as described by the *PMBOK® Guide*—Sixth Edition

Plan quality management—Defining quality requirements and then documenting how the project will achieve compliance

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Manage quality—Auditing quality requirements and results from quality control measurements to ensure appropriate levels of quality are achieved and standards are in use

Control quality—The process of monitoring and recording results of executing quality activities to assess performance and recommend necessary changes.

Remember, the customer defines quality. The project manager has ultimate responsibility for quality in the project environment. Prevention over inspection is the main goal of a quality process.

Cost of quality includes two major components: the cost of conformance and the cost of nonconformance.

- The cost of conformance includes prevention and appraisal.
- The cost of nonconformance includes internal and external failure.

Quality policies and procedures will vary greatly from one company to another. A general awareness of quality principles and tools and techniques is important for the PMP® exam.

Remember the differences between quality assurance (process) and quality control (action based on measurements).

Quality is a continuous process of improvement.

The Shewhart chart, adapted by Deming, displays the process of plan, do, check, act.

Crosby believes that zero defects can be achieved and that the cost of quality is associated with nonconformance

Juran was focused on fitness for use, conformance to specifications, safety, and the legal aspects of quality—warranties, liabilities

Taguchi developed the design of experiments process. He believed that quality should be designed in, not inspected in. As results move further from target, it becomes more costly to return to the target.

Control charts will assist in the identification of assignable causes. The main components of a control chart are the mean or process average, the upper control limit (UCL and lower control limit (LCL). Control charts will identify trends, runs, processes in control, and processes out of control.

Remember the various quality control tools—control charts, Pareto diagrams, check sheets, cause-and-effect diagrams, histograms, scatter diagrams, attribute sampling, and variable sampling.

Information about quality is often communicated using:

- Flow charts
- Process flows
- Logical data models
- Scatter diagrams
- Histograms
- Affinity diagrams

Managing quality incudes the use of the following tools and techniques:

- Alternatives analysis
- Document analysis
- Process analysis
- Cause-and-effect diagrams
- Root cause analysis

Additional tips and practice items for the PMP® exam are included in each chapter and in Chapter 22, "PMP® and CAPM® Exam Review."

Answers to Questions and Exercises

1. a
2. c
3. a. Juran
   b. Taguchi
   c. Deming
   d. Juran
   e. Crosby
   f. Juran
   g. Deming
   h. Crosby
   i. Crosby
   j. Deming
   k. Crosby
4. a
5. Chart A: I—2, II—1,3,4
   Chart B: I—1, II—2
   Chart C: I—3, II—5
6. a. Quality assurance
   b. Quality control
   c. Quality control
   d. Quality assurance
   e. Quality assurance
   f. Quality assurance
   g. Quality control
   h. Quality control
   i. Quality control
7. a. Cost of nonconformance
   b. Cost of conformance
   c. Cost of conformance
   d. Cost of nonconformance
8. a. Prevention costs
   b. Internal failure
   c. External failure
   d. Prevention costs
   e. Prevention costs
   f. Internal failure
   g. Prevention costs
   h. Internal failure
   i. Internal failure
   j. External failure
   k. Appraisal costs
   l. Appraisal costs

9. a. Continuous improvement
   b. Fitness for use
   c. Conformance to requirements
10. a. Plan-do-check-act cycle
    b. The trilogy
    c. The four absolutes
11. a. 85%–15% rule
    b. Cost of quality
    c. Quality is free
12. False
13. True
14. True
15. True
16. True
17. False
18. True
19. False
20. False
21. True
22. True
23. False
24. d
25. d
26. True
27. False
28. True
29. True
30. False
31. False
32. a. Average
    b. Most frequent
    c. Middle
33. 80% of problems are associated with 20% of the causes
34. Rework, scrape, defects, repairs

35. Accuracy is defined as the ability of a measurement to match the actual or real value of the quantity being measured. Precision is defined as (1) The ability of a measurement to be consistently reproduced" and (2) The number of significant digits to which a value has been reliably measured.
36. This is a question that may not have a simple true or false answer. It depends on the organization, the level of authority of the project manager, the support level of the sponsor, and the organizational structure.
37. False
38. b
39. This indicates a run and the cause should be investigated.
40. The purpose of a quality audit is to determine if project activities comply with organizational policies, processes, and procedures.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, or enhancement of your skills as you prepare for the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

CHAPTER TWENTY-ONE

Modern Developments in Project Management

The basic principles of project management have been in existence for thousands of years. The Great Wall of China and the pyramids in Egypt and in Mexico were constructed using some form of project management. Many of these principles remain in use today, but over the centuries project management has evolved as new tools and techniques were developed to gain efficiencies in planning, the use of resources, and the management of time. In the past few decades, there has been an increased interest in project management not only at the single project level but also at the program and portfolio level. Organizations are now focusing on the business value of project management and how it fits into the strategic planning process. In the recent past, the triple constraints of time, scope, and cost were the main driving factors in determining project success and in trade-off analysis. Today, project success is based on several elements most significantly, customer satisfaction and value attained. There is also interest in how to further financial gains, increase productivity, and reduce costs through organizational or enterprise-wide project management.

What is known as "modern project management" began to emerge in the 1940s and was primarily associated with large defense and armed forces projects. Techniques such as program evaluation and review technique (PERT), The work breakdown structure, critical path method (CPM) and precedence diagramming method (PDM) eventually migrated into the business environment and become common within a growing worldwide community of project managers. Project management continues to evolve through the development of more sophisticated software, enterprise resource planning systems, project management information systems, and new techniques such as agile.

In the early to mid-1990s, the project management office (PMO) became a focus of attention as organizations saw value in standardizing their project management processes. PMOs were introduced to ensure consistency across an organization during project planning and execution. The capability maturity model (CMM) also became an item of interest to many corporate executives. CMM introduced a model to reach business and project management maturity by assessing processes and procedures that were used and building on those processes to create best practices

and a culture of continuous improvement. Six Sigma, the development of competency models, and development of methods for managing multiple projects soon followed.

The foundation for achieving excellence in project management can best be described as the project management maturity model (PMMM), which is comprised of five levels:

- Level one—Common language
- Level two—Common process
- Level three—Singular methodology
- Level four –Benchmarking
- Level five—Continuous improvement

The PMMM provides an organization with an assessment process that will identify opportunities to improve internal project management process and allow an organization to better determine its competitive advantage.

Other methodologies and techniques are also being used by many companies. These techniques include agile project management, Lean Management, and value-driven project management.

The following are the major areas of interest that have surfaced as project management continues to develop:

- The project management maturity model (PMMM)
- Developing effective procedural documentation (standards and guidelines)
- Project management methodologies (at the project, program, and portfolio levels)
- Continuous improvement (CMM, CMMi)
- Capacity planning
- Competency models (organizational and project management)
- Management of multiple projects
- End of phase review meetings (project evaluations and reviews)
- Critical chain or theory of constraints
- OPM3®—Organizational Project Management Maturity Model
- Rational unified process—RUP
- Agile project management
- Kanban
- Six Sigma and Lean Six Sigma
- Prince 2
- ISO 21500:2012 Standard for Project Management
- Global project management

▶ The Project Management Maturity Model (PMMM)—A Closer Look

The goal of PMMM is to assist an organization in achieving excellence in project management through a five-step process.

Level 1—Establish a common language. The first step is to ensure a basic knowledge of project management and an understanding of the accompanying terminology and language of project management.

Level 2—Common processes. Processes that are used repeatedly on projects that are successfully completed are defined and developed and then applied to other projects to increase the probability of success. These processes are recognized as also contributing to or supporting other processes within an organization.

Level 3—Singular methodology. Recognition of the synergistic value of combining organizational processes into a singular methodology that improves the ability to control project outcomes and promote consistency within an organization.

Level 4—Benchmarking. Recognizing that process improvement is necessary to maintain a competitive advantage. Comparison of project results to organizational goals and industry best practices is necessary and must be performed on a regular basis.

Level 5—Continuous improvement. The evaluation of information obtained through benchmarking and the actions taken to improve a process.

Although depicted in the model as a series of steps, these levels and their associated activities may overlap depending upon the capabilities of the organization.

The project management maturity model can be expected to impact the culture of an organization as processes are developed and longstanding procedures and positions of authority are affected, and in many cases, change considerably as more formal project management processes are introduced.

▶ Other Developments in Project Management

■ Developing Procedural Documentation

Procedural documentation will increase efficiencies, establish more consistency in planning projects, and assist an organization in achieving project management maturity.

Benefits of procedural documentation:

- Establishment of guidelines and greater uniformity
- Less but more useful documentation
- More effective and clear communication
- Standardized reports, forms, and data

- Greater unity within and across project teams
- Basis for analysis
- Minimize paperwork
- Reduction in conflict over procedures

Project Management Methodologies (at the project, program, and portfolio levels)

Establishing methodologies for managing projects, programs, and portfolios will increase the likelihood of success at each of the levels. This greatly depends upon the acceptance of these methodologies by the project managers and project teams assigned to projects and programs. Care should be taken to introduce methodologies with a focus on the impact to organizational culture and business value. It may take significant time for methodologies to become accepted and assimilated into the organization's work environment, and if not properly introduced, they could meet with great resistance from project personnel. Project management offices can be used to facilitate the introduction of methodologies and changes to organizational culture.

Continuous Improvement (CMM and Six Sigma)

Continuous improvement can be associated with the Deming/Shewhart model—PDCA or plan, do, check, act, or the capability maturity model (CMM), which is very similar to the PMMM. These models encourage an organization to assess performance and determine actions to progress through steps, phases, or levels to achieve a high level of maturity. Six Sigma is considered a strategic approach to continuous improvement. It involves a long-term commitment to reduce variance and minimize defects through tighter and tighter quality controls. Six Sigma is described using the acronym DMAIC—define, measure, analyze, improve, control.

Capacity Planning

The improvements gained through effective project management are measured through increased productivity, the need for fewer resources, and completing more work in less time. The continuous advances in technology also increase organizational capability and capacity. The combination of technology and a well-defined and supported project management methodology position an organization to increase overall performance in resource planning and consistency of work performed. The gains obtained through efficient processes and methodologies impacts an organization's business forecasts by requiring adjustments in items such as anticipated growth, future staffing, and new product development.

Competency Models

Job descriptions were used to provide information about what an employee was expected to do. They did not address the level of competency and mainly focused on

the expectations of management. In today's project environment, project managers are expected to assume many roles including leader, planner, and manager. Competency models will be used to determine the skill levels and ability of project managers, which, in turn, will be used to identify where additional skills training and development may be needed. Competency models will address and score abilities in such areas as project management (planning, scope definition, WBS development), interpersonal skills (conflict management, motivation, communication), business acumen (organizational processes, financial management), and leadership.

Specific Project Manager Competencies

- Project management knowledge (process) competencies: What the PM knows about applying project management techniques to project activities
- Project management performance (technical/scientific) competencies: How the PM applies knowledge to meet project requirements
- PM personal (leadership) competencies: How a PM behaves/performs in the project environment

PMI has introduced the Talent Triangle, which addresses leadership, technical knowledge, and strategic and business management techniques

Management of Multiple Projects

Today's project environment often requires a project manager to manage several projects concurrently. These projects may range from very small projects with short durations to more complex projects with longer durations. The span of control (number of projects assigned) to a project manager is usually dependent on previous experience, track record, and overall competency. Managing multiple projects presents new challenges to the project manager and is a significant change from a single project mentality.

End-of-Phase Review Meetings (Project Evaluations and Reviews)

Today, many organizations have established processes for reviewing projects throughout the life cycle, not just at the end of the project. This is essential to ensure that the organization continues to support projects that will yield the greatest benefits to the organization. Establishing criteria for success by phase will increase the probability of successful completion of the project and assist an organization in managing its resources more effectively.

Critical Chain or Theory of Constraints

This is a method of planning and managing projects that places more emphasis on the resources required to execute project tasks. It was developed by Eliyahu M. Goldratt. This method contrasts the more traditional Critical Path method, which emphasizes task order and rigid scheduling. A Critical Chain project network will tend to keep

the resources load leveled but will require them to be flexible in their start times and to quickly switch between tasks and task chains to keep the whole project on schedule. Project buffers and activities buffers are used to manage project work throughput. There is also emphasis on correcting and strengthening any weak links (resource constraints) that may be identified. Critical Chain is often referred to as managing the "weakest link," whereby constraints are identified and elevated to reduce the pressure or strengthen the link. Project buffers and task buffers are utilized in the critical chain approach to reduce pressure in "bottleneck" areas. Another characteristic of Critical Chain is the focus on eliminating the "student syndrome" or Parkinson's law, which states that work will expand to meet the time given.

■ Organizational Project Management Maturity Model—OPM3®

A standard developed by the Project Management Institute for reviewing, managing and enhancing organization project management through best-practices. OPM3® provides a way for organizations to understand their project management processes and measure their capabilities in preparation for improvement. OPM3 includes three major elements:

- **Knowledge:** Project management best practices in use across many industries
- **Assessment:** Evaluation of current project management capabilities to identify areas in need of improvement
- **Improvement:** Develop a plan based on the results of the assessment to achieve improvement goals.

■ Rational Unified Process (RUP)

A prescriptive, well-defined system development process often used to develop systems based on object and/or component-based technologies. It is based on planning and engineering principles such as taking an iterative, requirements-driven, architecture-specific approach to software development. It focuses on relatively short-term iterations with well-defined goals and go/no-go decision points at the end of each phase, to provide greater visibility into the development process.

■ Agile Project Management

A highly iterative and incremental process involving developers and project stakeholders actively working together to produce a series of short gains where needs and functionality (requirements) are identified and prioritized. It is a rapid planning process that involves several iterations, reviews, and utilization of lessons learned and provides an opportunity for immediate feedback from stakeholders.

The agile manifesto is centered on four values:

- Communication with parties is more important than standard procedures and tools.
- Focus on delivering a working application and focus less on providing thorough documentation.

- Collaborate more with clients,
- Be open to changes instead of freezing the scope of the work.

Kaizen

Kaizen is the Japanese word for improvement or change for the better. It is a process for continuous improvement. The approach seeks to achieve small, incremental changes in processes in order to improve efficiency and quality.

Kanban

Kanban is a system that emphasizes a just in time approach to manage inventory and focuses on customer actual needs rather than on management forecasts, The kanban approach was popularized by Toyota by standardizing the flow of parts on the assembly lines. The kanban process starts with the customer order and follows the order through production. Kanban follows a process that ensures that items will only be manufactured or ordered when they are actually needed.

Value-Driven Project Management

To achieve project success, greater emphasis must be placed on factors well beyond the familiar triple constraint. Value may defined differently by the stakeholder involved in a project. Values are developed from exposure to business environments, social environments, and family environments. Types of values include political, social, economic, aesthetic, religious, and theoretical. Project value is determined not only at the completion of the project in terms of performance against plans but also in the residual value gained over many years.

In the future, project value may become the only constraint or at least the most important constraint. The definition of a project will become "a collection of sustainable values scheduled for realization. Project success will be measured on whether the sustainable value was created. One of the criteria for evaluating potential projects as part of the portfolio of projects will be the value that can be added for the customer and the supplier and how the creation of that value can be shown to fully support the company's business objectives.

Areas in Project Management Where Change Is Expected

Major breakthroughs and the introduction of truly new tools and techniques are not very common with the practice of project management but there is a relatively steady and continuous effort to improve how project work is managed. Changes and improvements can be expected to continue in following areas:

- Project selection: Ensuring the right projects have been assigned. The use of business cases and assessment of value
- Prioritization of projects: Gaining maximum business value by applying and managing resources effectively

- Management of scope changes—connections between projects
- Change management in general: Change management procedures will become more agile to meet the needs of the end users and customers.
- Capacity planning: Using technology and improving processes
- Program and/or portfolio methods and procedures: New guidelines that allow a greater degree of flexibility in decision making
- Organizational structures: Changing the existing structure to increase the effectiveness of the project management methodology. More influence and authority granted to the project manager
- Agile project management: Techniques used to accelerate the delivery of software functionality; will migrate into other industries
- Remote teams: The use of technology and techniques for managing remote and virtual teams will affect the role and the leadership styles of the project manager
- Enterprise project management software will evolve to provide transparency between internal systems such as CRM

► Activities, Questions, and Exercises

Refer to Chapter 21 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition) for supporting information. Review each of the following questions or exercises and provide the answers in the space provided.

1. The five levels of the Project Management Maturity Model are:

_____

_____

_____

_____

_____

2. How does agile project management differ from what is known as "traditional" project management?

_____

_____

_____

_____

_____

_____

3. What does the acronym DMAIC refer to?

4. What is the major difference between the CPM (critical path method) and critical chain method?

5. Why is it important to identify and document best practices? Why is continuous improvement a major factor in achieving project management maturity?

6. Why does an organization experience high levels of risk and difficulty when attempting to achieve level three of the project management maturity model?

7. What is the difference between a job description and a competency model?

8. What are the major constraints generally considered during capacity planning?

9. What are the core competencies a project manager must demonstrate to successfully execute the position?

10. What are the four values of the Agile Manifesto?

► Answers to Questions and Exercises

1. The five levels of the project management maturity model are: Establish a common language, define common processes, create a singular methodology, benchmark, and continuous improvement.
2. Traditional project management emphasizes a disciplined approach to planning in which several phases exist, many controls are in place, and progress is measured in terms of the entire project. Agile is an accelerated and iterative approach using short incremental steps that are analyzed for lessons learned.

3. It is associated with the Six Sigma approach to improving quality and reducing the number of defects.
4. CPM focuses on sequence of activities and activity duration to produce a critical path—the longest path through a project network. The Critical Chain method focuses on resource constraints and the use of project and activities buffers to relieve constraints.
5. Documenting best practices will improve overall project and organizational performance by making useful information available to multiple project teams that may reduce cost, accelerate the project completion time frame, improve quality, and reduce risk. Continuous improvement is the highest level of the Project Management Maturity Model and indicates that the organization has achieved a success-based culture through a practice of analyzing performance to generate a steadily position of superiority over competitors.
6. The changes involved in establishing a methodology may have an effect on corporate culture, there may be resistance to changes in process, and an unwillingness to accept changes in authority and the decision-making process.
7. Job descriptions emphasize deliverables and specific expectations. Competency models emphasize skills required to achieve deliverables.
8. Available resources, facilities, cash flow, existing technology.
9. Core competency requirements will vary by organization but commonly include leadership, project management technical skills—planning, scope development, schedule development, change control—interpersonal skills, and communications.
10. Communication with parties is more important than standard procedures and tools.
    - Focus on delivering a working application and focus less on providing thorough documentation.
    - Collaborate more with clients.
    - Be open to changes instead of freezing the scope of the work.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in your personal development, enhancement of your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

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CHAPTER TWENTY-TWO

PMP® and CAPM® Exam Review

The Project Management Professional Exam, commonly known as the PMP® exam, is intended to assess a project manager's competency when assigned to lead and direct a project. According to the Project Management Institute (PMI), the PMP® certification demonstrates to employers, clients, and colleagues that a project manager possesses project management knowledge, experience, and skills to bring projects to successful completion. The exam is based on the principles and knowledge areas provided in the *Guide to the Project Management Body of Knowledge,* also known as the *PMBOK® Guide* (Sixth Edition), and other sources of knowledge, including personal experience. It is important to note that the *PMBOK® Guide* is not an all-inclusive document. It provides information about the framework and general principles of project management. It provides information about five major project management processes and ten knowledge areas and describes techniques and tools that are considered to be "good" practices for managing projects. The *PMBOK® Guide* describes the role of the project manager and provides a basis for establishing a project management methodology. The *PMBOK® Guide* is an essential part of the PMP® exam study process and should be included in a comprehensive study plan or exam preparation process.

The exam is based on five major project management processes:

- Initiating
- Planning
- Executing
- Monitoring and controlling
- Closing

An additional area, or domain, of project management that had been highlighted separately in the past, referred to as professional and social responsibility is now embedded in the five major process groups. The exam candidate should become familiar with the

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PMI® Code of Ethics and Professional Conduct and include the document as part of the overall study process.

The PMP® exam is a four-hour computer-based exam with 200 multiple-choice questions intended to test a candidate's knowledge about project management and the ability of the project manager to effectively lead and direct project teams. The questions are arranged in the form of scenarios and project situations and require the candidate to apply project management knowledge and experience to determine the most appropriate answer and course of action. The questions may test a candidate's knowledge about a specific process, a sequence of steps, the likely next step to resolve a situation, or the application of a number of project-management-related mathematical formulas. A combination of formal project management training, education, and actual experience as a project manager is essential for successfully achieving the PMP® credential.

The PMP® exam is a comprehensive exam that challenges the knowledge of the candidate through situational- and scenario-based questions that are designed to simulate actual project management experiences. The exam is based in part on the current version of the *PMBOK® Guide* (generally updated every four years), but also includes questions that go well beyond the project management framework and processes described in the *PMBOK® Guide*. Knowledge of leadership techniques, organizational structure, managerial theory and practice, team motivation, conflict resolution, negotiating, problem solving, scheduling techniques including CPM, forward and backward pass, critical chain, contract types and sharing ratios, and the application of earned value analysis will be tested along with the processes explained in the *PMBOK® Guide*.

Candidates for the exam must apply to the Project Management Institute and complete a detailed and rigorous application process. For information about the exam and how to apply as a candidate visit the PMI website at www.pmi.org.

The CAPM® exam, Certified Associate in Project Management, is a credential designed for practicing project managers who have not accumulated the required hours of experience to qualify for the PMP® exam or are beginning a career in project management. The CAPM® credential indicates a specific level of experience and education in project management and generally is considered to be part of the career path development process for new and aspiring project managers.

► Eligibility for the PMP® Exam

The Project Management Institute has established very specific qualifying criteria for the PMP® exam. To qualify and to be approved to sit for the exam, the candidate should possess a four-year degree (bachelor's or the global equivalent) and have accumulated 4500 hours and at least three years of experience leading and directing projects. Thirty-five contact hours of formal and documented project management education are also required.

Candidates who do not possess a four-year degree may apply if they have a secondary diploma (high school or the global equivalent) along with at least five years of project

management experience that indicate 7,500 hours involved in leading and directing projects. Thirty-five hours of formal project management education are also required.

Educational contact hours refer to the total amount of time an applicant has spent learning in a formal instructional or educational environment. Contact hours are earned by attending project management-relevant training, either in classroom or virtual/online training programs. For the application, project management experience hours are limited to the past eight years. A complete *PMP® Credential Handbook* is available from PMI at www.pmi.org.

► Eligibility for the CAPM® Exam

The Certified Associate in Project Management (CAPM)® examination is a knowledge-based exam that refers to the content of *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* current edition. The CAPM® exam is a three-hour, 150 multiple-choice question examination. The CAPM® exam focuses on the fundamental knowledge of project management. Many of the exam questions are derived from the *PMBOK® Guide*. PMI offers a basic knowledge assessment on line which will assist in determining your level of knowledge of project management and provide you with a recommendation for further study and preparation. To maintain your CAPM, you must retake the exam every five years.

Requirements to qualify for the CAPM® exam:

- Secondary degree (high school diploma, associate's degree or the global equivalent)
- 1,500 hours of project experience

  or

- 23 hours of project management education completed by the time you sit for the exam

Applicants must complete the CAPM® Credential Application online or via a downloadable form available from the PMI website at www.pmi.org.

► General Information about the Exams

The PMP® exam has been developed for experienced project managers, project leaders, and project directors who are in decision-making and leadership positions and for those who influence project decisions. The CAPM® exam has been developed for project managers who plan to continue their careers as project managers and have not met the qualifications regarding education, experience, and credentials to apply for the PMP® exam. The CAPM® is an excellent step toward the PMP® certification. Preparation for the exam includes a comprehensive study process, a disciplined approach to study, and a specific selection of study resources, including the *PMBOK® Guide.* Time and effort for study will depend on the experience level of the candidate and the level of formal education acquired.

Although the PMP® and CAPM® exams are designed for different levels of qualification and experience, the following information will assist in the study and preparation for each exam.

▶ Working the Workbook

This section of the workbook is intended to provide a summary review of the key points of project management, the processes within the *PMBOK® Guide* (Sixth Edition), and highlight the elements of each knowledge area and process group that are likely to be included in the exam.

Study note: It is important to obtain a copy of the sixth edition of the *PMBOK® Guide* and read it thoroughly. It contains an enormous amount of information about project management and is referred to as the standard for developing a project management methodology. The key to successful PMP exam study and preparation is to take the time to fully understand how each knowledge area described in the *PMBOK® Guide* is interrelated and that all knowledge areas are integrated as the project is planned, executed, and eventually closed. The five major process groups—initiating, planning, executing, monitoring and controlling, and closing—link the 10 knowledge areas by defining the relationships of the subprocesses within each knowledge area to the higher-level overall project life cycle.

A basic study plan for the *PMBOK® Guide*

- Read every chapter of the guide. The first three chapters describe the purpose of the guide, provide a common vocabulary, and provide key definitions, including information about programs and portfolio management, business case development, and the environment in which projects operate. These chapters create a project management context and framework and introduce the five major process groups.
- As you begin the study process, read chapters 1 through 3 in one study session. These chapters are essential in developing an understanding of how the *PMBOK® Guide* is arranged and they provide information about important project management terms, including enterprise environmental factors, organizational process assets, stakeholder types, organizational structure, and project life cycle phases.
- Read each of the remaining chapters in succession, making note of the key concepts in each chapter. The recommendation is to read one chapter during each study session and to focus on understanding the information provided before progressing to the next chapter. The chapters contain a large amount of information and you can easily become overwhelmed and lose focus. Patience and a steady pace is your best strategy. Makes notes as you review each chapter and review them often. Use additional references such as the book *Project Management: A Systems Approach to Planning, Scheduling and Controlling* (12th edition), to obtain further details about the information provided in the *PMBOK® Guide.* The *PMBOK® Guide* does not provide detailed and comprehensive explanations of many important project management terms, tools, and techniques so additional sources of information will be necessary to complete the study process.

- Ensure that you review and understand the flow charts that appear in each chapter. These flow charts provide information about how knowledge areas and process groups are interrelated and illustrate the relationships and flows of the inputs, tools and techniques, and outputs of each process within a knowledge area.
- Refer to Table 1-4, Project Management Process Group and Knowledge Area Mapping, in the *PMBOK® Guide.* This table provides an overview of the five major processes and the linkages to the ten knowledge areas. It also shows the logically grouped subprocesses that support the five major process groups.
- Review very often the overview charts that are found in each knowledge area chapter and learn to recognize the inputs, tools and techniques, and outputs. Concentrate on why an input is important, how a tool or technique is applied, and how the resulting output becomes an input to another process. It is not essential to memorize the *PMBOK® Guide.* The study goal is not memorization, but understanding rationale and application of the knowledge, tools and techniques
- As you progress through the *PMBOK® Guide* you will begin to see a repetition of many processes. The processes are interrelated and the outputs of one process will frequently become the inputs to another process. This repetition emphasizes the integrative nature of project management and indicates how many processes are linked and are interdependent.
- The chapter entitled "Project Integration Management" is an overview of how the five process groups and ten knowledge areas are utilized to manage a project life cycle. Information in this chapter refers to many of the processes that are associated with each of the other knowledge areas. Project integration management describes how all of the knowledge areas are combined and coordinated to develop a project management plan and eventually achieve project success. The details of the processes described in the integration management chapter are provided in each of the knowledge area chapters.
- When you have read and studied all chapters, review the glossary and then reread the chapter "Project Integration Management." A review of this chapter will help to further reinforce the knowledge obtained from reading the other chapters.
- Test yourself frequently with practice questions and try to relate the processes explained in the *PMBOK® Guide* with actual projects you have been or are currently assigned to. Not every process will be applicable to your projects but it will help with your study if you can relate the processes to your project assignments whenever possible.

► Preparing for the PMP® Exam

The PMP® exam requires a considerable amount of study and practice, especially for those who have not studied or taken an exam for some time. It is important to note that the CAPM exam addresses much of the same information found in the PMP exam. The major difference is that the CAPM focuses more on terminology,

definitions, and activities that would be defined as support for a project manager. The PMP® exam focuses much more on decision making, analyzing situations, and making decisions.

The following steps are suggested to fully prepare for the exam:

- Obtain the PMP® exam certification handbook from www.pmi.org.
- Review the qualifications and verify that you are eligible to apply for the exam.
- Obtain a copy of the current *PMBOK® Guide* (there is usually an overlap period when a new edition of the *PMBOK® Guide* is released and the exam is updated to reflect any changes. Check with PMI to determine which edition is appropriate for study.
- Read each chapter of the *PMBOK® Guide.* Take notes to further increase retention but do not try to memorize each section. Learn to apply the knowledge through practical application.
- When you find a term or subject that you are not familiar with, research the topic to ensure you have a full understanding. Use other sources of information, including text books and online sources, to enhance the learning process.
- Read the *PMBOK® Guide* knowledge areas one chapter at a time. There is a lot of information to absorb. It is best to create a personal study plan and establish a suitable pace for study. Take the time to learn about project management while you are studying.
- Obtain additional books for study. Recommendation: *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (12th edition), by Harold Kerzner, Ph.D. (John Wiley & Sons, 2017).
- Plan to study at least one hour each day and plan for a minimum of 40 to 60 hours of study.
- Plan to attend a formal class in project management. You need 35 hours of formal project management training and education to satisfy eligibility requirements.
- Take note of all formulas that are associated with project planning: economic models such as present value, net present value, benefit-to-cost ratio, PERT weighted average formula, earned value management, standard deviation, communications channels, CPM-forward and backward pass, expected monetary value, contract sharing ratios. Most of the formulas are either not available or not explained in detail in the *PMBOK® Guide.* Use other resources to obtain this information.
- Obtain additional practice exams and questions and keep track of your test results.
- If possible and convenient, start a study group. Get plenty of rest the night before the exam.
- Plan to take the exam as close as possible to the completion of your studying so as to minimize the loss of learning.
- Last-minute cramming is not recommended!

► Improving Your Project Management Competency

This workbook has introduced you to several project management processes, tools, and techniques. To further your knowledge and enhance your competency, consider the following recommendations:

1. During the time you are actively managing a project, select a process, a tool or technique, or a specific concept from the workbook or a PMBOK® knowledge area and ask yourself, "How can I apply this concept, process, or technique to my current environment?" Example: Creating a WBS for a new project. Ask yourself, "Why is the WBS important? How would you obtain buy-in from team members to create and use a WBS? How would you start the process of developing the WBS? What preparatory work would you be required to perform? How will this process add value to your project?" Asking and answering these questions will also assist in the study process for the certification exam.
2. If you cannot apply the concept, ask yourself why. What is preventing the use of the concept? Where is there resistance? Why is there resistance? Why is the concept not applicable to your environment? It is important to note that the *PMBOK® Guide* provides a number of "good practices" that are used in most projects. It doesn't not imply that every process is used for every project.
3. If you feel that a process should be used in your organization, ask, "What changes must be introduced within the organization to gain acceptance of the process or technique? How will the process add business value? What benefits will be gained?" These questions will assist you in developing a more complete understanding of the processes, tools and techniques described in the material and will prepare you more completely for the PMP® exam. This approach will also improve your competency and capability to manage your projects more effectively.

► Project Management Knowledge Review: Key Topics, Learning Points, and Exam Tips

Project management, when applied correctly and consistently, will contribute to overall business value and improved customer and employee satisfaction.

Why an organization needs project management

- To ensure the "right projects" are selected and then managed effectively
- To clearly identify and assign project roles and responsibilities
- To identify and establish organization and project priorities
- To manage deadlines and schedules more effectively
- To determine and assign accountability and authority
- To ensure proper documentation: determining what project documentation is needed and avoiding overdocumentation

- To provide a common methodology that is applied enterprise-wide for the purpose of improving efficiencies in resource management, estimating, and project performance control
- To provide effective and timely status reports and communications
- To effectively control changes to the project plan and to the objectives of the project
- To manage multiple projects more effectively
- To reduce rework and eliminate redundant work
- To establish consistency in the planning and executing of project work
- To manage risk effectively
- To balance the competing demands of scope, quality, schedule, budget, resources, risk, and other competing demands
- To capture and share lessons learned for continuous improvement
- To develop best practices from lessons learned and focus on continuous improvement
- To ensure the desired business results and targeted value of the project is achieved

Key Learning Points of Chapters 1, 2, and 3

The first three chapters of the *PMBOK® Guide* address the following major topics:

- Foundational elements of project management
- Common project terms and definitions
- Business value creation
- The importance of project management
- Organizational strategy
- Operations and project management
- Project life cycles
- Project management processes
- Business cases
- Project benefits management
- The environment in which projects operate
- Organizational structures
- The role of the project manager

Glossary

Business value The entire value of the business, the sum of all tangible and intangible elements, including assets, stock equity, customer satisfaction, employee morale, brand recognition, market, and competitive position.

Deliverable A tangible, verifiable work output. Projects generally have one major deliverable that is actually the sum of or combination of many deliverables. During project planning, deliverables are generally defined in each project phase and reviewed for acceptance prior to the start of the next phase. These are referred to as "interim deliverables."

Enterprise environmental factors Internal and external factors that influence project planning, including organizational culture, structure, and governance. industry standards, infrastructure, human resource capabilities and skills, risk tolerance, and politics.

Interpersonal skills The successful project manager is expected to effectively manage project teams through interpersonal skills, including relationship building, communication, influencing skills, leadership, motivation, negotiating skills, conflict management, and problem solving. The PMI® Talent Triangle includes a reference to interpersonal skills in the leadership component of the triangle.

Key management skills The key skills associated with general management and project management include leadership, communications, organizing, team building, conflict resolution, planning, and administration.

Leadership and management It is important to differentiate leadership from management.

Leadership: Relational Power	Management: Positional Power
Develop	Maintain
Innovate	Administrate
Trust	Control
The horizon	The bottom line
Does the right thing	Does things right

Organizational process assets Processes, policies, and procedures for conducting work. Examples: standardized guidelines, templates, project closure guidelines, change control procedures, health and safety policies, and security procedures.

Organizational structures There are several types of organizational structure: The most common structures are functional, matrix, and projectized. The matrix structure can be further defined as one of three possible subtypes: weak matrix, where the project manager has little to no authority; balanced matrix, where the project manager and function manager have equal levels of authority; and strong matrix, where the project manager has a greater level of authority than the functional manager. Consider the advantages and disadvantages of each type of structure. Example: The project manager authority in each type of organizational structure is different and may have an impact on how the project manager influences the project. In the functional structure the project manager has very little authority and acts as a coordinator or expeditor. In the strong matrix, the project manager has greater influence and has the authority to make financial decisions, direct resources, and delegate work assignments to functional managers. Refer to Table 2-1, Influences of Organizational Structure, in the *PMBOK® Guide* (Sixth Edition) for additional information and other types of structures.

Phases and project life cycles Projects are divided into phases for control purposes and to make the project more manageable. Phases also allow project managers to manage progress incrementally, make decisions regarding project continuation (go–no-go decisions), and provide an opportunity to review project team and contractor performance. Phases also provide an opportunity to identify and assess project risks more effectively. There are three basic phase-to-phase relationships:

- Sequential: A series of phase
- Overlapping: A technique to accelerate a schedule known as fast tracking
- Iterative: Repeating and allowing for changes and adjustments

Plan–do–check–act cycle The Shewhart chart, known as the PDCA cycle, which was adopted by Deming as a clearly defined process for continuous improvement, is an underlying concept of project management and provided a basis for the development of the five major project management process groups: initiating, planning, executing, monitoring and controlling, and closing, described within the *PMBOK® Guide.*

Portfolio management A collection of projects and programs and other work that are grouped together to facilitate effective management of that work to meet strategic objectives.

Program Generally considered to comprise several projects that are related in some way and are managed in a coordinated way to obtain benefits that would not be possible if they were managed separately. Programs do not have a definitive end date and tend to be ongoing for longer, sometimes undetermined, time frames.

Progressive elaboration The process of proceeding in incremental steps, increasing in detail as the project moves forward through phases.

Project A temporary endeavor that is unique, constrained by resources, planned, executed, and controlled. A project produces one or more deliverables. Project work is similar to operations work in many ways but the major difference is that a project work associated with a project is temporary (has a specific start and end) and operations work is considered ongoing and repetitive.

Relationships among projects, programs, and portfolios

Portfolios are a collection of projects, programs, and operations. Programs comprise a group of related projects. Projects have defined start and end dates. Projects and programs focus on correct implementation (executing the "right way"). Portfolio management focuses on doing the "right projects" and is associated with strategic planning and higher-level organizational management.

Project environment It is important to be aware of organizational structure, internal politics, how project management is positioned within an organization, functional differences and priorities, cultural differences, the international economic and political environment, and the physical environment that a project team may be working with.

Project initiation context Projects are initiated in response to factors that affect the organization: regulatory, legal, and social requirements, stakeholder needs, business change and technology advances, and creating and improving products.

Project management The application of knowledge, skills, and tools to meet stated requirements. This includes setting objectives, balancing competing demands of time, cost, scope, quality, risk, resources, and other constraints or demands.

Project Management Institute Code of Ethics and Professional Conduct The obligation of trust, fairness, honesty, and respect and a commitment to ethics, compliance with laws, and observance of cultural diversity. PMI members have determined that **honesty, responsibility, respect, and fairness** are the values that drive ethical conduct for the project management profession.

Project management office An organizational body or entity established by an organization and assigned various responsibilities related to the centralized and coordinated management of projects. Three are three major types of PMOs: supportive, controlling, and directive. Refer to the *PMBOK® Guide* (Sixth Edition), section 2.4.4.3, for detailed descriptions of each type.

Project management process groups The five major process groups: initiating, planning, executing, monitoring and controlling, and closing. It is important to note that these are not phases. These processes are present in each phase of the project life cycle and assist in providing a consistent approach to achieving objectives.

Project-based organizations This type of organization conducts the majority of its business and work as projects and utilizes and enterprise-wide project management methodology.

Rolling wave planning A form of progressive elaboration where near-term work is planned in detail at a low level of the WBS and work scheduled for the future is planned at a high level. As work is completed in one phase or period, the work of the next phase or near term is planned in more detail.

Stakeholders People or organizations directly involved in or in some way impacted either positively or negatively as a result of the project. Stakeholders can be considered positive (support the project) or negative (impede the project). Project managers should consider the risks and potential impact of the negative stakeholder (whether internal or external to the organization). Key stakeholders include project manager, sponsor, customer, project team, the PMO (project management office), the performing organization, operations management, suppliers and business partners, the end user, and contractors.

Relationship of the 10 knowledge areas

Three key words describe how the knowledge areas are view and managed: All knowledge areas are integrated, interrelated, and interdependent. All ten knowledge areas are part of an integrated system of project management. Consider project management to be a system of components. Each component has a specific function and significantly influences and interacts with the other parts of the system.

Relationships to other knowledge areas

Project management has many similarities to general management. General management skills include financial management and accounting, purchasing and procurement, contracts and commercial law, strategic planning, tactical planning, operational planning, organizational structures, safety practices, and information technology management. Project management requires knowledge of these areas to ensure effective integration with operations during project planning and execution. Project management may also include specific functions found in defined industries. This is referred to as application area knowledge. Examples include software development, construction, aerospace, IT, and automobile design where there may be a requirement to possess knowledge of the technology and terminology associated with the specific discipline to successfully manage the project.

Ten Knowledge Areas of the *PMBOK® Guide* Project integration management, project scope management, project schedule management. project cost management, project quality management, project resources management, project communications management, project risk management, project procurement management, and project stakeholder management. All ten knowledge areas are integrated and have an interrelationship. The knowledge areas are part of a total project management system. The inputs for one process are, in many cases, the results of outputs from a process associated with another knowledge area. An effective study practice is to review the overview charts found in each chapter of the *PMBOK® Guide* to gain an understanding of the process relationships referred to as inputs, tools and techniques, and outputs. Focus on the logical flow: Inputs are necessary items that must be considered. Tools and techniques are used to process the inputs. Outputs are the results of the use of tools and techniques. Outputs generally become inputs to other processes and may be included in several subprocesses in each of the knowledge areas.

Study note

An important item to remember, in additional to the glossary terms provided in this workbook: Projects have greater risk and a lower probability of success at project start-up. In the early stages of the project, the scope is not fully defined and elaborated, and the details required to develop an effective plan have not been completely identified and documented. Uncertainty is extremely high as the project is initiated, and there is generally a perception of high risk. As the project is progressively elaborated, the risk associated with the project is reduced as more information becomes available. Risk strategies and responses are planned, resulting in more reliable estimates, more complete plans, and higher probability of success.

Project risk will not be eliminated during the project progression through the project life cycle, but the ability to manage risk more effectively is improved as more project information is gathered and risk management techniques are utilized.

Responsibilities and Competencies of the Project Manager

The project manager generally assumes many roles and responsibilities during a project assignment. Typical roles include:

- Managing teams and team members
- Defining and assigning project work responsibilities
- Proving leadership

The project manager is also expected to possess a high level of competency as a team leader

- Project management knowledge: The project manager should possess significant knowledge of project management. This relates to performance and what the project manager can accomplish by applying project management knowledge.
- Personal: Displaying the appropriate behavior, developing and enhancing core interpersonal skills, understanding the effect of personality characteristics and attitude, and demonstrating the ability to manage and lead a team.

Remember

Each knowledge area in the *PMBOK® Guide* consists of several subprocesses that support the five major process groups. These processes are managed through:

- Inputs (items that that are necessary or should be considered for planning)
- Tools and techniques (the actions and steps taken to process the inputs)
- Outputs (the results of the processing of the inputs)

There is a basic process flow in which inputs are identified, then processed using tools and techniques to produce the outputs, which are, in most cases the results or deliverables of the entire process. Each knowledge area is part of the total project management system and all knowledge areas are integrated within the system.

Project integration management includes the processes, actions, and activities that will bring together all project-related work. Integration management unifies, combines, and coordinates the specific activities of the project management knowledge areas.

The main process groups within project integration management are develop project charter, develop project management plan, direct and

(*Continued*)

manage project work, manage project knowledge, monitor and control project work, perform integrated change control, and close project or phase.

Study Tip: Review the overview chart provided in each knowledge area chapter of the *PMBOK® Guide* and follow through from the inputs of each process group to the tools and techniques and then to the outputs. In many of the processes, you will see that the output of one process may become an input to several other processes. You will also notice that many inputs and tools and techniques are used in the subprocess groups of several knowledge areas. Take time to review why an input is important and how it will be used. Think about the actual actions taking place when applying the tools and techniques and what outputs are produced. The flow of inputs, tools and techniques, and outputs actually provides a logical basis for planning and managing a project. The exam may include questions that relate specifically to the flow of inputs to tools and techniques, and outputs. Example: You have just completed the project charter. What specific and techniques are generally used to develop the charter? Answer: Expert judgment, data gathering, interpersonal and team skills.

■ Project Integration Management Terms

Agile, iterative, and adaptive environments The emergence of agile approaches to managing projects and the popularity of iterative processes and methods requires project managers to become familiar with these techniques and terms. The agile and iterative environments focus on collaborative decision making and greater flexibility in responding to change.

Integrated change control Integrated change control involves monitoring project performance results, managing change requests, and reviewing and approval of configuration changes. An integrated change control process is used to minimize scope changes and reduce or eliminate scope creep. Approved changes require the project manager to update plans (documentation updates), schedule and implementation of the change, validation that the change has been successfully implemented, and recording of lessons learned. The ten knowledge areas are managed in an integrated manner with an understanding that a change in one area can impact any or all of the elements of each knowledge area. It is important to consider and assess the impact of a change before implementing the change. This is referred to as "impact analysis" and is a component of the change management process. A schedule slip or a cost overrun are also considered to be a change and will require attention and action by the project manager and team. When a change is approved, it is important to schedule the change to be implemented at the appropriate time to ensure minimal impact on ongoing operations, the current flow of project work, or other projects.

Project Benefits Management Plan This plan includes the strategic alignment of the project with the business objectives of the organization and the target benefits of the project. It also includes information about when benefits will be delivered and the metrics to measure the benefits.

Project charter A document that formally recognizes the project and authorizes the project manager to apply organizational resources. The charter establishes an initial high-level set of requirements and identifies key project stakeholders. During the development of the project charter it is important to refer to the business case and the rationale driving the project, the product to be produced, and relationship of the project to the strategic objectives of the organization. If a formal contract or statement of work is involved in project initiation, it is important to review the terms and conditions agreed upon as the project charter is created. The charter generally establishes the authority level of the project manager and provides clearly documented visible support from senior level management.

Project Management Information System (PMIS) A system of systems and includes all of the systems used to obtain project data, analyze data, and distribute information to the project stakeholders. The project management information system is any system or group of systems working together to gather, store, and distribute information about your project. Examples: time reporting system, time management system, enterprise resource planning (ERP), accounting system, and project software.

Project management plan The guide used by the project manager and team; includes the actions required to integrate the many subsidiary plans such as cost management, change control, quality management, and scope management into the total or integrated project plan. The project management plan is expected to change as the project progresses and new details emerge. Typical outputs of many *PMBOK® Guide* processes are document updates, and project plan updates.

General Study Tip

Always consider the enterprise environmental factors and organizational process assets that may affect the project planning process. Enterprise environmental factors are inputs to many project management processes.

Project selection methods Prior to the development of the project charter, an organization will engage in a project selection process to consider and determine which projects would be most beneficial for the organization. Business cases and benefit measurement methods are used to select the projects that will be selected for implementation. A benefit cost analysis may be conducted to determine if the project is value adding. This analysis answers the question "Should we do it?"

A feasibility study will determine if the organization has the capability to perform the project work and answers the question "Should we do it?"

Many organizations consider a combination of tangible benefits such as profit and cost savings, and the intangible benefits such as good will, morale, reputation, and customer sat-

isfaction when selecting projects. Selection methods may include calculation of NPV (net present value, or time value of money). An important formula to remember is the present value formula: Present value PV = $FV/(1 + r)^n$, where PV is present value, FV is future value, r = rate, n is an exponent referring to the number of years. This formula discounts future cash flows back to current or present value in terms of dollars (or currency). Other forms of project selection methods include internal rate of return (IRR), an iterative process that will determine the rate or cost of capital at which the project NPV would equal zero; breakeven analysis, payback period, return on investment (ROI), and benefit to cost ratio.

Project statement of work Narrative description of products and services to be produced as a result of the project. The statement of work often precedes the approval of a contract and the authorization to proceed with the formal processes of procuring goods and services. The SOW usually provides information about business need, product description, and the work required to satisfy a need. It is not a plan, but it is a key input to the planning process.

Subsidiary plans Plans that support the project management plan. Examples are the scope management plan, requirements management plan, quality management plan, and process improvement plan.

■ Additional Terms and Definitions

Change Control Board A team or group designated or empowered to review and determine the value of a change and to approve or deny change requests. Commonly referred to as a CCB.

Configuration management A process that ensures that configuration changes (changes to features, functions, physical dimensions) are managed appropriately and follow an approval process to prevent or reduce the risks of additional cost, scope changes, or other impacts to the project. Configuration management is a subset of integrated change control.

Constraints and assumptions Identifies the limitations within which the project manager must operate. Examples of constraints include limited budget, predetermined milestones, and resource availability. Constraints may also be described in terms such as "must start no later than," "must finish no later than," "must start no earlier than," "must finish no earlier than." It is important to identify assumptions that have been made by key stakeholders. Assumptions in this context are defined as items that can be believed to be true, real, or certain for planning purposes. All assumptions should be validated to avoid serious risk situations.

Historical records These records provide an opportunity to learn from past projects. Use lessons learned and experience to reduce project related problems and recurring project issues.

Organizational policies Consider the policies and procedures defined by your organization and how they can impact the planning of your projects. Example: Hiring process, budget policies, selection process, and the like. These are referred to as organizational process assets.

Organizational strategies Consider the goals and objectives of the organization and how the project may impact business value and supports those goals. Projects are business investments and it is important to make sure the project can be linked to strategic and operational objectives.

Project plan The approved document that provides the baseline for executing and managing the project.

Work authorization system The process that ensures the right work is done at the right time in the right sequence.

■ Additional Study Items

Trends and Emerging Practices in Project Integration Management

The *PMBOK® Guide* Sixth Edition includes references to internal and external factors that may affect how a project is managed. These factors include use of automated tools, updating project management knowledge, expanding project boundaries, hybrid methodologies.

Closing the Project or Phase

Project plans should include a process for closing out the project or a phase of a project. There are two major procedures for project closure: administrative closure (project reviews, verifying project financials, analyzing project success or failure, lessons learned), and contract closure (the actions required to close contractual agreements and ensure that terms and conditions have been met). The closing process should include a plan that will satisfy project completion requirements and define exit criteria.

Directing and Managing Project Work

Performing the work described in the project management plan such as creating deliverables, obtaining project staff, generating project data and reports, and procuring resources. The outputs of the direct and manage project work include project deliverables, work performance data, issue log, change requests, project management plan updates, project document updates, and organizational process asset updates. Direct and manage project work also includes taking corrective action, preventive action, and defect repair.

Managing Project Knowledge

This involves using existing project knowledge and creating new knowledge to achieve project objectives. Knowledge may include explicit informant such as words, pictures, and numbers, or tacit information such as insights, experience, and "know-how."

Monitoring and Controlling Project Work

This includes tracking, reviewing, and managing project progress, comparing actual performance to planned performance, identifying variance, reporting project status, and managing change.

Outputs from Other Processes

This refers to the many outputs of the total planning processes included in the *PMBOK® Guide*. Outputs from the planning processes of each knowledge area are generally included in project integration management.

Directing and Manage Project Work

Performing the work described in the project management plan such as creating deliverables, obtaining project staff, generating project data and reports, and procuring resources. The outputs of the direct and manage project work include project deliverables, work performance data, issue log, change requests, project management plan updates, project document updates, and organizational process asset updates. Direct and manage project work also includes taking corrective action, preventive action, and defect repair.

Monitoring and Control Project Work

This includes tracking, reviewing, and managing project progress, comparing actual performance to planned performance, identifying variance, reporting project status, and managing change.

Performing Integrated Change Control

Integrated change control involves monitoring project performance results, managing change requests, and reviewing and approval of configuration changes. An integrated change control process is used to minimize scope changes and reduce or eliminate scope creep. Approved changes require the project manager to update plans (documentation updates), schedule and implementation of the change, validation that the change has been successfully implemented, and recording of lessons learned. The 10 knowledge areas are managed in an integrated manner with an understanding that a change in one area can impact any or all of the elements of each knowledge area. It is important to consider and assess the impact of a change before implementing the change. This is referred to as "impact analysis" and is a component of the change management process. A schedule slip or a cost overrun are also considered to be a change and will require attention and action by the project manager and team. When a change is approved, it is important to schedule the change to be implemented at the appropriate time to ensure minimal impact to on ongoing operations, the current flow of project work, or other projects.

Closing the Project or Phase

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(project reviews, verifying project financials, analyzing project success or failure, lessons learned), and contract closure (the actions required to close contractual agreements and ensure that terms and conditions have been met). The closing process should include a plan that will satisfy project completion requirements and define exit criteria.

▶ Project Scope Management Processes

Remember

Ensure that the project includes all work and only the work required to complete the objectives of the project.

The project manager and project team will become involved in the scope planning process to define and control what is and what is not included in the project work. This involves creating a project scope management plan that describes and documents how the project scope will be defined, verified, and controlled. The scope management plan is a subsidiary plan to the project management plan. There are two types of scope. *Product scope* includes the features, functions, and physical characteristics of the product service, or result of the project. *Project scope* is work that must be completed to produce the product, service, or result.

Project scope management includes the following major processes:

Plan scope management: Creating a scope management plan that will guide the team in determining how the scope will be defined, validated, and controlled. The major outputs are the scope management plan and the requirements management plan. Key terms are:

- Project charter
- Enterprise environmental factors
- Organizational process assets
- Expert judgment, data analysis

Collect requirements: Defining and documenting the needs of the stakeholders. Collect requirements provides the basis for defining the product and project scope. Remember that stakeholders can be affected negatively or positively by the results of the project. Key terms in the collect requirements process are:

- Assumption log
- Lessons learned register
- Stakeholder register
- Interviews
- Focus groups

- Facilitated workshops
- Questionnaires
- Group creativity techniques (brainstorming, nominal group technique, affinity diagrams)
- Group decision-making techniques (unanimity, majority, plurality, autocratic)
- Multi-criteria decision analysis
- Observations
- Surveys
- Prototypes
- Benchmarking
- Mind mapping
- Joint application design
- Quality function deployment
- User stories
- Context diagrams
- Prototypes
- Requirements traceability matrix

Review the different types of requirements—functional, quality, safety, nonfunctional etc.—in the *PMBOK® Guide* (Sixth Edition), section 5.2.3.1.

Define scope: Developing a detailed description of the project scope and the product or products to be delivered. Proper scope definition will enable the project team to develop effective plans to achieve the desired results. The major output is the project scope statement.

Key terms

- Expert judgment
- Product analysis
- Alternatives analysis
- Facilitated workshops
- Multi-criteria decision analysis

Other terms associated with scope definition:

- Stakeholder analysis
- Project scope statement
- Project deliverables
- Product acceptance criteria

Scope statement (includes product scope description, project deliverables, acceptance criteria, project exclusions) Project objectives should be "SMART": specific, measurable, attainable, realistic, and time-based.

Create WBS: The project team jointly develops the work breakdown structure using the process of decomposition. The WBS is a hierarchal grouping of project components, tasks, and activities. The WBS is defined to a level of detail that will enable the project team to plan and manage the project effectively. The lowest-level deliverable of a branch of the WBS is the work package, which includes the activities that must be completed to produce higher-level deliverables.

Key terms

- Decomposition (the process of breaking the WBS into smaller parts)
- WBS templates (may be created from previous projects and can accelerate the planning process)
- WBS dictionary (provides detailed information about elements of the WBS)
- Scope baseline (the defined project work that must be completed)

Major outputs

- Scope baseline (includes scope statement, WBS, work packages, planning packages, and WBS dictionary)

Other breakdown structures

- OBS (organizational breakdown structure)
- BOM (bill of materials)
- RBS (risk breakdown structure)

Validate scope: The process of determining the correctness of the work completed through inspections and reviews of project work results. This means making sure that what was expected to be produced was actually produced. Validate scope leads to formal *acceptance*. This is an important item to remember: connect scope verification with the term "formal acceptance" of the project deliverables.

Key terms

- Inspection
- Decision making
- Work performance information
- Acceptance
- Change requests

Control scope: Monitoring the project to ensure changes are managed through an approval process. Use of change requests and a configuration control process. Approved changes require updates to the plan and documentation of lessons learned.

Key terms

- Change control system
- Data analysis
- Variance analysis
- Trend analysis

Major outputs

- Work performance information
- Change requests
- Project management plan updates
- Project document updates

▶ Project Schedule Management Processes

Remember

The processes required to ensure timely completion of the project. Project schedule management involves several planning and controlling activities and includes the further development of the WBS into lower levels of detail referred to as work packages. The work packages comprise activities that will be performed by the assigned resources to complete the deliverable associated with the work package. The activities in the work packages are arranged in a logical sequence of predecessor and successor relationships, using the precedence diagramming method. The duration of each activity is estimated by the assigned functional managers. This combination of planning outputs will produce a project schedule. In addition, schedule management is associated with effective use of resources, managing personal time, delegation of work, anticipating and planning for risks, and balancing the needs of the stakeholders. A schedule baseline is established and as the project life cycle progresses, the project manager and team will monitor project performance, control changes, and manage schedule variances.

Plan schedule management: Establish policies and procedures to effectively develop, execute, manage, and control the project schedule. Inputs include project charter, project management plan, enterprise environmental factors, organizational process assets.

Key terms

- Project schedule model
- Level of accuracy (range of the estimate, unit of measure [hours, days])

- Control thresholds (agreed amount of variation allowed, rules of performance)
- Schedule performance measures such as earned value management

Define activities: The project manager works with the project team to identify the specific activities that must be performed to produce project deliverables. This process will further define the WBS and create work packages. This process, known as decomposition, is an extension of the development of the WBS. Work packages include activities that must be completed to produce the lower level deliverables that will ultimately be aggregated to produce the total project deliverable. Inputs include schedule management plan, scope baseline, enterprise environmental factors, organizational process assets.

Key terms

- Rolling wave planning
- Decomposition
- Activity attributes
- Milestone list
- Schedule baseline

Tools and techniques

- Expert judgment
- Decomposition (breaks the WBS down further into work packages and activities)
- Rolling wave planning (work to be performed in the near term is planned in detail, later work is planned at a higher level)

Sequence activities: This process is intended to define and document the logical relationships among project activities. There are four types of dependencies considered when developing a project schedule: mandatory dependency (hard logic; a physiological dependency), discretionary dependency (soft logic; use of best practices), external dependency (factors outside the project and outside of the control of the project manager that may affect the project), internal dependencies (items that can be controlled by the project team).

The sequence activities process produces a network diagram that displays the predecessor/successor relationships or logical relationships between activities and displays the flow of the work from start to finish.

Precedence diagramming method (PDM): Also known as activity on the node, the PDM is the prevalent form of network diagramming when sequencing activities.

Types of dependencies: Mandatory, discretionary, and external

leads (acceleration of time between activities to reduce path duration)

Lags: Required delays between the finish of an activity and the start of a succeeding activity

Relationships used in the PDM process: Finish to start, start to start, finish to finish, and start to finish

Major outputs

- Project schedule network diagrams
- Project document updates (activity attributes, activity lists, assumption log, milestone list)

Estimate activity duration: The processes required to estimate the number of work periods needed to complete project activities with the estimated resources.

Remember to determine the type of resource required, the availability of the resources needed for the project, the number of resources needed, and assess resource capabilities. The capability or skill level and the available time to perform project activities will affect the duration estimate of each activity. Consider historical information and lessons learned when estimating duration. Duration estimating also includes risk management and determining the appropriate reserve time or contingency, and the extended time required when resources are not assigned to the project full time. Ramp up time, when using part time project team members and performers, is a factor when estimating duration. Additional factors to consider: law of diminishing returns, number of resources, advances in technology, and motivation of the team.

Key terms

- Activity attributes
- Resource calendars
- Resource breakdown structure
- Resource requirements
- Analogous, parametric, and bottom-up estimating
- PERT weighted average estimate
- Beta distribution
- Triangular distribution

Tools and techniques

- Expert judgment
- Analogous estimating (comparing a project to a similar project)
- Parametric estimates (using mathematical algorithms) three-point estimating (triangular distribution)
- Beta distribution (using optimistic, pessimistic, and 4 times the most likely values)
- Formula: (O + 4M + P) / 6
- Bottom-up estimating
- Data analysis (alternatives analysis, reserve analysis)
- Decision-making techniques (brainstorming, nominal group technique, delphi technique)
- Risk management (awareness of known unknowns and the “unknown unknowns”)
- Meetings

Major outputs

- Duration estimates
- Basis of estimates (the supporting detail for estimates submitted)

Develop schedule: The process of analyzing activity sequences, activity duration, project constraints, and developing a schedule that can be managed effectively. The schedule is submitted for review and approval by the key stakeholders. Schedule development considers availability of resources, capability and skills of the resources, number of resources available, the resource calendar (including international calendar issues), vacation time, sick time, external issues (weather), and lead or lag requirements, and the logical relationships of the activities.

Key terms

- Network schedule analysis
- CPM (critical path method; uses four types of logical relationships—finish to start, start to start, finish to finish, start to finish)
- Schedule compression (fast tracking and crashing)
- PDM
- Network diagram
- Resource leveling
- Resource smoothing leads
- Lags
- What-if scenarios
- Simulation
- PMIS
- Agile release planning
- Schedule baseline
- Bar charts
- Milestone charts
- Schedule data (schedule milestones, activity attributes, assumptions, constraints)

Tools and techniques

- Network analysis
- Critical path method
- Critical chain method
- Resource optimization techniques
- Modeling techniques
- Leads and lags
- Scheduling tools

- Schedule compression (includes fast tracking or overlapping tasks or project phases. This technique generally introduces additional project risk. It is important to assess the risks before fast tracking and determine if the risks are deemed acceptable). Crashing is another form of schedule compression that may shorten the project duration by adding resources or using overtime to reduce the duration of activities on the critical path. This technique adds cost and may not fully achieve the desired results.)

Major inputs

- Activity list
- Assumption log
- Basis of estimates
- Duration estimates
- Milestone list
- Lessons learned
- Schedule network diagrams
- Project team assignments
- Resource calendars
- Resource requirements
- Risk register

Major outputs

- Schedule baseline
- Project schedule
- Schedule data
- Project calendars
- Project management plan
- Project document updates

Control schedule: This process includes determining the status of the project schedule by assessing variance, influencing the factors that cause schedule changes, determining if a schedule change has occurred by comparing actual performance to planned performance, and effectively and efficiently managing approved changes. This involves the review of project reports, performance data, change requests, and the use of a schedule change control system. Control includes the analysis of variances, reconsidering schedule reserves, reprioritizing remaining work, taking corrective action, and documenting lessons learned.

Key terms

- Variance analysis
- Earned value management

- Resource leveling
- Progress reporting
- Schedule change control system
- Schedule compression.

Tools and techniques

- Data analysis (earned value analysis, iteration burndown chart (agile methods)
- Performance reviews (variance analysis, trend analysis, what-if analysis)
- CPM
- Critical chain method
- Resource optimization methods
- Modeling techniques
- Adjusting leads and lags
- Schedule compression

Major inputs

- Project management plan
- Project schedule
- Work performance data

Major outputs

- Work performance information
- Schedule forecasts
- Project management plan updates

Time Management Terms

Backward pass Determines late start and finish dates. Begins at the end milestone and proceeds back through the network. At points of convergence the lower value will determine the late start.

CPM Critical Path Method. Determines the early start and early finish and late start and late finish of each project activity.

Crashing Reducing critical path duration by adding resources or using overtime to compress the activity duration.

Fast-tracking Overlapping activities. Beginning an activity before its successor is complete.

Float ownership The float is "owned" by the entire path, not the individual activity. Path float is not determined by summing up the float of each activity on the path. Path float is determined by how usage of float on one activity impacts the other activities on the path.

Forward pass Determines early start and finish dates. Moves from the project start through the network to the project finish. At points of convergence the greatest value is used to determine the start of the convergent activity. (The point of convergence is also referred to as a "sink point.")

Free float The amount of time a task may slip without affecting succeeding activities.

Path convergence Multiple activities that precede an activity. In the forward pass process the early start of the succeeding is activity is determined by the activity with the greatest early finish value.

PDM Precedence diagram method. There are four logical relationships: FS (finish to start, the most common type of relationship), FF (finish to finish), SS (start to start), SF (start to finish).

PERT weighted average formula Optimistic + 4 times Most Likely + Pessimistic)/6

Slack Also known as *float*. A measure of flexibility of the activities in a network path. There is generally no float or slack on the critical path.

Standard deviation formula **($b - a$)/6** (Pessimistic – Optimistic divided by 6)

Total float The amount of time an activity may slip without affecting the project end date.

► Project Cost Management Processes

Project cost management includes the processes that are used to estimate project costs, establish the project budget, allocate costs across each phase of the project life cycle, monitor project expenses, and control project costs through analysis of variances from the approved project cost baseline.

Typical project costs include direct costs (human resources; labor and salaries), materials and equipment, capital costs, rent, leases, travel expenses, and indirect costs (overhead expenses, recurring costs [electricity, water], training, and insurance).

The four major processes associated with project cost management are plan cost management, estimate costs, determine budget, and control costs.

Key terms

- Cost management primarily addresses the costs of the resources associated with completing project activities. It also includes the decisions and factors regarding recurring costs and other activities that impact the delivery of the product or service.

Plan Cost Management: This is the process of establishing policies and procedures for developing the project budget, managing the budget, and controlling costs.

Tools and techniques

- Expert judgment
- Data Analysis
- Alternative analysis

- Make-or-buy decisions
- Renting and leasing
- Meetings

Major inputs

- Project charter
- Project management plan
- Subsidiary plans for schedule and risk management
- Enterprise environmental factors
- Organizational process assets

Major outputs

- The cost management plan, which would normally establish units of measure, level of precision, level of accuracy, control thresholds, and guideline or rules for performance measurement.

Estimate costs: The process of developing an approximation of the monetary resources required to complete project activities. Estimating project costs may involve the use of analogous, parametric, and bottom-up estimating techniques, three-point estimates, and risk analysis.

Key terms

- Analogous estimating (use of similar projects to develop a top-down estimate)
- Parametric estimating (use of mathematical algorithms such as cost per square foot multiplied by the number of square feet)
- Bottom-up estimating (use of the WBS to aggregate costs from the work package level to the project level)
- Three-point estimating (using optimistic, most likely and pessimistic values and triangular or beta distribution)
- Cost of quality (costs associated with conformance to quality requirements such as training and inspections)
- Reserve analysis (analyzing the planned reserves)
- Level of precision (rounding data to a prescribed precision level)
- Units of measure (hours, weeks, lump sum, control thresholds, allowable variance from a plan)
- Rules of performance measurement (for example, the use of earned value analysis or determining the control points to be used on the WBS)
- Vendor bid analysis (review of bids to determine accuracy, fairness, consistency within the discipline)
- Project scope statement

- Triangular distribution
- Beta distribution
- WBS
- WBS Dictionary

Tools and techniques

- Expert judgment
- Analogous estimating
- Parametric estimating
- Bottom-up estimating
- Three point estimating
- Reserve analysis
- Cost of quality
- PMIS
- Project management software
- Vendor bid analysis
- Group decision-making techniques.

Study note: The tools and techniques described in the *PMBOK® Guide* are recommended for use in planning and controlling the many processes associated with the knowledge areas. It is not the intention of these lists to suggest that all tools and techniques must be used on all projects. The tools and techniques have been derived from extensive research about the best practices used by project managers and are provided for consideration.

Major inputs

- Cost management plan
- Resource requirements
- Scope baseline
- Project schedule
- Risk register
- Lessons learned
- Market conditions
- Commercial information
- Exchange rates
- Enterprise environmental factors
- Organizational process assets

Consider why each of these inputs is necessary to develop reliable estimates. For example, enterprise environmental factors such as resource capability, the risk tolerance

of an organization, political factors, and industry standards may directly affect the planning process and cause the project team to adjust estimates, change strategies, and build in additional contingencies.

Major outputs

- Activity cost estimates
- basis of estimates
- project document updates

Determine budget: This is the process of aggregating the estimated costs of all individual project activities to establish the project cost baseline. This process will establish a *time-phased budget,* which is used to monitor project cost performance through each life cycle phase.

Key terms

- Cost aggregation (create a summary of all project costs, usually derived from the WBS)
- Reserve analysis
- Cost baseline
- Time-phased budget (allocation of project costs to each phase of the project)
- Risk register
- Funding limit reconciliation (resolving differences between the planned project budget and the funding limits defined by the organization; also refers to leveling out the work to manage the rate of expenditure)

Tools and Techniques

- Cost aggregation
- Data analysis (reserve analysis, expert judgment)
- Historical relationships
- Funding limit reconciliation
- Financing

Major inputs

- Project management plan, which includes the cost management plan and scope baseline
- Basis of the estimates (details about how estimates were determined
- Project schedule
- Resource calendars
- Risk register
- Agreements

- Enterprise environmental factors
- Organizational process assets

Major outputs

- Cost baseline
- Project funding requirements
- Project document updates

Control costs: Monitoring the project through each phase and identifying changes or variances in project costs and taking corrective action. This also includes the management of change requests, analyzing performance data, and producing measurements for analysis. A commonly used process is earned value management, which is intended to identify variances and trends using three main elements for measurement: (1) planned value, the cost of activities scheduled to be accomplished at the time of measurement; (2) earned value, the planned cost of activities that have been completed at the time of measurement; and (3) actual cost, the amount actually paid for activities accomplished at the time of measurement.

Key terms

- Variance management (identifying and managing results to ensure they are within acceptable parameters)
- Cost change control system,
- Performance measurement analysis
- Earned value management planned value (PV)
- Earned value (EV)
- Actual cost (AC)
- To complete performance index (TCPI)

Tools and techniques

- Expert judgment
- Data analysis
- Earned value management
- Variance analysis
- Trend analysis
- Complete performance index
- Performance reviews
- Project software
- Reserve analysis

Major inputs

- Project management plan (includes the cost management plan and cost baseline funding requirements)
- Work performance data
- Organizational process assets

Refer to section 7.4.2.3 of the *PMBOK® Guide* (Sixth Edition), budget at completion (BAC), estimate at completion (EAC), S-curves, graphical depiction of project status using a time line, cost measurements, and date of measurement.

Cost Management Terms

Actual cost of work performed (ACWP) Also known as AC or actual cost, this is the amount that was paid for the work that was performed at the time of measurement.

Budget at completion (BAC) This is the final planned and approved budget, the baseline to compare against actual results.

Budgeted cost of work performed (BCWP) Also known as EV or earned value, this is the estimated or planned cost of the work that has been completed at the time of measurement; the amount that was planned to be paid for the work that has been accomplished.

Budgeted cost of work scheduled (BCWS) Also known as PV or planned value, this the planned cost of the work (or work packages) that should have been completed at the time of measurement.

Breakeven The point at which cash outflow and inflow are equal. Breakeven analysis is also used to make rent, buy, or lease decisions.

Direct costs Costs directly and clearly associated with the project. Labor, material, equipment, and supplies are considered direct project costs.

Future value formula FV = PV $(1 + r)n$ where FV= future value, PV = present value, r = interest rate or cost of capital, and n = years

Indirect costs Costs that are not directly associated with the project but that can impact the overall budget. Examples: overhead, building maintenance, benefits, organization operational costs such as rent, utility bills, etc.

Internal rate of return (IRR) This is an iterative process used to determine the actual rate or return realized from an investment;. IRR is often referred to as ROI. The process requires several iterations to determine the rate at which the NPV becomes zero. The IRR generally must meet or exceed a predetermined "hurdle rate" established by an organization as part of project selection criteria. This process will provide an organization with a reliable assessment of the return on investment of a project. IRR is compared with other projects during the selection process.

Learning curves Used as a basis for predicting cost and quantity outputs of a process over time. The basic rule of learning curves is: As units are produced, the time and cost required to produce the unit decreases. Productivity improves through repetition.

The rate of improvement decreases during the process until a point where the output reaches a level where improvement is minimal. This process is often associated with estimating manufacturing process outputs.

Life cycle costing The total cost of a product from research and development to salvage or retirement. The project life cycle is included with the product life cycle.

Net present value (NPV) The sum of the present values of the cash flows for each year of an investment minus the initial investment. If NPV is greater than zero, the project will generate revenue or profit. The greater the NPV, the more acceptable the project will be financially. A NPV of less than zero would indicate that the project will result in a financial loss.

Payback period Period of time required to recover the initial investment. It generally does not consider the time value of money. The period of time required to "recover" the sum of the original investment. Example: a $1000 investment that returned $200 per year would have a five-year payback period. A short-term payback period is generally preferred, typically 2–3 years.

Present value formula PV = FV/(1 + *r*)*n* where PV = present value, FV = future value, *r* = discount rate or cost of capital, *n* = years. Present value is used to discount a future value of an investment to the current or present value. This technique is used in the project selection process to determine, among other factors, which projects will have the greatest financial advantage and produce the highest level of business value.

Sunk cost Money already spent that cannot be recovered. Generally not considered as a factor in the go and no-go decision process.

To complete performance index (TCPI) A measure of the performance level required to achieve the approved budget. The calculation of TCPI depends on the current project cost performance and the specific direction of management regarding the need to achieve the original approved budget, or the decision to make an approved change in the cost baseline.

■ Earned Value Formulas

EV (BCWP) – AC (ACWP) = cost variance (CV) (a negative cost variance indicates a budget overrun)

EV – PV (BCWS) = schedule variance (SV) (a negative *SV* means the project or work package is behind schedule)

EV/AC (ACWP) = cost performance index (CPI) (a measure of efficiency in managing the project budget)

EV/PV (BCWS) = schedule performance index (SPI) (a measure of efficiency in managing the project schedule)

Quick exam reference:

$$EV - AC = CV$$

$$EV - PV = SV$$

$$EV/AC = CPI$$

$$EV/PV = SPI$$

A performance index (PI) that equals 1 means there is no variance and the project or work package is performing as planned and at the expected level of efficiency. A PI greater than 1 indicates superior performance (greater efficiency than planned). Example: receiving $1.10 in value for every one dollar spent. A PI less than 1 indicates a performance problem such as a schedule slippage or a cost overrun.

Estimate at Complete (EAC) is the forecasted project competition cost based on current performance data. There are three formulas highlighted in the *PMBOK® Guide*—Sixth Edition:

EAC = AC + (BAC – EV). This formula is used when a risk assessment indicates that all remaining work will be accomplished at the budgeted rate. This is a highly optimistic prediction.

EAC = BAC / CPI. This formula is used when it is assumed that all future work (ETC, or estimate to complete) will be completed at the rate of actual performance to date.

EAC = AC + (BAC – EV) / (CPI × SPI) Used. This formula is used when the project schedule is a significant factor impacting the remaining work (ETC). The formula considers the efficiency rate of cost and schedule performance.

Earned Value Special Note: The PMP® exam is likely to use the acronyms EV (earned value) instead of BCWP, PV (planned value) instead of BCWS, and AC (actual cost) instead of ACWP.

PV, EV, and AC are the acronyms associated with the *PMBOK® Guide.* Earned value information is the common denominator when determining cost and schedule variance.

▶ Project Quality Management Processes

Project quality management includes the processes that connect an organization's quality policies to the project environment and provide guidance to determine the quality policies, quality objectives, and responsibility for quality that will be used during project planning and implementation.

Project quality management emphasizes customer satisfaction through delivery of agreed upon project deliverables and specified functionality, quality management focuses on prevention of problems and defects over inspection, continuous improvement, and ensuring that management responsibility is clearly defined and accepted.

According to the *PMBOK® Guide,* the major process of project quality management are:

- Plan quality management
- Manage quality
- Control quality

Plan quality management: Determining what quality requirements and standards are relevant to the deliverables of the project and the management of the overall project methodology. The quality management plan is intended to ensure policy compliance, standards and regulatory compliance, continuous improvement, and stakeholder engagement.

Tools and techniques

- Expert judgment
- Data gathering (benchmarking, brainstorming, interviews)
- Data analysis (cost/benefit analysis, balancing the cost of quality and the profitability or return for the investment in the quality process)
- Decision making (multi-criteria decision analysis)
- Communication (flow charts, process flows, logical data models)
- Test and inspection planning
- Meetings.

Study note: Tools and techniques are associated with actions and activities.

Major inputs

- Project charter
- Project management plan (includes subsidiary plans such as requirements management plan and stakeholder engagement plan)
- Project documents (scope baseline, stakeholder register, cost baseline, schedule baseline, stakeholder resister, requirements documentation, risk register)
- Organizational process assets
- Enterprise environmental factors

Major outputs

- Quality management plan (a subsidiary plan)
- Quality metrics
- Project management plan updates
- Project document updates

Study note: The outputs of many of the PMBOK® processes found in each knowledge area include project management plan updates and project document updates. These updates are necessary to ensure that all approved changes have been processed and any adjustments to the plan have been recorded. Due to the nature of the project environment and the expectation that change will occur, these updates are necessary and are intended to keep stakeholders informed.

Manage quality: The application of the processes and systematic quality activities that will ensure project success and the achievement of project requirements. The auditing

of quality requirements and results to ensure appropriate levels of quality are being achieved are or meeting standards

Key terms

- Quality audits
- Process analysis
- Affinity diagrams
- Process decision program charts
- Interrelationship digraphs
- Tree diagrams (WBS, RBS, OBS)
- Prioritization matrices
- Activity network diagrams
- Matrix diagrams

Tools and techniques

- Data gathering
- Data analysis (examples: cause and effect diagrams, root cause analysis)
- Communication (scatter diagrams, histograms, affinity diagrams, flow charts
- Audits
- Design for X: (technical guidelines used during design to optimize the design process or specific elements of the design)

Study note: The *PMBOK® Guide* (Sixth Edition) breaks down inputs, tools and techniques, and outputs into detailed subcomponents. It is important to review each section of a process described in the *PMBOK® Guide* and develop an understanding of these detailed elements and how they flow in the implementation of the project.

Major inputs

- Project charter
- Project management plan (the quality management plan is a subsidiary plan; other subsidiary plans may be included and may provide information about process improvement, quality metrics, and quality control measurements)
- Several project documents are also included as inputs (requirements documentation, risk register, stakeholder register)

Major outputs

- Quality reports
- test and evaluation documents
- Change requests and updates

Control quality: The process of monitoring and recording project results to determine compliance with established and agreed upon requirements and to assess project

performance. Control quality also includes recommendations for changes to resolve quality related issues and to ensure the desired project results are attained.

Key terms

- Cause and effect diagrams
- Control charts
- Flow charting
- Pareto chart (80/20 rule)
- Run chart
- Trends
- Histogram
- Scatter diagram
- Statistical sampling
- Inspection
- Defect repair and review
- Prevention (keeping errors out of the hands of the customer)
- Attribute sampling (process to ensure results conform to requirements)
- Tolerances (specified range of acceptable results)

Tools and techniques

- The basic quality tools
- Statistical sampling
- Inspection
- Testing and product evaluation

Major inputs

- Quality management plan
- Lessons learned register
- Change requests
- Work performance data

Major outputs

- Quality control measurements
- Validated changes
- Verified deliverables
- Work performance information
- Change requests
- Project management plan updates

- Document updates
- Organizational process asset updates

You will notice that many inputs and tools and techniques are repeated several times throughout the *PMBOK® Guide.* This is further emphasis that all project processes and knowledge areas are interrelated and integrated.

Project Quality Management Terms

Attribute sampling Process that focuses on assessing outputs to determine if each output passes or fails an inspection: Either reject or accept the deliverable being reviewed.

Benchmarking Comparing desired or best in class performance with existing performance. Identifying areas for improvement or deficiencies in products and services and developing corrective actions.

Benefit cost analysis Determining the appropriate level of quality to be designed and included in a project deliverable or product to achieve an acceptable return on the investment and to meet customer needs. Generally the benefits received should be greater than the cost to produce the product or deliverable.

Control charts In statistical process control, control charts are tools used to determine if a manufacturing or business process is in a state of control by analyzing data points and their relationship to the mean or process average. The control chart analysis may include what is referred to as the Rule of 7 and the Rule of 21. Rule of 7: 7 consecutive data points above or below the mean indicate a run, 7 data points indicating a specific positive or negative direction indicates a trend. Generally, 21 data points are required for a sample to be statistically valid. Control charts are used to identify special or assignable causes and to determine if a process is in control or out of control. The control chart displays the process average, mean or center line, upper and lower control limits (UCL and LCL), and upper and lower specification limits.

Control quality Monitoring and analyzing project performance results to determine if they are acceptable and are within approved standards. Taking action to correct unacceptable variances.

Cost of conformance Part of the cost of quality. Includes two components: prevention (examples: training, design reviews), and appraisal (examples: inspections, testing).

Cost of nonconformance Part of the cost of quality. Includes two components: internal failure (examples: defects, rework) and external failure (examples: customer receives a defective product resulting in loss of business or liabilities).

Cost of quality There are two major components of the cost of quality: cost of conformance, which includes prevention and appraisal costs, and cost of nonconformance, which includes internal failure (rework) and external failure (customer dissatisfaction).

Customer defines quality The project team analyzes the customer's implied needs and develops approved and accepted stated needs (requirements) to meet the customer's

expectations. The project manager has ultimate responsibility for quality during the project life cycle and manages the project using the quality management plan.

Customer satisfaction Defining and then managing the work to meet customer expectations. A best practice is to define requirements and expectations early in the project and then review them on a regular basis. The goal is to achieve the desired result as expressed by the customer.

Defect Anything that will cause customer dissatisfaction.

Design of experiments Introduced by Taguchi, the general principle is that quality should be engineered into a product, not inspected into it. Basically, when a process has been defined, designed, developed, and approved after multiple iterations, expressly following the same process will produce the same results consistently.

DMAIC Define, measure, analyze, improve, control

DTRTRTFT Acronym for "do the right thing right the first time." Attributed to Philip Crosby.

Essential quality characteristics Utility (ease of use), financial (effective management of all associated costs), legal (warranties, safe for use), maintainability, reliability, availability.

Flow charting Diagramming a process to identify the specific steps to achieve a result. Identifying where gaps in the process exist, and to identify and eliminate redundant work. Flow charts are used to gain an understanding of the overall operation or flow of work. Flow charting is referenced in the *PMBOK® Guide* as an element of communications.

Grade versus quality Low grade basically means fewer feature and functions but is not an indication of quality. Products can be considered to be of high quality and low grade: well made but missing the technical characteristics and functionality of other similar products. Low grade is not necessarily a problem but poor quality is always a problem. Example: Software with limited functions may serve a specific need and is produced with high quality but limited features. (It does what it was intended to do, but it is low grade, that is, it does not have all of the features and functions of a higher-grade product.

Inspection Examining work outputs by conducting walkthroughs, testing, and reviews.

ISO 9000 International certification indicating documented processes for quality. ISO 9001 is the most comprehensive certification in the series. ISO 9000 is updated approximately every four years. Note that ISO is derived from the Greek word *isos,* meaning "equal."

Key components of quality management The main goal: customer satisfaction. The emphasis should be on prevention over inspection. There should be clearly defined roles for management regarding responsibility, supporting continuous improvement, and achieving defined requirements.

Management responsibility Participation of all employees is desired to achieve quality objectives. According to Deming, management is responsible to provide resources

with the appropriate training, tools equipment and materials. Management is basically responsible for 85% of quality issues. This means that most quality issues require the involvement of management to resolve them.

Pareto diagram A histogram that displays problems or issues by frequency of occurrence and is associated with the 80/20 rule as it applies to quality: 80% of problems are associated with 20% of the causes. The Pareto diagram and process is associated with the phrases "vital few and trivial many," "select the low-hanging fruit," and "biggest bang for the buck."

Prevention Keeping errors out of the process and preventing errors from reaching customer. Prevention may include training, documenting processes, using the appropriate equipment, scheduling the appropriate time to perform work. Poke Yoka, a process of error proofing, is an example of prevention.

Prevention over inspection Prevention is emphasized in most quality processes. It is generally less costly to prevent errors than to inspect for, identify, and correct errors.

Quality The basic definition is "The conformance to specifications or requirements and fitness for use."

Quality assurance Systematic activities implemented to ensure that the project will satisfy quality standards. Quality assurance is associated with audits designed to determine if approved and required processes are followed and to identify where variations from process and/or standards may be causing problems or issues with products and deliverables.

Quality control Measuring performance to determine where variances exist and taking actions to correct unacceptable variance. Includes inspection, control charts, Pareto diagrams (80/20 rule), histograms, scatter diagrams.

Quality gurus People who have significantly influenced the implementation and advancement of quality management processes and the connection of quality and business results.

W. Edwards Deming: Supported and emphasized the use of the Shewhart chart (the cycle of plan, do, check, act), proclaimed that 85% of quality issues require management involvement, emphasized statistical analysis and continuous improvement

Joseph Juran: Emphasized fitness for use, advised to be aware of the legal issues associated with poor quality

Philip Crosby: Postulated that quality is free, the cost of quality is associated with nonconformance; professed that zero defects is possible

Taguchi: Developed the design of experiments approach, postulated that quality should be engineered into a product not inspected into the product, emphasized that as results move further from the target, the cost of correcting problems and variations will increase

Ishikawa: Developed the cause-and-effect diagram also referred to as the Fishbone diagram.

Feigenbaum: Developed the concept of total quality management (everyone in the organization is involved in quality-related activities and the quality improvement processes).

Quality planning Developing a subsidiary to the project management plan for the purpose of managing the quality of project deliverables.

Quality policy This policy is generally developed by the performing organization. It is an indication of the intentions of an organization as it relates to quality. The organizational quality policy is usually established by upper management (or a steering committee) and compliance is expected from everyone in an organization, including project teams. Project quality policies are an extension of the organization's quality policy and may be customized as needed, based on project and stakeholder requirements.

Sampling Use of statistics to determine if products meet required specifications. There are two basic types of sampling: attribute and variable. Attribute sampling is a pass or fail approach, with no flexibility in accepting results. Results either conform or do not conform to requirements. Variable sampling allows for some tolerance from target and acceptable variance is measured using a specific scale.

Shewhart chart: plan, do, check, act Displays the basic principles of continuous improvement. Developed by Shewhart and emphasized by Deming.

Sigma Statistical expression indicating how much variation there is in a product.

Six Sigma Generally defined as the process that will eventually result in 3.4 defects per million opportunities for failure. There is usually a high cost during the early stages of implementation. From a strategic perspective the costs are expected to be recovered over time. The goal of Six Sigma is to minimize defects through continuous analysis and action. Six Sigma results are achieved through a process known as DMAIC: define, measure, analyze, improve, and control. The process includes the use of tools such as Pareto charts, control charts, variance testing, and design of experiments.

Six Sigma tools and processes eliminate unnecessary tasks and reduce or remove rework.

Measurements associated with achieving Six Sigma results:

3 Sigma: 66,800 defects per million opportunities

4 Sigma: 6,210 defects per million opportunities

5 Sigma: 230 defects per million opportunities

Statistical sampling Method of determining the appropriate sample group from a population to determine if the entire population is acceptable. There are different types of sampling: 100% sampling (used when quantities are very small), single sampling, double sampling, and multiple sampling. During the sampling process it is possible to experience producer's or alpha risk (the risk to a seller that a good lot will be rejected) and consumer's or beta risk (the risk that a consumer will accept a bad lot).

Total quality management (TQM) An organizational approach to quality that starts at the top management level and includes all levels of employees. The focus of TQM is continuous improvement through training, awareness about quality, and active involvement in quality initiatives.

Variable sampling Units are measured using a scale to determine acceptance. A tolerance specification is established and allows some flexibility when determining the acceptance of deliverables.

▶ Project Resource Management Processes

Remember

Human resources management includes the processes that are used to organize and manage the project team. This includes selection of the project team, the leader's responsibility to motivate and lead a team, managing conflict, defining the difference between authority and power, influencing people, managing interpersonal interfaces, delivering project level and individual personal performance appraisals, managing with professionalism, and ethical behavior. Organizational structure is generally included as art of the knowledge area of resource management.

Organizational structure depends on the preferences of executive management and the type of business. There are several types of organizational structures. Three types are very common: functional, matrix, and projectized structures.

Key Concepts of Resource Management

Clearly defined roles and responsibilities are assigned to collectively achieve project goals. The project manager is the team leader and acquires, develops, motivates, and empowers the team. The project management must be aware of and manage cultural differences. The project manager subscribes to ethical and professional behavior.

Resource management includes the human resources, equipment, materials, and supplies necessary to complete project work.

Emotional intelligence (self-awareness and relationship management) is a key factor in effective management and leadership of a team.

Diversity and geographical location are factors to be considered by the project manager.

Plan resource management: The process of identifying resource requirements, estimating the resources necessary, and acquiring, and managing the resources. Resource management also includes identifying project roles, establishing reporting relationships, and creating the staffing plan.

Key terms

- Organization chart
- Networking
- Organizational theory
- Roles and responsibilities
- Matrix-based charts (examples: RAM, responsibility assignment matrix; RACI, responsible, accountable, consult, inform)

- Role (the function assigned to a person)
- Authority (the rights to make decisions and sign approvals)
- Responsibility (specifically assigned duties expected to be completed)

Tools and techniques

- Communication
- Organization charts and position descriptions
- Networking
- Organizational theory (functional, matrix, projectized)
- Expert judgment
- Meetings

Major inputs

- Project charter
- Project management plan
- Project documents
- Enterprise environmental factors
- Organizational process assets

Estimate activity resources: Determining quantity and type of resources.

Tools and techniques

- Estimating types such as parametric, analogous and bottom-up
- Use of experts
- Meetings
- Major outputs
- Documentation about resource requirements
- Resource breakdown structure
- Supporting information (basis of estimates)

Major inputs

- Project management plan
- Project documents

Study note: The *PMBOK® Guide* provides detailed lists of inputs, tools and techniques, and outputs for all knowledge area subprocesses.

Acquire resources: The process of confirming and obtaining the human resources, equipment, materials and supplies required to complete the project. Obtaining the human resources can be accomplished through hiring, outsourcing, or transferring internal resources.

Key terms

- Preassignment (team selected and in place before project manager is assigned)
- Negotiation (discussing and bargaining for desired resources)
- Acquisition (outsourcing or obtaining external resources)
- Virtual teams (geographically dispersed teams where resources are identified and obtained in the specific area rather than expending funds to send resources to the locations. Virtual teams may have little to no actual face-to-face contact.)
- Multi-criteria decision analysis (using specific criteria determined by the project manager and other stakeholders. Criteria may include availability, cost, experience, ability, knowledge, skills, and attitude)
- International factors (time difference, location, communications ability, resource calendars)

Tools and techniques

- Decision making based on availability, cost, and experience
- Interpersonal, team building, and relationship-building skills
- Pre-assignment
- Virtual teams
- Negotiation
- Multi-criteria decision analysis

Major inputs

- Project management plan
- Project documents resource management plan
- Enterprise environmental factors
- Organizational process assets

Study note: Project documents are documents that generally provide information. Examples include resource calendars, project schedule, stakeholder register, risk register. Refer to the *PMBOK® Guide* for detailed listing and description of project documents.

Develop the project team: The process of improving competencies, building the project team, improving performance, improving teamwork.

Key terms

- General management skills
- Interpersonal skills
- Tuckman model (forming, storming, norming, performing, adjourning)
- Motivation

- Influencing
- Negotiation
- Team
- Team-building activities
- Ground rules
- Team charters
- Co-location
- Recognition
- Reward

Tools and techniques

- Co-location
- Virtual teams
- Interpersonal skills (emotional intelligence, conflict management, negotiation, influencing, team building and facilitation)
- Training (the specific training needs of the team, team building activities, reward and recognition, performance assessments)

Major inputs

- Resource management plan, subsidiary plan that may include training strategies, defined resource requirements, specified feedback processes, rewards process;
- Project documents, including project staff assignments, resource calendars

Study note: Maintain an awareness of cultural differences.

Manage team: The process of tracking the performance of the team and providing feedback on results, resolving problems and issues, coordinating changes, and managing the effectiveness of the team to improve overall project performance.

Tools and techniques

- Observation and conversation (connect with project team members, remain visible, observe the work being performed, engage in discussions)
- Project performance appraisals
- Conflict management (withdraw/avoid, smooth/accommodate, compromise/reconcile, force/direct, collaborate/problem-solve)
- Interpersonal skills (leadership, influencing, effective decision making)

Major inputs:

- Resource management plan
- Project team assignments
- Team charter

- Team performance assessments
- Issue log
- Work performance reports
- Organizational process assets

Control resources: Ensure that resources have been assigned and are available as planned and monitoring the work performed.

Key terms

- Team performance assessment
- Tuckman–Jensen model (forming, storming, norming, performing, adjourning)
- Project performance appraisals
- Observation and conversation
- Conflict-management-handling modes
- Issue log

Tools and techniques

- Data analysis (cost benefit analysis, project performance reviews)
- Problem solving
- Major inputs: Resource management plan
- Project documents (issues log, project schedule, resource assignments, and other documents)
- Work performance data

Major outputs

- Work performance data
- Change requests
- Updates of project documents

Study note: Review the overview charts and detailed knowledge areas subprocesses, and observe the flow of inputs to tools and techniques that will produce outputs. Outputs become inputs to other processes.

Project Resource Management Terms

Conflict Management There are five general types of conflict handling: (1) withdrawing, (2) smoothing, (3) compromise, (4) forcing, and (5) collaboration through confrontation (working together by confronting the problem, not each other, and using problem-solving techniques).

Herzberg's theory The manager must address hygiene factors such as working conditions, peer relationships, level of supervision, working environment, and compensation

before attempting to motivate the workforce. If these factors are not managed and provided at a satisfactory level they may cause pain, discomfort, or conflict. They are not considered to be motivators but must be managed to remove any potential dissatisfaction among employees. Once the hygiene factors are satisfied, motivating factors can be introduced. Examples of motivators are personal growth, advancement, increased responsibility, challenging work, and recognition.

Interrelationships The many interfaces a project manager will be expected to manage and work with during the project life cycle. Example: functional groups such as engineering, design, and operations. Project interfaces include organizational functions (business units), technical groups (design group and production groups), and interpersonal relationships (formal and informal personal relationships with stakeholders).

Leadership skills Project managers are expected to lead the project team and should provide coaching, facilitation, authoritative leadership, supportive leadership, vision, direction, and motivation.

Maslow's Hierarchy of Needs Expressed graphically as a pyramid. The lowest or first level is the physiological needs of an individual. As each motivating factor is achieved, it is no longer considered to be a motivator and the individual will seek to attain the next level. The five major levels are physiological needs, safety and security, social needs, esteem, and self-actualization.

Major sources of conflict

Schedule priorities, priorities in general, project costs, estimating techniques, different opinions, lack of communication. Consider projects that you have been assigned to and identify other sources of conflict and the solutions to those conflicts. Escalation to the project sponsor or project executive may be necessary to resolve some conflicts. Generally conflicts are resolved by understanding the needs of the opposing person or group and identifying common areas of agreement.

Motivation theories Theory X: The manager believes employees attempt to avoid work and therefore they must be closely supervised, Theory Y: A participative management style in which the manager believes the workforce can be trusted and they are willing to accept responsibility, Theory Z: Introduced by William Ouchi, a communal type of structure where the workers focus on the higher-level needs and goals of an organization and the organization focuses on cultivating employee loyalty. Other motivation theories include Maslow's hierarchy of needs, Frederick Herzberg's hygiene theory that emphasizes the need to focus on factors that may cause dissatisfaction and then to identify motivators that will inspire team members to perform at higher levels.

Negotiating Project managers must develop effective negotiating skills. This includes understanding other viewpoints and needs, creating an environment for effective negotiation, and developing negotiation skills and tactics such as concessions, compromise,

minimum and maximum values, bargaining, protocol, cultural sensitivity, fair and reasonable offers, and teaming agreements. Items that may require negotiation include: obtaining resources, schedule development, activity duration estimates, funding requirements, and resolving conflicts.

Organizational influences Remember the difference between a project-based and a non-project-based organization. Project-based: the organization performs most work as project work or manages projects for external customers. Non-project-based organizations do not have a formal project management methodology or do not normally engage in project-type work.

Organizational structure There are several types of organizational structure—here most common forms are the functional, matrix, and projectized structures. Each type of structure has unique characteristics, advantages, and disadvantages. The authority of the project manager is generally lowest in the functional structure, moderate in the matrix structure, and nearly total in the projectized structure.

Power and authority The project manager should be aware of the five major types of power or influence:

Legitimate or formal power: Based on position and rank in the organization

Expert power: Based on level of knowledge and experience

Penalty power: Based on the ability and authority to penalize employees or threaten disciplinary action; also known as coercive power

Reward power: Based on the ability and authority to offer items of perceived value to employees in exchange for work

Referent power: Influencing people through the power and authority of another, use of charisma

Project stakeholders Any person or organization that is involved in or directly impacted either positively or negatively as a result of the project.

Responsibility assignment matrix (RAM) The RAM is aligned with the WBS and links project team member responsibility with WBS elements. The RAM is used to clearly define responsibility for the completion of project tasks and major deliverables. It is generally not a tool used for determining resource requirements.

Roles and responsibilities: Should be identified and assigned during the project kick-off meeting. Identifying roles and responsibilities will help to minimize conflicts and improve overall project communications.

Team building The project manager must remember the importance of team building and the phases of team development: forming, storming, norming, performing, and adjourning. During the forming stage the team member will express concern and approach the project in a guarded state of mind. Conflict is greatest during the storming phase where disagreements about responsibilities will peak. Conflict begins to subside in the norming phase, and is minimized in the performing stage, where the team has learned to trust each other and protect each other. The project manager is

considered to be a team leader and should determine the best methods to enhance the performance of the team through team building activities, reward and recognition, training, appraisals, co-location when feasible, support, direction, feedback, and sincere and well-thought-out performance appraisals.

► Project Communications Management Processes

Remember

Project communications includes the processes that will ensure timely collection, analysis, preparation, and distribution of project information. It is about effectively and regularly exchanging information and establishing and managing the flow of information between the project manager and stakeholders. Project communication involves an understanding of stakeholder needs, stakeholder influences, and cultural differences. Communication also includes the use of communications models and establishing feedback loops to ensure that messages and information or understood by the receivers. Effective communication includes the timely generation, collection, distribution, storage, and retrieval of project information. A project management information system (PMIS) is a key element of project communications management.

There are three major subprocesses associated with project communications: plan communications management, manage communications, and control communications.

Communications activities include internal communications, external communications, formal and informal reports and memos, vertical and horizontal communications (upward, downward, and cross-organizational, official and unofficial reporting (off the record and grapevine type communications), written, oral, and verbal and nonverbal communications (body language). Many elements of effective communication are directly related to elements of human resource management such as conflict management, influencing skills, and team-building skills.

Plan communications management: Developing the most appropriate approach to manage project communications based on the needs of the stakeholders. Communications planning is based on the following questions: Who needs the information? What information is needed? When is the information needed? Why is the information needed? In what format should the information be sent? How frequently should the information be sent? The specific needs of the stakeholder will determine the communications to be provided.

Key terms

- Stakeholder analysis
- Expert judgment

- Stakeholder register
- Communications channel formula (The number of channels in a network are calculated using the formula $[N(N-1)] / 2$ where N = the number of people on a team)

Tools and Techniques

- Communications requirements analysis (determining the information needs of the stakeholders)
- Communications technology (how information will be transmitted to project stakeholders: infrastructure)
- Factors to consider include urgency of the message
- Availability of the technology
- Ease of use of technology
- Project environment (language differences, time zones, cultural differences, politics)
- Information sensitivity (managing intellectual property and confidential information)
- Communications models (sender-receiver model)
- Communications methods (push, pull, and interactive communication)
- Meetings (kickoff meetings, planning meetings status meetings, problem-solving meetings)

Major inputs

- Project charter
- Project management plan
- Project documents (stakeholder register a list of stakeholders and their perceived influence level)
- Enterprise environmental factors
- Organizational process assets

Study note: Meetings should always have a purpose, agenda, and time limit.

Manage communications: The process of developing, collecting, storing, retrieving, analyzing and timely dissemination of project information. This may include, type of media to be used, writing styles, meeting management, technology, presentation techniques, facilitating, and listening.

Key terms

- Project scope statement
- Constraints, assumptions
- Communications requirements analysis
- Communications technology
- Sender–receiver model

- Communications methods (interactive communications, push communications, pull communications)
- Communications requirements (relates to the specific needs of the stakeholders in terms of type of information and format desired by the stakeholder)
- Communications technology (associated with how information will be transferred to stakeholders in terms of information systems and capabilities of the stakeholders to access review and respond to information)
- Communications skills (clarity of the message, providing feedback, understanding nonverbal indicators, ability to present effectively)

Tools and Techniques

- Communications technology
- Communications models
- Communications methods
- Communications skills
- Information management systems (email, fax, messaging, websites, collaborative software)
- Performance reporting (earned value analysis, status reports)

Major inputs

- Communication management plan
- Stakeholder management plan
- Project documents (change log, issue log, lessons learned etc.)
- Work performance reports
- Enterprise environmental factors
- Organizational process assets.

Monitor communications: This process includes providing relevant project information to the stakeholders in a timely manner, optimizing the flow of project information, and ensuring that the information needs of the stakeholders are satisfied.

Key terms

- Stakeholders
- Project management information systems
- Sender–receiver models
- Communications methods (push, pull, and interactive)
- Issue logs
- Managing resistance to change
- Document updates

- Variance analysis
- Project performance forecasts
- Earned value management

Performance reporting and performance forecasts are associated with collecting, reviewing, analyzing, and then disseminating the information to the appropriate stakeholders. Performance reporting includes status reports (the current project condition), progress reports (what has been accomplished to date), and forecasts (what is expected or anticipated to occur in the future). The use of project information dashboards and balanced scorecards are popular forms of status reporting.

Earned value analysis is also associated with performance reporting (refer to the information in project cost management). It utilizes three key values to assess project performance: planned value, or PV (also known as BCWS or Budgeted Cost of Work Scheduled), actual cost, or AC (also known as ACWP or actual cost of work performed), and earned value, or EV (also known as BCWP or budgeted cost of work performed). These values are used to calculate cost variance (EV – AC = CV), schedule variance (EV – PV = SV), cost performance index CPI = EV/AC, and schedule performance index SPI EV/PV.

Tools and techniques

- Project management information systems
- Expert judgment
- Meetings
- Data analysis
- Interpersonal skills

Major inputs

- Project management plan
- Project communications plan
- Stakeholder engagement plan
- Work performance data
- Organizational process assets
- Enterprise environmental factors

Communications Management Terms

Assumptions Planning items that are not based in fact and carry some degree of risk. Assumptions should be validated

Communication Types of communication include internal communication within the performing organization; external communication with suppliers, the media, and the public; formal and informal communications; vertical (upward and downward) communications; horizontal communications across organizations; official and unofficial communications; verbal communication; and nonverbal communications (body language).

Communications channel formula Determines the number of communications channels present within a project team. Knowledge of communications channels assists in developing plans to ensure effective communication and minimize potential breakdowns in communications.

Communications channels (X) = N (N – 1)/2 where N = number of people on the project team and X is the number of channels of communication. Communications channels assume two-way communication.

Increasing the number of people on a project team increases the number of channels of communication in the network exists between project team members and increases the potential for communications issues to develop.

Constraints Identified limitations that may obstruct or impede communications.

Sender–receiver model The basic elements of the sender–receiver model are the sender or transmitter, the message, encoding message, the personality screen, sender's region of experience, receiver, receiver perception screen, noise (factors that cause distortion of the message), medium (method to convey the message) receiver's region of experience, receiver's decoding of the message, feedback loop for the message, receiver personality screen, and sender perception screen.

The sender prepares or encodes a message to transmit to a receiver. The message passes through the sender's personality screen (which may be a point where some distortion of the message may occur) and through the region of experience of the sender to the receiver. The message passes through the receiver's perception screen and is then decoded. During this process the message may become distorted by the common communications barriers that are present during information exchanges (evaluative tendency, opposing views, poor listening as examples). To ensure that the message was received as intended, it is recommended that the receiver provide feedback about the message by encoding a response to the message and sending it back to the originator (sender or transmitter), passing through the receiver's personality screen, through the region of experience of the receiver, then through the sender's perception screen. The message is decoded by the original sender to determine if the message was sent and received as intended. The model illustrates the potential for distortion to occur during the communications process and to develop plans to minimize that distortion.

For more information refer to Chapter 5 of this workbook and Chapter 5 of *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*.

► Project Risk Management Processes

Remember

Project risk management includes the processes of developing the risk management plan identification of risks, prioritization of risks through analysis, responding to risks and controlling risks. Risk management involves the assessment of threats as well as opportunities and is included in every phase of the project life cycle.

Risk management is justifiable regardless of project size or complexity and should begin at the start of contract negotiations and continue through project charter development, the project kickoff meeting and in all planning discussions. Risk is always present and the project manager and team should continually assess project risk and revise or update risk plans.

Plan risk management: The process of deciding on the approach to conducting risk management and managing project risk; defining the activities that will effectively manage risk through the project life cycle.

Nonevent risks

- Variability risks (changes in productivity, errors, unseasonable weather)
- Ambiguity risks (deficit of knowledge and understanding
- Gaps that require investigation

Key terms

- Risk appetite (degree of uncertainty an organization is willing to accept)
- Risk tolerance (volume and intensity of risk that an organization can withstand)
- Risk threshold (level of uncertainty or impact that a stakeholder is willing to manage)
- Risk categories (specific identified groupings of risk causes and events)
- Beta distribution
- Triangular distribution
- Risk breakdown structure (RBS)
- Probability and impact

Major inputs

Project management plan, project charter, stakeholder register, enterprise environmental factors, organizational process assets

Tools and techniques

- Data analysis (analytical techniques such as stakeholder assessment, analyzing risk attitude, risk tolerances and risk appetite)
- Expert judgment
- Meetings

The planning process will establish the methodologies, roles and responsibilities of the key stakeholders involved, a budget process for managing risk, and the timing for when risk management activities will occur.

Study note: There are two primary components of risk: probability and impact. Urgency is also a factor when planning for risk and determining responses.

Identify risk: The use of various techniques to determine which risks might affect the project and documenting their characteristics.

Key terms

- Delphi technique (use of experts who are kept anonymous)
- SWOT analysis
- Stakeholder risk tolerance
- Probability impact matrix
- Risk register (list of identified risks)
- Prompt lists (predetermined list of risk categories)

Tools and techniques

- Documentation reviews
- Information-gathering techniques (brainstorming, Delphi technique, SWOT analysis (strengths weaknesses, opportunities, and threats)
- Checklist analysis
- Assumptions analysis
- Diagramming techniques (cause and effect, flow charts, influence diagrams)

Major inputs

- Subsidiary plans
- Risk management plan
- Cost management plan
- Schedule management plan
- Quality management plan
- Human resource management plan
- Activity cost estimates
- Activity duration estimates
- Scope baseline
- Stakeholder register
- Project documents
- Enterprise environmental factors
- Organizational process assets

Perform qualitative risk analysis: The process of prioritizing risks for additional analysis or action by considering the probability and impact of the risk. This type of analysis utilizes the experience of the project team, lessons learned, previous projects, and historical information to assess project risk events.

Key terms

- Probability and impact matrix
- Risk data quality assessment

- Risk categorization (sort risk events into specific groups using the risk breakdown structure, or RBS)
- Risk urgency assessment (determining near-term and longer-term risk impacts)
- Expert judgment, assumptions log updates (adding new information as it becomes available)
- Documenting new assumptions based on progressive elaboration of the project

Tools and techniques

- Data analysis (risk probability and impact assessment, the likelihood of an event and the consequences if it occurs)
- Probability and impact matrix (used to prioritize risk events using a numerical scale or narrative description: high, medium, low)
- Risk data quality assessment (the reliability of the information gathered)
- Risk categorization, risk urgency assessment, expert judgment, assessment of risk parameters (urgency, proximity, dormancy, manageability)

Major inputs

- Risk management plan
- Scope baseline
- Risk register
- Enterprise environmental factors
- Organizational process assets

Perform quantitative risk analysis: A numerically based and more robust approach to risk analysis using mathematical models and simulations to determine the effect of identified risk events. This approach is more scientific and data-based than qualitative analysis and requires the use of specific software and specialized techniques.

Key terms

- Sensitivity analysis (use of a tornado diagram to display sources of uncertainty determined by assessing impact to a specific value such as net present value)
- Expected monetary value (the result of the outcome of decision tree analysis)

The outputs of quantitative analysis provide a detailed probabilistic view of the project and will assist in determining the likelihood of achieving project objectives. The process will also assist in prioritizing risks and repeated use of the processes will enable the identification of trends that will provide additional insight for risk planning purposes.

Tools and techniques

- Data gathering and representation techniques
- Interviewing, probability distributions (uniform, normal, beta, and triangular)

- Expert judgment
- Data analysis and modeling techniques (examples: sensitivity analysis, expected monetary value analysis, decision tree analysis, modeling and simulations, Monte Carlo analysis)

Major inputs

- Risk register
- Risk management plan
- Cost management plan
- Schedule management plan
- Enterprise environmental factors
- Organizational process assets

Plan risk responses: The process of determining the appropriate actions and identifying the options that may be used to reduce or eliminate project risks.

Key terms

- Risk responses (avoid, transfer, mitigate, accept, passive acceptance, active acceptance)
- Positive risk (opportunity)
- Negative risk (threat)
- Contingent response (a response that will be applied only under specific conditions)
- Primary risks
- Secondary risks (risks that arise as a result of a specific decision or action associated with a primary risk)
- Fallback plan

Tools and techniques

- Data gathering
- Interpersonal skills
- Strategies for negative risks or threats (escalate, avoid, transfer, mitigate)
- Strategies for positive risks or opportunities (escalate, exploit, share, enhance)
- Strategies for both negative and positive risks (acceptance, passive or active)
- Contingent response strategy
- Expert judgment

Major inputs

- Subsidiary plans
- Cost baseline

- Risk register
- Risk management plan
- Project documents (stakeholder register, resource calendar, etc.)

Implement risk responses: The process of engaging in and implementing the defined risk response strategies.

Tools and techniques

- Expert judgment
- Resource allocations
- Project management information system

Major inputs

- Project management plan
- Project documents, including lessons learned, risk register, risk report

Monitor risks: The process of tracking risks, identifying new risks, executing the risk response strategies, and maintaining awareness of risks and their impact through the project life cycle

Key terms

- Recommended corrective actions
- Recommended preventive actions
- Integrated change control process
- Assumptions log

Tools and techniques

- Risk reassessment (identifying new risk situations)
- Risk audits (reviewing the effectiveness of risk processes)
- Variance and trend analysis (comparing plans to actual results)
- Technical performance measurement (quantifiable measurements of performance such as defects recorded, capacity, or deviation from specifications)
- Reserve analysis
- Meetings

Major inputs

- Risk register
- Project management plan
- Work performance data
- Work performance reports
- Issue log, lessons learned

■ Risk Management Terms

Brainstorming Gathering risk data from the project team by openly generating ideas and avoiding assessment of the ideas until the generation of new ideas has been exhausted.

Decision tree Associated with quantitative risk analysis. The decision tree assists in determining the potential outcomes of specific scenarios or paths by considering probability, initial cost, net path value, and the expected monetary value of each path. Decision trees assist in identifying the implications of choosing each of the available alternatives and providing information to make the best choice.

Delphi technique A process used in decision making and analysis whereby subject matter experts are engaged to provide input in an anonymous setting to eliminate bias.

Expected monetary value The calculated final outcome based on the probable outcomes of a scenario. It is expressed mathematically as the product of an event's probability of occurrence and the gain or loss that will result.

Hurwitz and Wald criterion (maximax and maximin) The Hurwitz, or maximax, criterion is associated with organizations that have a high tolerance for risk and a "go-for-broke" attitude. The Wald or maximin criterion is associated with risk-averse organizations that are concerned with the potential loss associated with a decision or action.

Monte Carlo process A computer simulation in which variable data is used to determine probable outcomes. When applied to project management the project is simulated through software by introducing variable data such as optimistic, pessimistic, and the most likely values for activities. Generally this type of simulation (similar to the throwing of dice) is done many times (the typical default in Monte Carlo software is 1000 simulations) to determine possible outcomes and the probability of achieving a specific result. Examples: The results may indicate the probability completing a project by a certain date or at a specified total budget or expenditure. Monte Carlo simulation furnishes the decision maker with a range of possible outcomes and provides the data to assist in making risk decisions.

Nominal group technique A form of brainstorming where information is gathered as a group and the prioritization of items is accomplished through anonymous voting.

Probability/impact matrix A matrix utilized to establish the value of a risk or establish a risk rating by multiplying probability by impact. Scales may be ordinal (.1.2.3.4.5) or cardinal (low, moderate, high ratings). The matrix displays an axis for level of probability and a level for risk impact.

Residual risk The remaining value of a risk in terms of probability and impact after mitigation. Generally there is a cost associated with responding to an identified risk event. The project budget planning process should also include an assessment of risk mitigation costs and the contingencies that may be required after mitigation.

Risk response strategies The typical responses to risk situations: For threats the responses are escalate, avoid transfer mitigation, and accept. The responses for opportunity are escalate, exploit, enhance, share, and accept. There are two forms of

acceptance. Passive acceptance means that no specific action will be taken. Active acceptance means a specific contingency will be planned.

Risk tolerance There are risk seekers, risk averse organizations, and risk neutral organizations. Risk tolerance is an enterprise environmental factor and is affected by management's view of risk, the willingness to take risks, and the nature of the business. The utility factor is important. It is a measure of the tolerance for risk. Utility is defined as the willingness to accept risk, work with it, and manage it. Utility, as it relates to the risk-averse organization, rises at a decreasing rate as risk increases. Basically the greater the risk, the less the risk averse person can accept it and manage it. Utility rises at a faster rate for the risk seeker as risk intensity increases. Risk seekers thrive on risk opportunities.

Risk triggers Symptoms and indications that suggest a risk event could occur. It is important to address risk triggers before a serious risk event occurs.

Secondary risk Risk generated by the response to a primary risk.

Sensitivity analysis A technique used to determine how different values of an independent variable will impact a particular dependent variable under a given set of assumptions. This technique is used within specific boundaries that will depend on one or more input variables, such as the effect that changes in material costs will have on net present value. Commonly displayed as a "tornado" diagram.

Threshold Amount of risk an organization or key stakeholders are willing to accept.

Types of risks Insurable risk: These risk events are associated with a chance for loss only. Example: accidents, workman's compensation. Business risk: These risk events are associated with a chance for profit or loss. Examples: competition, market conditions, new product development.

Workaround A temporary response to an unplanned event.

► Procurement Management Processes

Project procurement includes the processes that will assist in determining the specific goods or services that must be procured externally from an organization. Procurement management addresses make-or-buy decisions, buyer and seller relationships, types of contracts, and the risks associated with contract types. It also includes contract negotiations, managing the seller, observing seller/contractor work performance, managing contract terms and conditions, and closing contracts and procurement activities.

Project procurement management is the process of determining what, when, and how to purchase or acquire products or services. It includes three major processes:

1. Plan procurement management: Preparing the approach to that will decide what to procure and how to manage the procurement process
2. Conduct procurements: The processes associated with submitting proposals, selecting sellers, and awarding a contract
3. Control procurements: Managing procurement relationships, managing changes, and documenting performance

Key terms

- Make-or-buy analysis (determining the capability of an organization to produce deliverables internally using available resources and capacity or selecting a contractor to perform the work)
- Procurement statement of work (defines the work that will be included in the negotiated contract)
- Source selection criteria (the specific requirements that must be fulfilled by a contractor/seller to be included in the bid process)
- Procurement documents (RFP, RFI, invitation to bid, RFQ [request for quotation])

Tools and techniques

- Data gathering
- Make or buy analysis
- Expert judgment
- Market research
- Meetings
- Source selection analysis

Major inputs

- Project charter
- Project management plan
- Business documents
- Project documents
- Requirements documentation
- Risk register
- Activity resource requirements
- Project schedule
- Activity cost estimates
- Stakeholder register
- Enterprise environmental factors
- Organizational process assets
- Approved supplier lists
- Formal procurement procedures
- Contract types. Common contract types include fixed price, fixed price incentive fee, cost reimbursable (cost plus fixed fee, cost plus award fee, time, and material)

Conduct procurements: The processes that will identify and document procurement requirements and determine potential suppliers or sellers.

Key terms

- Bidder conference (provides all parties with a clear and common understanding of the work requested)
- Proposal evaluation techniques (formal process of reviewing the submitted proposals. These techniques will vary by organization)
- Independent estimates (prepared by the buyer or by an external source to use as a benchmark when evaluating proposals)
- Procurement negotiations (selecting the appropriate negotiating team, determining the appropriate tactics, selecting the location for negotiations, establishing appropriate protocol)

Tools and techniques

- Bidder conference
- Proposal evaluation techniques
- Independent estimates
- Expert judgment
- Advertising
- Analytical techniques
- Internet search
- Procurement negotiations
- Standard forms
- Procurement documents
- Evaluation criteria

Major inputs

- Project management plan
- Subsidiary plans
- Procurement management plan
- Risk management plan
- Procurement documents
- Source selection criteria
- Seller proposals
- Project documents
- Make-or-buy decisions
- Procurement statement of work
- Organizational process assets

Source selection criteria: This process includes understanding of the needs of the buyer, proposed cost of the sellers' services, technical capability of the seller, the managerial approach, warranties, financial and production capacity, and references from previous work.

Key terms

- Weighting system (used to ensure fair assessment of sellers)
- Screening system (ensures that minimum qualifications are satisfied)
- Contract (a mutual agreement that includes a consideration (down payment and agreed-upon costs), established for a legal purpose and provided by law

Control procurements: The process of managing the contract terms and conditions and the procurement relationships between buyer and seller. Managing changes and documenting the performance of the seller during execution.

Key terms

- Dispute negotiations (discussing and settling outstanding issues and disagreements, sometimes conducted through arbitration)
- Punch list (list of items prepared by the client or customer that require resolution by the supplier)
- Deliverable acceptance (formal acceptance as defined in the contract and procurement documents, usually a signature finalizing the completion of the entire procurement process)
- Lessons learned (documented areas where improvement is possible)

Tools and techniques

- Expert judgment
- Contract change control system
- Procurement performance review
- Inspections and audits
- Earned value management
- Inspections
- Performance reporting
- Payment system
- Claims administration
- Records management system

Major inputs

- Project management plan
- Procurement documents

- Agreements
- Approved change requests
- Work performance reports
- Work performance data

The control procurements process is intended to provide direction to the seller, establish the process to authorize when work can begin, manage the quality of the work performed, manage changes, and ensure that risks are identified and managed with the appropriate response.

PMP® Exam Study Terms

Remember to review the different types of contracts and the advantages and disadvantages of each type.

As an example: When selecting the lump sum or firm fixed-price contract (FFP), the risk is associated with the seller. Use of the cost-plus contracts generally shifts the risk to the buyer.

Administrative changes Generally this type of change is for records only and does not impact the work of the project. Example: changing the account that funds will be drawn from, address changes.

Bidder conference A meeting scheduled by the buyer to provide information to all potential bidders. The meeting provides a "level playing field" for potential contractors.

Close out Punch lists (list of unsatisfactory items prepared by the buyer) are prepared, verification of contracted deliverables is conducted, formal acceptance is obtained, post project reviews are scheduled and conducted, contract reviews are conducted, and final payments are made. Project close out is often referred to as a project in itself. It requires planning, coordination, and a specific set of objectives.

Constructive change An action or inaction by a party associated with the project that impacts the actual work and requires a change to the planned work. There is usually a cost associated with a constructive change.

Contract A legal document that includes an offer, acceptance, and consideration (something of value).

Definitive contract: The final, agreed upon contract

Completion contract: The contractor/supplier/seller is required to produce a specific end product or deliverable

Term contract: A contract that is intended to deliver a specific level of effort in a given time frame and may not include a specific tangible deliverable

Contract types

Firm fixed price (FFP) or lump sum

Fixed price incentive fee (FPIF)

Cost plus incentive fee (CPIF)

Time and material (T&M)

Purchase order

Cost plus percentage of cost (CPPC)

Cost plus fixed fee (CPFF)

Remember the risks associated with each type of contract and which party or parties are exposed to the greatest risk. Incentive contracts will include a sharing ratio that is negotiated between the buyer and seller and is intended to create a desire to manage costs effectively.

Contract close out The process that includes development of punch lists, verification of contracted deliverables, formal acceptance or deliverables, post-project reviews, contract reviews.

Fait accompli An accomplished fact; a thing already done. Commonly referred to as "a done deal."

Force majeure A common clause in contracts that essentially frees both parties from liability or obligation when an extraordinary event or circumstance beyond the control of the parties, such as a war, strike, riot, crime, or act of nature occurs (e.g., flooding, earthquake, volcano).

Liquidated damages A contractually agreed upon amount to be paid in the event of a breach of the contract, in lieu of performance or quantification of actual damages sustained.

Make-or-buy decisions The decision to build or fabricate an item internally or to contract the work to a seller. Make-or-buy decisions depend on cost, desired level of control, capability of the buyer's organization, type of deliverable, capacity of the buyer's organization. Consider the benefits and disadvantages of the make and buy decisions and the risks that may be associated with the decision.

Negotiation Negotiation requires a specific skill set and is a necessary activity in the procurement process. There are several negotiation tactics that may be utilized during discussions and contract development activities. Skillful negotiation includes understanding the needs of the other parties involved, developing fair and reasonable offers, and willingness to make concessions, understanding the minimum and maximum allowable amounts to associate with each element to be received or given during the negotiations. Hygiene issues such as type of room set up, location, type of tables and positioning of the parties involved, and cultural differences are included in the total negotiation process.

Nondisclosure agreement A nondisclosure agreement (NDA), also known as a confidentiality agreement, confidential disclosure agreement (CDA), proprietary information agreement (PIA), or secrecy agreement, is a legal contract between at least two parties that outlines confidential materials or knowledge the parties wish to share with one another for certain purposes, but wish to restrict access to by other parties. It is a contract through which the parties agree not to disclose information outside of agreed upon boundaries and restrictions described in the agreement.

Penalty clause A provision in a contract that stipulates an excessive pecuniary charge against a defaulting party. Generally, this is a late fee imposed on a seller if a milestone is not fulfilled.

Privity In contract law, privity provides that a contract cannot confer rights or impose obligations arising under it on any person or agent except the parties to it. Privity is basically the legal relationship established between the parties through the contract.

Project reviews At project completion the project manager and team conduct reviews of the entire project and compare actual results with contractual agreements. Lesson learned are identified and plans for process improvement are often developed. Project reviews may be conducted several times during the project life cycle.

Project stakeholder management Identifying the people, organizations, external groups, and other entities that have an interest in the project or are impacted either positively or negatively as a result of the project. There are four major processes included in stakeholder management

- Identify stakeholders
- Plan stakeholder engagement
- Manage stakeholder engagement
- Monitor stakeholder engagement

Special terms and conditions Make sure to identify penalty clauses, liquidated damages clauses, force majeure clauses (natural disasters, events that cannot be controlled by the contractor) and other contract terms and conditions that may have a significant impact on the interests of the parties involved.

Statement of work A narrative description of work to be completed under contract. This document provides details about the work to be done by the contractor and allows to seller/contractor to determine if the work can be performed successfully.

Termination for convenience A provision in the contract that allows the project to be terminated by the buyer for other than performance reasons. Example: The technology is no longer needed, there are no additional funds to support the project, the buyer organization has a change in strategic direction.

Termination due to default A breach in the agreement by the contractor, failure to provide what was agreed upon in the contract results in termination of the contract.

► Stakeholder Management Processes

Identify stakeholders: The process of determining the key stakeholders and the groups or organizations that will be involved or affected by the project.

Key terms

- Stakeholder analysis: Systematically gathering and analyzing information to determine the interests, needs and expectations of the people and organizations that may be included in the project.
- Stakeholder register: A list of stakeholders, their level of influence, and the strategies defined to deal with each stakeholder.

- Power/interest grid: A technique and model that will assist in determining the level of influence and interest of an identified stakeholder.
- Salience model: A method that will assist in determining the ability of a stakeholder to impose their will on the project activities, their urgency level, and the legitimacy of their involvement in the project.

The power/interest grid and the salience model provide an opportunity to develop strategies for managing the identified stakeholders.

Major inputs

- Project charter
- Procurement documents
- Business documents
- Business case
- Enterprise environmental factors
- Organizational process assets

Tools and techniques

- Stakeholder analysis
- Expert judgment
- Meetings

Plan stakeholder management: Developing the strategies for working with and dealing with the needs of the identified stakeholders. Establishing processes and plans for effectively managing the many interrelationships and reporting structures associated with the project.

Key terms

- Analytical techniques: Determining the level of engagement of the stakeholders. Examples: awareness, resistance, neutral, supportive, leader. These levels of interest are generally captured in the stakeholder assessment matrix.

Tools and techniques

- Expert judgment
- Data gathering
- Stakeholder engagement assessment matrix
- Meetings
- Analytical techniques

Major inputs

- Project management plan
- Subsidiary plans (resource management plan, communications management plan)

- Project documents (stakeholder register)
- Enterprise environmental factors
- Organizational process assets

Manage stakeholder engagement: The process of communicating with stakeholders and managing their expectations.

Key terms

- Communications methods (interactive, push and pull communications)
- Interpersonal skills (listening, building trust, managing and resolving conflict, managing resistance to change)
- Management skills (influencing people, facilitating consensus, negotiating agreements, modifying behaviors to achieve objectives)

Tools and techniques

- Expert judgment
- Inspection
- Communications methods
- Interpersonal skills
- Management skills

Major inputs

- Stakeholder engagement plan
- Communications management plan
- Project documents (change log, issue log)
- Organizational process assets

Monitor stakeholder engagement: The process of monitoring stakeholder relationships and adjusting strategies to meet changing needs.

Key term

- Information management systems: System or group of systems used for the purpose of gathering, storing, analyzing, and disseminating project information.

Tools and techniques

- Data analysis
- Alternatives analysis
- Root cause analysis
- Information management systems
- Expert judgment
- Meetings

Major inputs

- Project management plan
- Subsidiary plans
- Resource management
- Communications management
- Issue log
- Lessons learned
- Work performance data
- Project documents

▶ General Note about Outputs to *PMBOK® Guide* Processes

The outputs of the processes associated with each of the *PMBOK® Guide* processes will, in most cases become inputs to another set of processes. As you read each knowledge area and the associated processes, you will notice a consistent flow of processes from inputs to tools and techniques to outputs. As you progress through the *PMBOK® Guide,* you will notice that many inputs and tools and techniques are repeatedly included in the processes associated with the knowledge area. This repetition emphasizes the integrative nature of managing a project. It will also assist you in becoming familiar with the terminology and the application of the process components.

▶ Professional Responsibility

The domain of professional and social responsibility is now embedded in the five project management domains: initiating, planning, executing, monitoring and controlling, and closing. The exam is structured to provide questions derived from each process group and many questions will include references or situations that are associated with ethics, professional conduct, legal issues and other factors associated with project leadership.

- PMI view: Ethics is about making the best possible decisions concerning people, resources, and the environment. Ethical choices diminish risk, advance positive results, increase trust, determine long term success, and build reputations. Leadership is absolutely dependent on ethical choices.
- PMI members have determined that honesty, responsibility, respect and fairness are the values that drive ethical conduct for the project management profession.

Professional responsibility is closely associated with the *PMBOK® Guide* knowledge areas: human resource management and communications management. Professional responsibility is also associated with diversity, cultural differences, managing in an international project environment such as sensitivity to time zones, geographic location,

political issues, ethics, ethnic differences, and customs. These are important factors to consider during project planning and implementation. PMP® candidates should include in their study the issues and sensitivities of managing in an international project environment. Review the Code of Ethics and Professional Conduct developed by PMI and available at the PMI website, www.pmi.org.

Professional responsibility includes the following subjects. Project managers are expected to be aware of these items and manage appropriately through all project life cycle phases and when managing each of the five major process groups:

- Ensuring individual integrity

  Responsibilities of employers (fairness and respect for employees), accommodating employee needs, managing diversity in the workplace, complying with federal employment laws, dealing ethically with all project stakeholders, making ethical business decisions (honesty and integrity), and dealing ethically with employees, customers, and other businesses
- Promoting interaction among stakeholders

  Listening skills, understanding and adapting communication styles to manage team effectively (styles may be authoritative, facilitating, judicial, participative), effective negotiation and conflict resolution (balancing stakeholder needs, fair and reasonable offers, establishing partnerships), recognizing conflict and managing conflicts effectively to seek a win-win solution. Conflict management handling modes: collaboration, compromise, forcing, withdrawing, and smoothing
- Enhancing personal and professional competence

  Creating a personal development plan for self-improvement and continuous education, becoming a mentor and coach
- Contributing to the project management knowledge base

  Documenting and sharing lessons learned. Writing articles, books, and presenting information at project management events.

Study note: Review the current PMI Code of Ethics and Professional Conduct. The code specifies four areas: honesty, responsibility, respect, and fairness that are the basic essence of the responsibilities of the project manager.

► Project Management Formulas

The following are formulas that may be associated with PMP® exam questions:

Communications channels $X = [(N) \times (N - 1)] / 2$ where X is the number of channels of communication and N is the number of people on the team

PERT Weighted average formula (Optimistic + 4 times the most likely value + Pessimistic) / 6 – Beta distribution

Float is obtained during the forward and backward pass calculations in CPM. Float is the difference between the late finish and early finish of an activity. In some situations,

calculation of float will depend on the logical relationship between activities. Consider finish to start, start to start, and finish to finish relationships and the differences between early start and late start and early finish and late finish when determining how a slippage may impact the project end date. In some cases the float may actually be calculated as the difference between the early start and late start of an activity when a start to start relationship is used.

Free float is the difference between the early start of an activity and the early finish of a predecessor activity. Free float is the amount of time an activity can slip before it affects its successor activities.

Standard Deviation (Pessimistic – Optimistic) / 6

Net Present Value The sum of the present values minus the initial cost

Present Value FV / (1 + *r*) *n*

Future Value PV (1 + *r*) *n*

■ Earned Value Formulas

EV (BCWP) – AC (ACWP) = Cost variance (CV) (a negative cost variance = budget overrun)

EV – PV (BCWS) = Schedule variance (SV) (a negative SV means the project or work package is behind schedule)

EV/AC (ACWP) = Cost performance index (CPI) (a measure of efficiency in managing the project budget)

EV/PV (BCWS) = Schedule performance index (SPI) (a measure of efficiency in managing the project schedule)

A performance index (PI) that equals 1 means there is no variance and the project or work package is performing as planned. A PI greater than 1 indicates superior performance. A PI less than 1 indicates a schedule slippage or a cost overrun.

EAC (Estimate at Complete)

EAC = AC + BAC -EV where BAC is the Budget at Complete. This formula is used when variances are determined to be atypical and the remaining work will be completed at the budgeted rate.

EAC = BAC / CPI. Used when current variances are seen as typical and are expected to continue as the project progresses,

EAC = AC + [BAC – EV] / cumulative CPI × cumulative SPI. Used when project schedule is a factor impacting the ETC effort (Estimate to Complete)

TCPI = [BAC – EV] / [BAC – AC]. Used when the approved BAC must be met

TCPI = [BAC – EV] / [EAC – AC]. Used when the original BAC cannot be met.

Your Personal Learning Library

Write down your thoughts, ideas, and observations about the material in the chapter that may assist you with your learning experience. Create action items and additional study plans to assist you in enhancing your skills, or for preparing to take the PMP® or CAPM® exam.

Insights, key learning points, personal recommendations for additional study, areas for review, application to your work environment, items for further discussion with associates.

Personal Action Items:	
Action Item	**Target Date for Completion**

▶ Practice Questions for the Project Management Professional (PMP)® Exam

■ Integration Management

The following questions will be helpful in reviewing integration management.

1. The triple constraints commonly associated with managing a project are:
   - **a.** Time, cost, and profitability
   - **b.** Resources required, sponsorship involvement, and funding
   - **c.** Time, cost, and quality and/or scope
   - **d.** Calendar dates, facilities available, and funding
2. Which of the following is not associated with the definition of a project?
   - **a.** Repetitive activities
   - **b.** Constraints
   - **c.** Consumption of resources
   - **d.** A well-defined objective
3. Which of the following is usually not part of the criteria for project success?
   - **a.** Customer satisfaction
   - **b.** Customer acceptance
   - **c.** Meeting at least 75 percent of specification requirements
   - **d.** Meeting the triple constraint requirements
4. Which of the following is generally not a benefit achieved from using project management?
   - **a.** Flexibility in the project's end date
   - **b.** Improved risk management
   - **c.** Improved estimating
   - **d.** Tracking of projects
5. To whom would the project manager go first for staffing a project?
   - **a.** The project management office
   - **b.** The human resources department
   - **c.** The line manager
   - **d.** The executive sponsor
6. Where would the project manager go first for resolving conflicts between the project and line managers?
   - **a.** Assistant project manager for conflicts
   - **b.** The project sponsor
   - **c.** The executive steering committee
   - **d.** The human resources department

7. After the project is initiated, the customer wants some degree of confidence that the customer's objectives are achievable. Which document would the project manager use first to convince the customer?
   a. The customer's statement of work
   b. The project manager's scope statement
   c. The project plan
   d. The scope baseline
8. The project manager normally meets with the project sponsor during project initiation to get assistance in:
   a. Defining the project's objectives in both business and technical terms
   b. Developing the project plan
   c. Performing the project feasibility study
   d. Performing the project cost-benefit analysis
9. The role of the project sponsor during project execution is to:
   a. Validate the project's objectives
   b. Validate the execution of the plan
   c. Make all project decisions
   d. Resolve problems/conflicts that cannot be resolved elsewhere in the organization
10. The role of the project sponsor during the closure of the project or a life cycle phase of the project is to:
   a. Validate that the profit margins are correct
   b. Sign off on the acceptance of the deliverables
   c. Administer performance reviews of the project team members
   d. Get the customer to agree to follow-on work

Answers

1. c
2. a
3. c
4. a
5. c
6. b
7. c
8. a
9. d
10. b

■ Project Scope Management

The following multiple-choice questions will be helpful in reviewing the principles of project scope management.

1. Which document would the project manager identify first to the project team at the initial kickoff meeting to show that the project is officially sanctioned as a project?
   a. Project charter
   b. Project plan
   c. Feasibility study
   d. Cost-benefit analysis
2. A project manager is unsure of what is required in a certain work package. To get a better understanding of what the work package involves, the project manager would first look at the:
   a. Schedule control documents
   b. Code of accounts
   c. WBS dictionary
   d. Risk management plan

Answer questions 3 through 6 using the work breakdown structure shown below (numbers in parentheses show the dollar value for a particular element):

1.00.00
- 1.1.0 ($25k)
  - 1.1.1
  - 1.1.2 ($12k)
- 1.2.0
  - 1.2.1 ($16k)
  - 1.2.2.0
    - 1.2.2.1 ($20k)
    - 1.2.2.2 ($30k)

3. The cost of WBS element 1.2.2.0 is:
   a. $20K
   b. $30K
   c. $50K
   d. Cannot be determined
4. The cost of WBS element 1.1.1 is:
   a. $12K
   b. $13K
   c. $25K
   d. Cannot be determined
5. The cost of the entire program (1.00.00) is:
   a. $25K
   b. $66K
   c. $91K
   d. Cannot be determined

6. The work packages in the WBS are at WBS level(s):
   a. 2 only
   b. 3 only
   c. 4 only
   d. 3 and 4
7. One of the outputs of the PMBOK® Define Scope Process is:
   a. A project charter
   b. A scope statement
   c. A detailed WBS
   d. None of the above
8. One of your contractors has sent you an e-mail requesting that they be allowed to conduct only eight tests rather than the ten tests required by the specification. What should the project manager do first?
   a. Change the scope baseline
   b. Ask contractor to put forth a change request
   c. Look at the penalty clauses in the contract
   d. Ask your sponsor for his/her opinion
9. One of your contractors sends you an e-mail request to use high-quality raw materials in your project stating that this will be value-added and improve quality. What should the project manager do first?
   a. Change the scope baseline
   b. Ask the contractor to put forth a change request
   c. Ask your sponsor for his/her opinion
   d. Change the WBS
10. The change control board, of which you are a member, approves a significant scope change. The first document that the project manager should update would be the:
   a. Scope baseline
   b. Schedule
   c. WBS
   d. Budget

Answers

1. a
2. c
3. c
4. b
5. c
6. d
7. b
8. b
9. b
10. a

■ Project Time Management

The following multiple-choice questions will be helpful in reviewing the principles of project time management:

1. The shortest time necessary to complete all of the activities in a network is called the:
   - **a.** Activity duration length
   - **b.** Critical path
   - **c.** Maximum slack path
   - **d.** Compression path
2. Which of the following cannot be identified after performing a forward and backward pass?
   - **a.** Free float
   - **b.** Slack time
   - **c.** Critical path activities
   - **d.** How much overtime is planned
3. Which of the following is not a commonly used technique for schedule compression?
   - **a.** Resource reduction
   - **b.** Reducing scope
   - **c.** Fast-tracking activities
   - **d.** Use of overtime
4. A network-based schedule has four paths, namely 7, 8, 9, and 10 weeks. If the 10-week path is compressed to 8 weeks, then:
   - **a.** We now have two critical paths
   - **b.** The 9-week path is now the critical path
   - **c.** Only the 7-week path has slack
   - **d.** Not enough information is provided to make a determination
5. The major disadvantage of using bar charts to manage a project is that bar charts:
   - **a.** Do not show dependencies between activities
   - **b.** Are ineffective for projects under one year in length
   - **c.** Are ineffective for projects under $1 million in size
   - **d.** Do not identify start and end dates of a schedule
6. Which of the following steps would a project do first in the development of a network diagram?
   - **a.** Listing of the activities
   - **b.** Determination of dependencies
   - **c.** Calculation of effort
   - **d.** Calculation of durations

7. Reducing the peaks and valleys in manpower assignments in order to obtain a relatively smooth manpower curve is called:
   a. Manpower allocation
   b. Resource leveling
   c. Resource allocation
   d. Resource commitment planning
8. Activities with no time duration are called _____ activities.
   a. Reserve
   b. Dummy
   c. Zero slack
   d. Supervision
9. Optimistic, pessimistic, and most likely activity times are associated with:
   a. PERT
   b. GERT
   c. PDM
   d. ADM
10. The most common "constraint" or relationship in a precedence network is:
   a. Start to start
   b. Start to finish
   c. Finish to start
   d. Finish to finish

Answers

1. b
2. d
3. a
4. d
5. a
6. a
7. b
8. b
9. a
10. c

■ Project Cost Management

The following questions will be helpful in reviewing the principles of project cost management.

1. In earned value measurement, earned value is represented by:
   a. BCWS
   b. BCWP
   c. ACWP
   d. None of the above

2. If BCWS = 1,000, BCWP = 1,200, and ACWP = 1,300, the project is:
   a. Ahead of schedule and under budget
   b. Ahead of schedule and over budget
   c. Behind schedule and over budget
   d. Behind schedule and under budget
3. If BAC = $20,000 and the project is 40% complete, then the earned value is:
   a. $5,000
   b. $8,000
   c. $20,000
   d. Cannot be determined
4. If BAC = $12,000 and CPI = 1.2, then the variance at completion is:
   a. –$2,000
   b. +$2,000
   c. –$3,000
   d. +$3,000
5. If BAC = $12,000 and CPI = 0.8, then the variance at completion is:
   a. –$2,000
   b. +$2,000
   c. –$3,000
   d. +$3,000
6. If BAC for a work package is $10,000 and BCWP = $4,000, then the work package is _____ percent complete.
   a. 40
   b. 80
   c. 100
   d. 120
7. If CPI = 1.1 and SPI = 0.95, then the trend for the project is:
   a. Running over budget but ahead of schedule
   b. Running over budget but behind schedule
   c. Running under budget but ahead of schedule
   d. Running under budget but behind schedule
8. The document that describes a work package, identifies the cost centers allowed to charge against this work package, and establishes the charge number for this work package is the:
   a. Code of accounts
   b. Work breakdown structure

c. Work authorization form

d. None of the above

9. Unknown problems such as escalation factors are often budgeted for using the:

a. Project manager's charge number

b. Project sponsor's charge number

c. Management reserve

d. Configuration management cost account

10. EAC, ETC, SPI, and CPI most often appear in which type of report?

a. Performance

b. Status

c. Forecast

d. Exception

11. If BAC = $24,000, BCWP = $12,000, ACWP = $10,000, and CPI = 1.2, then the cost that remains to finish the project is:

a. $10,000

b. $12,000

c. $14,000

d. Cannot be determined

12. There are several purposes for the 50%–50% rule, but the primary purpose of the 50%–50% rule is to calculate:

a. BCWS

b. BCWP

c. ACWP

d. BAC

13. When a project is completed, which of the following must be true?

a. BAC = ACWP

b. ACWP = BCWP

c. SV = 0

d. BAC = ETC

14. In March, CV = –$20,000 and in April, CV = –$30,000. In order to determine whether the situation has really deteriorated because of a larger unfavorable cost variance, we would need to calculate:

a. CV in percent

b. SV in dollars

c. SV in percent

d. All of the above

15. If a project manager is looking for revenue for a value-added scope change, the project manager's first choice would be:

a. Management reserve

b. Customer-funded scope change

c. Undistributed budget

d. Retained profits

16. A project was originally scheduled for 20 months. If CPI is 1.25, then the new schedule date is:

a. 16 months

b. 20 months

c. 25 months

d. Cannot be determined

17. The cost or financial baseline of a project is composed of:

a. Distributed budget only

b. Distributed and undistributed budgets only

c. Distributed budget, undistributed budget, and the management reserve only

d. Distributed budget, undistributed budget, management reserve, and profit only

Answers

1. b
2. b
3. b
4. b
5. c
6. a
7. d
8. c
9. c
10. c
11. a
12. b
13. c
14. a
15. b
16. d
17. b

■ Project Quality Management

The following questions will be helpful in reviewing the principles of project quality management.

1. Which of the following is not part of the generally accepted view of quality today?

a. Defects should be highlighted and brought to the surface

b. We can inspect in quality

c. Improved quality saves money and increases business

d. Quality is customer-focused

2. In today's view of quality, who defines quality?
   a. Contractor's senior management
   b. Project management
   c. Workers
   d. Customers
3. Which of the following are tools of quality control?
   a. Sampling tables
   b. Process charts
   c. Statistical and mathematical techniques
   d. All of the above
4. Which of the following is true of modern quality management?
   a. Quality is defined by the customer
   b. Quality has become a competitive weapon
   c. Quality is now an integral part of strategic planning
   d. All are true
5. A company dedicated to quality usually provides training for:
   a. Senior management and project managers
   b. Hourly workers
   c. Salaried workers
   d. All employees
6. Which of the following quality gurus believe "zero defects" is achievable?
   a. Deming
   b. Juran
   c. Crosby
   d. All of the above
7. What are the components of Juran's Trilogy?
   a. Quality improvement, quality planning, and quality control
   b. Quality improvement, zero defects, and quality control
   c. Quality improvement, quality planning, and PERT charting
   d. Quality improvement, quality inspections, and quality control
8. Which of the following is not one of Crosby's Four Absolutes of Quality?
   a. Quality means conformance to requirements
   b. Quality comes from prevention
   c. Quality is measured by the cost of conformance
   d. Quality means that the performance standard is "zero defects"

9. According to Deming, what percentage of the costs of quality is generally attributable to management?
   a. 100%
   b. 85%
   c. 55%
   d. 15%
10. Inspection:
   a. Is an appropriate way to ensure quality
   b. Is expensive and time-consuming
   c. Reduces rework and overall costs
   d. Is always effective in stopping defective products from reaching the customer
11. The Taguchi method philosophies concentrate on improving quality during the:
   a. Conceptual phase
   b. Design phase
   c. Implementation phase
   d. Closure phase
12. A well-written policy statement on quality will:
   a. Be a statement of how, not what or why
   b. Promote consistency throughout the organization and across projects
   c. Provide an explanation of how customers view quality in their own organizations
   d. Provide provisions for changing the policy only on a yearly basis
13. Quality assurance includes:
   a. Identifying objectives and standards
   b. Conducting quality audits
   c. Planning for continuous collection of data
   d. All of the above
14. What is the order of the four steps in Deming's Cycle for Continuous Improvement?
   a. Plan, do, check, and act
   b. Do, plan, act, and check
   c. Check, do, act, and plan
   d. Act, check, do, and plan
15. Quality audits:
   a. Are unnecessary if you do it right the first time
   b. Must be performed daily for each process

c. Are expensive and therefore not worth doing

d. Are necessary for validation that the quality policy is being followed and adhered to

16. Which of the following is/are typical tool(s) of statistical process control?

a. Pareto analysis

b. Cause-and-effect analysis

c. Process control charts

d. All of the above

17. Which of the following methods is best suited to identifying the "vital few"?

a. Pareto analysis

b. Cause-and-effect analysis

c. Trend analysis

d. Process control charts

18. When a process is set up optimally, the upper and lower specification limits typically are:

a. Set equal to the upper and lower control limits

b. Set outside the upper and lower control limits

c. Set inside the upper and lower control limits

d. Set an equal distance from the mean value

19. The upper and lower control limits are typically set:

a. One standard deviation from the mean in each direction

b. 3σ (three sigma) from the mean in each direction

c. Outside the upper and lower specification limits

d. To detect and flag when a process may be out of control

20. Which of the following is not indicative of today's views of the quality management process applied to a given project?

a. Defects should be highlighted and brought to the surface

b. The ultimate responsibility for quality lies primarily with senior management or sponsor, but everyone should be involved

c. Quality saves money

d. Problem identification leads to cooperative solutions

21. If the values generated from a process are normally distributed around the mean value, what percentage of the data points generated by the process will not fall within +/– three standard deviations of the mean?

a. 99.7%

b. 95.4%

c. 68.3%

d. 0.3%

Answers

1. b
2. d
3. d
4. d
5. d
6. c
7. a
8. c
9. b
10. b
11. b
12. b
13. d
14. a
15. d
16. d
17. a
18. b
19. b
20. b
21. d

■ Project Human Resources Management

The following multiple-choice questions will be helpful in reviewing the principles of project human resources management.

1. In which organizational form is it most difficult to integrate project activities?
   a. Classical/traditional
   b. Projectized
   c. Strong matrix
   d. Weak matrix
2. In which organization form would the project manager possess the greatest amount of authority?
   a. Classical/traditional
   b. Projectized
   c. Strong matrix
   d. Weak matrix
3. In which organizational form does the project manager often have the least amount of authority?
   a. Classical/traditional
   b. Projectized
   c. Strong matrix
   d. Weak matrix
4. In which organizational form is the project manager least likely to share resources with other projects?
   a. Classical/traditional
   b. Projectized

c. Strong matrix

d. Weak matrix

5. In which organizational form do project managers have the greatest likelihood of possessing reward power and have a wage and salary administration function? (The project and line manager are the same person.)

a. Classical/traditional

b. Projectized

c. Strong matrix

d. Weak matrix

6. In which organizational form is the worker in the greatest jeopardy of losing his/her job if the project gets cancelled?

a. Classical/traditional

b. Projectized

c. Strong matrix

d. Weak matrix

7. In which type of matrix structure would a project manager most likely have a command of technology?

a. Strong matrix

b. Balanced matrix

c. Weak matrix

d. Cross-cultural matrix

8. Which of the following is not one of the sources of authority for a project manager?

a. Project charter

b. Job description for a project manager

c. Delegation from senior management

d. Delegation from subordinates

9. Which form of power do project managers that have a command of technology and are leading R&D projects most frequently use?

a. Reward power

b. Legitimate power

c. Expert power

d. Referent power

10. If a project manager possesses penalty (or coercive) power, he most likely also possesses:

a. Reward power

b. Legitimate power

c. Expert power

d. Referent power

11. A project manager with a history of success in meeting deliverables and in working with the team members would most likely possess a great deal of:

a. Reward power

b. Legitimate power

c. Expert power

d. Referent power

12. Most project managers are motivated by which level of Maslow's hierarchy of human needs?

a. Safety

b. Socialization

c. Self-esteem

d. Self-actualization

13. You have been placed in charge of a project team. The majority of the team members have less than two years of experience working on project teams and most of the people have never worked with you previously. The leadership style you would most likely select would be:

a. Telling

b. Selling

c. Participating

d. Delegating

14. You have been placed in charge of a new project team and are fortunate to have been assigned the same people that worked for you on your last two projects. Both previous projects were very successful and the team performed as a high-performance team. The leadership style you would most likely use on the new project would be:

a. Telling

b. Selling

c. Participating

d. Delegating

15. Five people are in attendance in a meeting and are communicating with one another. How many two-way channels of communication are present?

a. 4

b. 5

c. 10

d. 20

16. A project manager provides a verbal set of instructions to two team members on how to perform a specific test. Without agreeing or disagreeing with the project manager, the two employees leave the project manager's office. Later, the project

manager discovers that the tests were not conducted according to his instructions. The most probable cause of failure would be:

a. Improper encoding

b. Improper decoding

c. Improper format for the message

d. Lack of feedback on instructions

17. A project manager that allows workers to be actively involved with the project manager in making decisions would be using a _____ leadership style.

a. Passive

b. Participative/democratic

c. Autocratic

d. Laissez-faire

18. A project manager that dictates all decisions and does not allow for any participation by the workers would be using a _____ leadership style.

a. Passive

b. Participative/democratic

c. Autocratic

d. Laissez-faire

19. A project manager that allows the team to make virtually all of the decisions without any involvement by the project manager would be using a _____ leadership style.

a. Passive

b. Participative/democratic

c. Autocratic

d. Laissez-faire

20. During project staffing, the primary role of senior management is in the selection of the _____.

a. Project manager

b. Assistant project managers

c. Functional team

d. Executives do not get involved in staffing

21. During project staffing, the primary role of line management is:

a. Approving the selection of the project manager

b. Approving the selection of the assistant project managers

c. Assigning functional resources based upon who is available

d. Assigning functional resources based upon availability and the skill set needed

22. A project manager is far more likely to succeed if it is obvious to everyone that:

a. The project manager has a command of technology

b. The project manager is at a higher pay grade that everyone else on the team

c. The project manager is over 45 years of age

d. Executive management has officially appointed the project manager

23. Most people believe that the best way to train someone in project management is through:

a. On-the-job training

b. University seminars

c. Graduate degrees in project management

d. Professional seminars and meetings

24. In staffing negotiations with the line manager, you identify a work package that requires a skill set of a Grade 7 worker. The line manager informs you that he will assign a Grade 6 and a Grade 8 worker. You should:

a. Refuse to accept the Grade 6 because you are not responsible for training

b. Ask for two different people

c. Ask the sponsor to interfere

d. Be happy! You have two workers.

25. You priced out a project work package at 1,000 hours assuming a Grade 7 employee would be assigned. The line manager assigns a Grade 9 employee. This will result in a significant cost overrun. The project manager should:

a. Reschedule the start date of the project based upon the availability of a Grade 7

b. Ask the sponsor for a higher priority for your project

c. Reduce the scope of the project

d. See if the Grade 9 can do the job in less time

26. As a project begins to wind down, the project manager should:

a. Release all nonessential personnel so that they can be assigned to other projects

b. Wait until the project is officially completed before releasing anyone

c. Wait until the line manager officially requests that the people be released

d. Talk to other project managers to see who wants your people

Answers

1. a
2. b
3. d
4. b
5. b
6. b
7. a
8. d
9. c
10. a

11. d
12. d
13. a
14. d
15. c
16. d
17. b
18. c
19. d
20. a
21. d
22. d
23. a
24. d
25. d
26. a

■ Project Communications Management

The following multiple-choice questions will be helpful in reviewing the principles of project communications management.

1. The sender–receiver model is designed to help project managers and team members improve their communications skills by emphasizing:
   a. The need for the project manager to engage in downward communication
   b. The importance of horizontal communications during project execution
   c. Potential communications barriers and the importance of feedback loops
   d. The need to communicate information verbally
2. To do communications planning, the process requires which of the following inputs?
   a. Work results, project plan, project records
   b. Communications requirements, communications technology, constraints, assumptions
   c. Performance reviews, trend analysis
   d. Project reports, product documentation, information retrieval systems
3. As a project manager you must identify the needs of the stakeholders involved in the project. These needs are identified in which of the following processes?
   a. Performance reviews
   b. Trend analysis
   c. Performance measurement
   d. Communications requirements
4. On most projects, the majority of communications planning is done
   a. During execution
   b. At the earliest stages of the project
   c. Just prior to closeout
   d. Evenly throughout each project phase

5. Project resources should be expended only on communicating information that:
   a. Contributes to the success of the project or where a lack of communication can lead to failure
   b. Comes from external sources such as government or regulatory agencies
   c. Has been generated internally by the organization's executive team
   d. Is developed by the project team
6. A factor in the determination of communications technology needs is:
   a. Stakeholder analysis
   b. The communications plan
   c. The immediacy of the need for information
   d. Communications skills of the project team and project manager
7. A collection and filing structure that details what methods will be used to gather and store various types of project information is the:
   a. Project management information system
   b. Communications management plan
   c. Scope statement
   d. Project assumption set
8. During project implementation, the project manager is required to submit several reports that will communicate information about the project. A description of the current condition of the project in relationship to schedule and other metrics is found in the:
   a. Status report
   b. Progress report
   c. Project forecast
   d. Quality report
9. A commonly used method for determining and then reporting project performance that integrates scope, time, and cost for assessment of results is:
   a. Trend analysis
   b. Variance analysis
   c. Earned value analysis
   d. Project presentations and review
10. The cost performance index or CPI is used to indicate:
   a. The sum of individual earned value budgets
   b. Cost efficiency
   c. The variance between EV and PV
   d. The variance between actual cost and budgeted cost

11. When a project or phase has been completed the project team should document results and formalize acceptance through the process of:
    a. Change control
    b. Earned value analysis
    c. Administrative closure
    d. Performance reporting
12. Your team currently includes 9 members. You increase the team size to 12. The number of two-way communications channels within the team has increased by:
    a. 10
    b. 30
    c. 9
    d. 54

Answers

1. c
2. b
3. d
4. b
5. a
6. c
7. b
8. a
9. c
10. b
11. c
12. b

■ Project Risk Management

The following multiple-choice questions will be helpful in reviewing the principles of project risk management.

1. The two major components of a risk are:
    a. Time and cost
    b. Uncertainty and impact
    c. Quality and time
    d. Cost and decision-making circumstances
2. When setting up a system to identify or classify risks, the project manager would most likely classify the risks according to:
    a. The probability of occurrence
    b. The magnitude of the impact, favorable or unfavorable
    c. The source of the risk
    d. The customer's risk identification system

3. If there is a 40 percent chance of making $100,000 and a 60 percent chance of losing $150,000, then the expected monetary outcome is:
   a. $50,000
   b. –$50,000
   c. $90,000
   d. –$90,000
4. The project is managing a project that has a very large profit potential for the company. However, there exists the possibility that part of work can be outsourced in which case proprietary knowledge will have to be provided to the contractor. If the project manager is unwilling to release proprietary knowledge, the project manager would most likely avoid the risk response method of:
   a. Assumption
   b. Mitigation
   c. Avoidance
   d. Transfer
5. One technique for risk evaluation uses a questionnaire, a series of rounds, reports submitted in confidence and then circulated with the source unidentified. If the project manager uses this technique, he/she is using:
   a. The Delphi technique
   b. The work group
   c. Unsolicited team responses
   d. A risk management team
6. In evaluating whether or not a risk is about to occur, the project manager would most likely look at which of the following first?
   a. Budgets
   b. Triggers
   c. Schedules
   d. Project plan
7. The project manager needs a tool for assessing or quantifying a risk. The project manager would accept all of the following except:
   a. Decision tree analysis
   b. Objective setting
   c. Simulation
   d. Interviewing
8. The project manager realizes that there is a high probability that risks will occur on the project, and some technique is necessary. A technique that depicts interactions

among decisions and associated events is needed. The project manager would most likely look at which of the following first?

a. Decision tree analysis
b. Earned value measurement system
c. Network scheduling system
d. Payoff matrix

9. Which risk response strategy would the project manager do first that reduces the probability or impact of the event without altering the project's objectives?

a. Avoidance
b. Acceptance
c. Mitigation
d. Transfer

10. Earned value measurement would be an example of:

a. Risk communication planning
b. Risk assessment
c. Risk response
d. Risk monitoring and control

Answers

1. a
2. c
3. b
4. d
5. a
6. b
7. b
8. a
9. c
10. d

■ Project Procurement Management

The following multiple-choice questions will be helpful in reviewing the principles of project procurement management.

1. The contractual statement of work document is:

a. A nonbinding legal document used to identify the responsibilities of the contractor
b. A definition of the contracted work for government contracts only
c. A narrative description of the work/deliverables to be accomplished and/or the resource skills required
d. A form of specification

2. A written or pictorial document that describes, defines, or specifies the services or items to be procured is:
   a. A specification document
   b. A Gantt chart
   c. A blueprint
   d. A risk management plan
3. The "order of precedence" is:
   a. The document that specifies the order (priority) in which project documents will be used when it becomes necessary to resolve inconsistencies between project documents
   b. The order in which project tasks should be completed
   c. The relationship that project tasks have to one another
   d. The ordered list (by quality) of the screened vendors for a project deliverable
4. In which type of contract arrangement is the contractor least likely to want to control costs?
   a. Cost plus percentage of cost
   b. Firm fixed price
   c. Time and materials
   d. Purchase order
5. In which type of contract arrangement is the contractor most likely to want to control costs?
   a. Cost plus percentage of cost
   b. Firm fixed price
   c. Time and materials
   d. Fixed price incentive fee
6. In which type of contract arrangement is the contractor at the most risk of absorbing all cost overruns?
   a. Cost plus percentage of cost
   b. Firm fixed price
   c. Time and materials
   d. Cost plus incentive fee
7. In which type of contract arrangement is the customer at the most risk of absorbing excessive cost overruns?
   a. Cost plus percentage of cost
   b. Firm fixed price
   c. Time and materials
   d. Fixed price incentive fee

8. What is the primary objective the customer's project manager focuses on when selecting a contract type?
   a. Transferring all risk to the contractor
   b. Creating reasonable contractor risk with provisions for efficient and economical performance incentives for the contractor
   c. Retaining all project risk, therefore reducing project contract costs
   d. None of the above
9. Which type of contract arrangement is specifically designed to give a contractor relief for inflation or material/labor cost increases on a long-term contract?
   a. Cost plus percentage of cost
   b. Firm fixed price
   c. Time and materials
   d. Firm fixed price with economic price adjustment
10. Which of the following is not a factor to consider when selecting a contract type?
   a. The type/complexity of the requirement
   b. The urgency of the requirement
   c. The extent of price competition
   d. All are factors to consider
11. In a fixed price incentive fee contract, the "point of total assumption" refers to the point in the project cost curve where:
   a. The customer assumes responsibility for every additional dollar that is spent in fulfillment of the contract
   b. The contractor assumes responsibility for every additional dollar that is spent in fulfillment of the contract
   c. The price ceiling is reached after the contractor recovers the target profit
   d. None of the above
12. A written *preliminary* contractual instrument prepared prior to the issuance of a definitive contract that authorizes the contractor to begin work immediately, within certain limitations, is known as a:
   a. Definitive contract
   b. Preliminary contract
   c. Letter contract/letter of intent
   d. Purchase order
13. A contract entered into after following normal procedures (i.e., negotiation of terms, conditions, cost, and schedule) but prior to initiation of performance is known as a:
   a. Definitive contract
   b. Completed contract
   c. Letter contract/letter of intent
   d. Pricing arrangement

14. Which of the following is not a function of the contract administration activity?

a. Contract change management

b. Specification interpretation

c. Determination of contract breach

d. Selection of the project manager

15. A fixed-price contract is typically sought by the project manager from the customer's organization when:

a. The risk and consequences associated with the contracted task are large and the customer wishes to transfer the risk

b. The project manager's company is proficient at dealing with the contracted activities

c. Neither the contractor nor the project manager understand the scope of the task

d. The project manager's company has excess production capacity

16. Which of the following is/are a typical action(s) a customer would take if the customer received nonconforming materials or products and the customer did not have the ability to bring the goods into conformance?

a. Reject the entire shipment but pay the full cost of the contract

b. Accept the entire shipment, no questions asked

c. Accept the shipment on condition that the nonconforming products will be brought into conformance by the vendor at the vendor's expense

d. Accept the shipment and resell it to a competitor

17. If a project manager requires the use of a piece of equipment, what is the break-even point where leasing and renting are the same?

Cost Categories	(a) Renting Costs	(b) Leasing Costs
Annual Maintenance	$ 0.00	$3,000.00
Daily Operation	$ 0.00	$70.00
Daily Rental	$100.00	$0.00

a. 300 days

b. 30 days

c. 100 days

d. 700 days

18. In which type of incentive contract is there a maximum or minimum value established on the profits allowed for the contract?

a. Cost-plus incentive fee contract

b. Fixed price incentive fee contract

c. Time and material incentive fee contract

d. Split pricing incentive fee contract

19. In which type of incentive contract is there a maximum or minimum value established on the final price of the contract?

a. Cost-plus incentive fee contract

b. Fixed price incentive fee contract

c. Time and material incentive fee contract

d. Split-pricing-incentive-fee contract

Answers

1. c
2. a
3. a
4. a
5. b
6. b
7. a
8. b
9. d
10. d
11. b
12. c
13. a
14. d
15. a
16. c
17. c
18. a
19. b

■ Professional and Social Responsibility

The following multiple-choice questions will be helpful in reviewing the principles of professional and social responsibility.

1. You have been sent on a business trip to visit one of the companies bidding on a contract to be awarded by your company. You are there to determine the validity of the information in their proposal. They take you to dinner one evening at a very expensive restaurant. When the bill comes, you should:

a. Thank them for their generosity and let them pay the bill

b. Thank them for their generosity and tell them that you prefer to pay for your own meal

c. Offer to pay for the meal for everyone and put it on your company's credit card

d. Offer to pay the bill, put it on your company's credit card, and make the appropriate adjustment in their bid price to cover the cost of the meals

2. You are preparing a proposal in response to a request for proposal (RFP) from a potentially important client. The salesperson in your company working on the proposal tells you to "lie" in the proposal to improve the company's chance of winning the contract. You should:
   a. Do as you are told
   b. Refuse to work on the proposal
   c. Report the matter to either your superior, the project sponsor, or the corporate legal group
   d. Resign from the company
3. You are preparing for a customer interface meeting and your project sponsor asks you to lie to the customer about certain test results. You should:
   a. Do as you are told
   b. Refuse to work on the project from this point forth
   c. Report the matter to either your superior or the corporate legal group for advice
   d. Resign from the company
4. One of the project managers in your company approaches you with a request to use some of the charge numbers from your project (which is currently running under budget) for work on their project (which is currently running over budget). Your contract is a cost-reimbursable contract for a client external to your company. You should:
   a. Do as you are requested
   b. Refuse to do this unless he allows you to use his charges number later on
   c. Report the matter to either your superior, the project sponsor, or the corporate legal group
   d. Ask the project manager to resign from the company
5. You have submitted a proposal to a client as part of a competitive bidding effort. One of the people evaluating your bid informs you that it is customary for you to send them some gifts in order to have a better chance of winning the contract. You should:
   a. Send them some gifts
   b. Do not send any gifts and see what happens
   c. Report the matter to either your superior, the project sponsor, or the corporate legal group for advice
   d. Withdraw the proposal
6. You just discovered that the company in which your brother-in-law is employed has submitted a proposal to your company. Your brother-in-law has asked you to do everything possible to make sure that his company will win the contract because his job may be in jeopardy. You should:
   a. Do what your brother-in-law requests
   b. Refuse to look into the matter and pretend it never happened

c. Report the conflict of interest to either your superior, the project sponsor, or the corporate legal group

d. Hire an attorney for advice

7. As part of a proposal evaluation team, you have discovered that the contract will be awarded to Alpha Company and that a formal announcement will be made in two days. The price of Alpha Company's stock may just skyrocket because of this contract award. You should:

   a. Purchase as much Alpha Company stock as you can within the next two days

   b. Tell family members to purchase the stock

   c. Tell employees in the company to purchase the stock

   d. Do nothing about stock purchases until after the formal announcement has been made

8. Your company has decided to cancel a contract with Beta Company. Only a handful of employees know about this upcoming cancellation. The announcement of the cancellation will not be made for about two days from now. You own several shares of Beta Company stock and know full well that the stock will plunge on the bad news. You should:

   a. Sell your stock as quickly as possible

   b. Sell your stock and tell others whom you know own the stock to do the same thing

   c. Tell the executives to sell their shares if they are stock owners

   d. Do nothing until after the formal announcement is made

9. You are performing a two-day quality audit of one of your suppliers. The supplier asks you to remain a few more days so that they can take you out deep sea fishing and gambling at the local casino. You should:

   a. Accept as long as you complete the audit within two days

   b. Accept but take vacation time for fishing and gambling

   c. Accept their invitation but at a later time so that it does not interfere with the audit

   d. Gracefully decline their invitation

10. You have been assigned as the project manager for a large project in the Pacific Rim. This is a very important project for both your company and the client. In your first meeting with the client, you are presented with a very expensive gift for yourself and another expensive gift for your wife. You were told by your company that this is considered an acceptable custom when doing work in this country. You should:

    a. Gracefully accept both gifts

    b. Gracefully accept both gifts but report only your gift to your company

    c. Gracefully accept both gifts and report both gifts to your company

    d. Gracefully refuse the acceptance of either gift

11. Your company is looking at the purchase of some property for a new plant. You are part of the committee making the final decision. You discover that the owner of a local auto dealership from whom you purchase family cars owns one of the properties. The owner of the dealership tells you in confidence that he will give you a new model car to use for free for up to three years if your company purchases his property for the new plant. You should:

a. Say thank you and accept the offer

b. Remove yourself from the committee for conflict of interest

c. Report the matter to either your superior, the project sponsor, or the corporate legal group for advice

d. Accept the offer as long as the car is in your spouse's name

12. Your company has embarked upon a large project (with you as project manager) and as an output from the project there will be some toxic waste as residue from the manufacturing operations. A subsidiary plan has been developed for the containment and removal of the toxic waste and no environmental danger exists. This information on toxic waste has not been made available to the general public yet, and the general public does not appear to know about this waste problem. During an interview with local newspaper personnel you are discussing the new project and the question of environmental concerns comes up. You should:

a. Say there are no problems with environmental concerns

b. Say that you have not looked at the environmental issues problems as yet

c. Say nothing and ask for the next question

d. Be truthful and reply as delicately as possible

13. As a project manager, you establish a project policy that you, in advance of the meeting, review all handouts presented to your external customer during project status review meetings. While reviewing the handouts, you notice that one slide contains company confidential information. Presenting this information to the customer would certainly enhance good will. You should:

a. Present the information to the customer

b. Remove the confidential information immediately

c. Discuss the possible violation with senior management and the legal department before taking any action

d. Discuss the situation first with the team member that created the slide, and then discuss the possible violation with senior management and the legal department before taking any action

14. You are managing a project for an external client. Your company developed a new testing procedure to validate certain properties of a product and the new testing procedure was developed entirely with internal funds. Your company owns all of the intellectual property rights associated with the new test. The workers that developed the new test used one of the components developed for your

current customer as part of the experimental process. The results using the new test showed that the component would actually exceed the customer's expectations. You should:

a. Show the results to the customer but do not discuss the fact that it came from the new test procedure

b. Do not show the results of the new test procedure since the customer's specifications call for use of the old test procedures

c. Change the customer's specifications first and then show the customer the results

d. Discuss the release of this information with your legal department and senior management before taking any action

15. Using the same scenario as in the previous question, assume that the new test procedure that is expected to be more accurate than the old test procedure indicates that performance will not meet customer specifications, whereas the old test indicates that customer specifications will be barely met. You should:

a. Present the old test results to the customer showing that specification requirements will be met

b. Show both sets of test results and explain that the new procedure is unproven technology

c. Change the customer's specifications first and then show the customer the results

d. Discuss the release of this information with your legal department and senior management before taking any action

16. Your customer has demanded to see the "raw data" test results from last week's testing. Usually the test results are not released to customers until after the company reaches a conclusion on the meaning of the test results. Your customer has heard from the grapevine that the testing showed poor results. Management has left the entire decision up to you. You should:

a. Show the results and explain that it is simply raw data and that your company's interpretation of the results will be forthcoming

b. Withhold the information until after the results are verified

c. Stall for time even if it means lying to the customer

d. Explain to the customer your company's policy of not releasing raw data

17. One of your team members plays golf with your external customer's project manager. You discover that the employee has been feeding the customer company-sensitive information. You should:

a. Inform the customer that project information from anyone other than the project manager is not official until released by the project manager

b. Change the contractual terms and conditions and release the information

c. Remove the employee from your project team

d. Explain to the employee the ramifications of his actions and that he still represents the company when not at work, then report this as a violation

18. Your company has a policy that all company-sensitive material must be stored in locked filing cabinets at the end of each day. One of your employees has received several notices from the security office for violating this policy. You should:

a. Reprimand the employee

b. Remove the employee from your project

c. Ask the human resources group to have the employee terminated

d. Counsel the employee as well as other team members on the importance of confidentiality and the possible consequences for violations

19. You have just received last month's earned value information that must be shown to the customer in the monthly status review meeting. Last month's data showed unfavorable variances that exceeded the permissible threshold limits on time and cost variances. This was the result of a prolonged power outage in the manufacturing area. Your manufacturing engineer tells you that this is not a problem and next month you will be right on target on time and cost as you have been in the last five months. You should:

a. Provide the data to the customer and be truthful in the explanation of the variances

b. Adjust the variances so that they fall within the threshold limits since this problem will correct itself next month

c. Do not report any variances this month

d. Expand the threshold limits on the acceptable variances but do not tell the customer

20. You are working in a foreign country where it is customary for a customer to present gifts to the contractor's project manager throughout the project as a way of showing appreciation. Declining the gifts would be perceived by the customer as an insult. Your company has a policy on how to report gifts received. The best way to handle this situation would be to:

a. Refuse all gifts

b. Send the customer a copy of our company's policy on accepting gifts

c. Accept the gifts and report the gifts according to policy

d. Report all gifts even though the policy says that some gifts need not be reported

21. You are interviewing a candidate to fill a project management position in your company. On his resume, he states that he is a PMP®. One of your workers who knows the candidate informs you that he is not a PMP® yet but is planning to take the test next month and certainly expects to pass. You should:

a. Wait until he passes the exam before interviewing him

b. Interview him and ask him why he lied

c. Inform PMI of the violation

d. Forget about it and hire him if he looks like the right person for the job

22. You are managing a multinational project from your office in Chicago. Half of your project team are from a foreign country but are living in Chicago while working on your project. These people inform you that two days during next week are national religious holidays in their country and they will be observing the holiday by not coming into work. You should:

a. Respect their beliefs and say nothing

b. Force them to work because they are in the United States where their holiday is not celebrated

c. Tell them that they must work noncompensated overtime when they return to work in order to make up the lost time

d. Remove them from the project team if possible

23. PMI informs you that one of your team members who took the PMP® exam last week and passed may have had the answers to the questions in advance provided to him by some of your other team members who are also PMP®s and were tutoring him. PMI is asking for your support in the investigation. You should:

a. Assist PMI in the investigation of the violation

b. Call in the employee for interrogation and counseling

c. Call in the other team members for interrogation and counseling

d. Tell PMI that it is their problem, not your problem

24. One of your team members has been with you for the past year since his graduation from college. The team member informs you that he is now a PMP® and shows you his certificate from PMI acknowledging this. You wonder how he was qualified to take the exam since he had no prior work experience prior to joining your company one year ago. You should:

a. Report this to PMI as a possible violation

b. Call in the employee for counseling

c. Ask the employee to surrender his PMP® credentials

d. Do nothing

25. Four companies have responded to your RFP. Each proposal has a different technical solution to your problem and each proposal states that the information in the proposal is company-proprietary knowledge and not to be shared with anyone. After evaluation of the proposals, you discover that the best technical approach is from the highest bidder. You are unhappy about this. You decide to show the proposal from the highest bidder to the lowest bidder to see if the lowest bidder can provide the same technical solution but at a lower cost. This situation is:

a. Acceptable since once the proposals are submitted to your company, you have unlimited access to the intellectual property in the proposals

b. Acceptable since all companies do this

c. Acceptable as long as you inform the high bidder that you are showing their proposal to the lowest bidder

d. Unacceptable and is a violation of the Code of Professional Conduct

Answers

1. b
2. c
3. c
4. c
5. c
6. c
7. d
8. d
9. d
10. c
11. c
12. d
13. d
14. d
15. d
16. a
17. d
18. d
19. a
20. d
21. c
22. a
23. a
24. a
25. d

Challenging and Engaging Questions and Exercises

Logic problems are a unique way of learning how to apply project management principles to project situations. They are enjoyable and entertaining. Include these problems in your project management studies to enhance the learning experience.

How to Solve Logic Problems

To solve logic problems, the wording in the clues must be read carefully. All of the necessary information is provided in the clues, and trial-and-error solutions are not necessary. The problems can be solved with simple logic. In some cases, grids are provided. Below is the technique for solving the grid problems.

Sample Logic Problem

Three married couples live in three different cities and each couple has a different number of children. The husbands are Alfred, Dirk, and Mickey. The wives are Annette, Barbara, and Cathy, but they are not necessarily married to the husbands according to the order of the husbands' names. The three cities in which the couples live are Boston, Chicago, and Denver, and the numbers of children are one, two, and three. In completing the table below, we will use a "•" to signify "yes" and an "X" to signify "No."

Clues

1. Barbara and Mickey are a couple but do not live in Chicago.
2. One of the couples, which does not include Annette, lives in Boston with their three children.
3. Alfred and his wife live in Denver; they have more than one child.
4. Cathy's husband's first name begins with an initial that appears later in the alphabet than Cathy's first name initial

For additional problems, see Kerzner, H., *Logic Problems for Project Managers* (Hoboken, NJ: John Wiley & Sons, 2006).

■ Explanation

From clue 1, Barbara and Mickey are husband and wife. So, a "•" can be placed at the intersection and the other cells have an "X." Likewise, because they do not live in Chicago, we can place an "X" in that location as well, and any other locations that relate Barbara or Mickey to Chicago. This is shown in the figure below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette			X						
	Barbara	X	X	•		X				
	Cathy			X						
Children	1									
	2									
	3									
City	Boston									
	Chicago			X						
	Denver									

With clue 2, we can signify a "Yes" in the box that signifies the intersection of Boston and three children, and also a "No" for the Annette location in that column. This is shown below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette			X	X					
	Barbara	X	X	•		X				
	Cathy			X						
Children	1				X					
	2				X					
	3				•	X	X			
City	Boston									
	Chicago			X						
	Denver									

Using clue 3, we can place a "Yes" in the intersection of Alfred and Denver, and the corresponding cells will then have a "No" response. We can also eliminate the one child cell from the Alfred row and the Denver column. The result is shown below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette			X	X					
	Barbara	X	X	●		X				
	Cathy			X						
Children	1	X			X					
	2				X					
	3				●	X	X			
City	Boston	X								
	Chicago	X		X						
	Denver	●	X	X						

Now notice that in the cells that relate husbands and cities, we know that Dirk must reside in Chicago and Mickey must reside in Boston. Also, Mickey must live in Boston with three children. The results are shown below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette			X	X					X
	Barbara	X	X	●	●	X	X	X	X	●
	Cathy			X	X					X
Children	1	X	●	X	X	●	X			
	2	●	X	X	X	X	●			
	3	X	X	●	●	X	X			
City	Boston	X	X	●						
	Chicago	X	●	X						
	Denver	●	X	X						

We also know from this figure that the city in which the couple has two children is Denver. This is represented in the figure below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette			X	X					X
	Barbara	X	X	●	●	X	X	X	X	●
	Cathy			X	X					X
Children	1	X	●	X	X	●	X			
	2	●	X	X	X	X	●			
	3	X	X	●	●	X	X			
City	Boston	X	X	●						
	Chicago	X	●	X						
	Denver	●	X	X						

Now using clue 4, we know that Cathy cannot be married to Alfred. Therefore, we can complete the figure as shown below.

		Husband			City			Children		
		Alfred	Dirk	Mickey	Boston	Chicago	Denver	1	2	3
Wife	Annette	●	X	X	X	X	●	X	●	X
	Barbara	X	X	●	●	X	X	X	X	●
	Cathy	X	●	X	X	●	X	●	X	X
Children	1	X	●	X	X	●	X			
	2	●	X	X	X	X	●			
	3	X	X	●	●	X	X			
City	Boston	X	X	●						
	Chicago	X	●	X						
	Denver	●	X	X						

We now know the solution to the problem:

- Alfred and Annette live in Denver with two children.
- Mickey and Barbara live in Boston with three children.
- Dirk and Cathy live in Chicago with one child.

Sometimes, you may have to go back over the clues a second or third time to extract more information. However, guessing is never required and logic must prevail.

For other types of logic problems, the difficulty is in knowing which clue or clues to start with. Since this may be more complex, hints are provided to assist you.

Now it's your turn to demonstrate your decision-making skills. Good luck!

▶ Logic Problem #1: Types of Contracts

In the figure below are six different contract types for six different project managers. From the clues under the figure, determine the contract type for each project manager and their position in the figure. Knowledge of each type of contract is essential to solve the problem.

Project Manager: Jane, Richard, Paul, Frank, Tim, Alice

Contract Type: Cost plus percentage of cost (CPPC), firm fixed price (FFP), cost plus incentive fee (CPIF), fixed price incentive fee (FPIF), cost plus fixed fee (CPFF), time and materials (T & M)

Clues:

1. The contract type that today is illegal in the government is located in position 4 in the diagram.
2. Tim's project has a contract that contains a "ceiling" and "floor" on profits.
3. Alice's contract is in an even-numbered position in the diagram.
4. The two incentive-type contracts are located in different rows in the figure and horizontally adjacent to only one other contract and both of the adjacent contracts are for projects managed by female project managers.

5. Frank's project, which is not in position 3, and Richard's project are not adjacent to each other either horizontally or vertically, and are located in different rows.
6. The contract type with the maximum risk exposure to the seller is to the right (as you look at the figure) and next to the cost-plus contract, where the fee is defined as a dollar value rather than as a percentage, and above the contract type that contains a "point of total assumption" term.

► Logic Problem #2: The Mysterious Network Diagram

A project manager discovers that his team has neglected to complete the network diagram for the project. The network diagram is shown below. However, the project manager has some information available, specifically that each activity, labeled A–G, has a different duration between one and seven weeks. Also, the slack time for each of the activities is known as shown below.

Duration (weeks): 1, 2, 3, 4, 5, 6, 7
Slack time (weeks): 0, 0, 0, 2, 4, 4, 7

Using the clues provided below, determine the duration of each activity as well as the early start, early finish, latest start, and latest finish times for each activity.

Clues

1. Activity E is on the critical path.
2. The early start time (ES) for Activity F is five weeks.
3. The duration of Activity B is seven weeks.
4. Activity D has four weeks of slack, but Activity F has the greatest amount of slack.
5. The early finish time (EF) for Activity G is 17 weeks.
6. The latest finish time (LF) for Activity E is 13 weeks.

Activity	Duration	Early Start	Early Finish	Latest Start	Latest Finish
A	_____	_____	_____	_____	_____
B	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____
D	_____	_____	_____	_____	_____
E	_____	_____	_____	_____	_____
F	_____	_____	_____	_____	_____
G	_____	_____	_____	_____	_____

► Logic Problem #3: The Incomplete Status Report

As a continuation of Logic Problem #2, you also discover that the status report for your project is somewhat incomplete. The status report is shown below. From the clues provided, complete the status report.

Clues

1. For Activity B, PV = $100
2. For Activity C, EV = $200
3. For Activity D, AC = $300
4. Activity A has not started yet.
5. For all of the activities EV (Total) = $930

Activity	PV	EV	AC	SV	CV
A	_____	_____	_____	($100)	0
B	_____	_____	_____	50	60
C	_____	_____	_____	60	60
D	_____	_____	_____	100	80
E	_____	_____	_____	120	(20)
	_____	_____	_____	_____	_____
Total	_____	_____	_____	_____	_____

► Logic Problem #4: Another Mysterious Network Diagram

A project manager discovers that his team has neglected to complete the network diagram for the project. The network diagram is shown below. However, the project manager has some information available, specifically that each activity, labeled A–G, has a different duration between one and seven weeks. Also, the slack time for each of the activities is known as shown below.

Duration (weeks): 1, 2, 3, 4, 5, 6, 7

Slack time (weeks): 0, 0, 0, 1, 1, 3, 7

Using the clues provided below, determine the duration of each activity as well as the early start, early finish, latest start, and latest finish times for each activity.

Clues

1. Activity E is the longest-duration activity and is on the critical path, which is the unlucky number 13; also, there is only one critical path.
2. The early finish time (EF) for Activity F is eleven weeks.
3. The latest start time (LS) for Activity D is nine weeks.
4. If Activity A slips by one week, it will be on a critical path.

Activity	Duration	Early Start	Early Finish	Latest Start	Latest Finish
A	_____	_____	_____	_____	_____
B	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____
D	_____	_____	_____	_____	_____
E	_____	_____	_____	_____	_____
F	_____	_____	_____	_____	_____
G	_____	_____	_____	_____	_____

► Logic Problem #5: Another Mysterious Network Diagram

A project manager discovers that his team has neglected to complete the network diagram for the project. The network diagram is shown below. However, the project manager has some information available, specifically that each activity, labeled A–G, has a different duration between one and seven weeks. Also, the slack time for each of the activities is known as shown below.

Duration (weeks): 1, 2, 3, 4, 5, 6, 7
Slack time (weeks): 0, 0, 0, 3, 6, 8, 8

Using the clues provided below, determine the duration of each activity as well as the early start, early finish, latest start, and latest finish times for each activity.

Clues

1. There exists only one critical path and it is the largest possible number given the possible durations shown.
2. Activity E has the smallest amount of slack that is greater than zero.
3. The early finish time (EF) for Activity A is four weeks and this does not equal the latest finish time (LF). (Note: There is no negative slack in the network.)
4. The slack in Activity C is eight weeks.
5. The duration of Activity F is greater than the duration of Activity C by at least two weeks.

Activity	Duration	Early Start	Early Finish	Latest Start	Latest Finish
A	_____	_____	_____	_____	_____
B	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____
D	_____	_____	_____	_____	_____
E	_____	_____	_____	_____	_____
F	_____	_____	_____	_____	_____
G	_____	_____	_____	_____	_____

▶ Answers

■ Logic Problem #1

Position #1: Paul; CPIF
Position #2: Alice; CPFF
Position #3: Richard; FFP
Position #4: Frank; CPPC
Position #5: Jane; T & M
Position #6: Tim; FPIC

■ Logic Problem #2

Activity	Duration	ES	EF	LS	LF
A	3	0	3	4	7
B	7	0	7	0	7
C	5	0	5	2	7
D	2	7	9	11	13
E	6	7	13	7	13
F	1	5	6	12	13
G	4	13	17	13	17

■ Logic Problem #3

Activity	PV	EV	AC
A	100	0	0
B	100	150	90
C	140	200	140
D	280	380	300
E	80	200	220
	700	930	750

■ Logic Problem #4

Activity	Duration	ES	EF	LS	LF
A	4	0	4	1	5
B	2	0	2	3	5
C	5	0	5	0	5
D	3	2	5	9	12

Activity	Duration	ES	EF	LS	LF
E	7	5	12	5	12
F	6	5	11	6	12
G	1	12	13	12	13

The critical path is thirteen weeks. Activity F has an early finish time of eleven weeks, but Activity F cannot be on the critical path because there is only one critical path, and Activity E is on the critical path. Therefore, Activity G must have a duration of one week. We now know ES, EF, LS, and LF for Activity E. Because Activity F has an EF of eleven weeks, the durations of Activities C and F must be eleven weeks, and therefore five and six weeks. Activity C must be five weeks to align with the ES of five in Activity E. If Activity C were six weeks in duration, the length of the critical path could not be thirteen weeks. Using clue 3, and knowing that LF of Activity D must be twelve weeks, the duration of Activity D must be three weeks. Using clue 4, which tells us that Activity A has only one week of slack, and knowing that the LF for activity A is five weeks, the duration of Activity A must be four weeks.

► Logic Problem #5

Activity	Duration	ES	EF	LS	LF
A	3	0	3	4	7
B	7	0	7	0	7
C	5	0	5	2	7
D	2	7	9	11	13
E	6	7	13	7	13
F	1	5	6	12	13
G	4	13	17	13	17

From the clues, Activities A, C, and E have slack. Activity F must also have slack since Activity C is on a path with it. Therefore, the critical path must be B-D-G. Since Activity C has eight weeks of slack, Activity F must also have eight weeks of slack, which means, by elimination, that Activity A has six weeks of slack and the duration for Activity A must be four weeks. From clue 1, the critical path, which must have three and only three activities in it, must be the numbers five, six, and seven, and must be equal to eighteen weeks. From clue 5, the duration for Activity F must be three weeks and Activity C must be one week. Therefore, Activity E must be two weeks in duration. Now we can calculate ES, EF, LS, and LF for Activities C and F. Since the length of the critical path is eighteen weeks, we now know that the duration of Activity G must be six weeks. After calculating ES, EF, LS, and LF for Activity E, we know that the duration of Activity B must be seven weeks.

▶ Challenging Questions and Scenarios

Exam Tip

The PMP® exam and the CAPM® exam will include several questions regarded as "challenging" and scenario-based. These are questions where a situation is provided and the basic question asks, "What should the project manager do next?" or "What will most likely happen next?" or "What tool would be most appropriate to use?" Consider the following examples. They will assist you in your exam preparation and help to further enhance your existing project management skills.

The following questions are designed to improve your ability to assess a situation from a project manager's perspective and determine the most appropriate response or action.

Example #1: You hire a contractor to perform several activities on your project. After a period of time, the contractor informs you that they are running late. What should the project manager do next? Your choices are:

a. Call a meeting with the contractor.

b. Call a meeting with the executives in the contractor's company.

c. Look at the penalty clauses in the contract.

d. Implement the risk management plan.

On the surface, it appears that you could argue any of the answers as being the correct answer. That's because we have a tendency to make assumptions and read things into the wording of the question, things that aren't there. The correct answer is to call a meeting with the contractor. After all, you cannot make a decision without gathering the facts first, and having a meeting with the contractor allows you to gather the facts.

Example #2: Let's use the same scenario as in Example #1, but in this case the contractor informs you that they have no chance of catching up on the schedule. In this case, you might be able to justify any of the four answers, but some additional information may need to be provided to differentiate between the answers. If no additional information is provided, then implementing the risk management plan may be correct.

For each of the following questions, pick the correct answer assuming the question asks, "What should the project manager do next?"

1. One of your contractors is running late and presents to you a plan to get back on schedule. The plan calls for running 10 tests rather than the 15 tests that are called

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out in the contractual requirements plan. The contractor believes this will save you money as well.

a. Agree to it quickly to maintain the schedule and reduce costs.

b. Ask your sponsor to make the decision.

c. Tell the contractor that you cannot violate requirements.

d. Ask the contractor to put it in writing, and present the recommendation to the change control board.

2. Your project is behind schedule. You just learned that another project in the company is further behind schedule than your project and senior management has instructed the functional managers to remove some of the resources from your project to see if they can be of assistance on the other project.

a. Begin looking at contingency plans and alternatives.

b. Meet with the executives and plead your case.

c. Meet with the functional managers and plead your case.

d. Ask your customer to plead your case with the executives.

3. Paula is an important member of your project team. She informs you that the company approved her application for tuition reimbursement to attend the MBA program at a local university. Most of the courses are in the evenings, but there may be one or two courses that meet in the mornings twice a week. You must sign off on this request because it could impact your project.

a. Refuse to let Paula attend the program until the project is completed.

b. Let Paula attend the program but replace her as a member of the project team as quickly as possible.

c. Discuss with Paula the options for attending class and still maintaining her performance on the project team.

d. Let the project sponsor make the final decision.

4. You hire a contractor to work on your project. In order for the contractor to perform correctly, your team must exchange some company proprietary information with the contractor. To make sure this flows smoothly you should:

a. Personally brief the team on the techniques for disclosing proprietary information.

b. Ask the sponsor to debrief the team on the company's policy for disclosing proprietary information.

c. Ask a representative from the legal group, or whoever is the company expert in proprietary information, to make the presentation.

d. Ask the team to read the confidentiality agreement that was part of the contract.

5. You have asked the team to voluntarily work a significant amount of overtime to maintain the project's schedule. You discover that one of the members of the team, while working overtime, inadvertently used the wrong lot of raw materials

during a production run and all of the units produced had to be thrown away. The loss was $75,000 and the production run had to be redone. Management has convened a meeting with you and the team to discuss what went wrong and who should be blamed.

a. At the beginning of the meeting, you should take personal responsibility for what happened without disclosing the name of the person who made the mistake.

b. At the beginning of the meeting, you should take personal responsibility for what happened and identify the person who made the mistake.

c. Say nothing. Let the executives run the meeting and see what develops.

d. Ask the team member who made the mistake to immediately step forward and explain what happened.

6. You are working on a firm-fixed-price contract. At the end of the first month, you provide the client with project performance reports that were generated from your enterprise project management methodology. The format of each report is standardized and used on all contracts. The client informs you that they want the reports modified to better fit their needs. There is a significant cost for modifying the reports, and you are unsure about whether the client would be willing to pay for the modifications.

a. Submit a change request to the client asking for payment for the modification. If the client refuses to pay, then refuse to make the modifications.

b. Make the modifications and then submit a change request to the client for payment.

c. Refuse to make the changes since you already have a signed contract.

d. Ask your sponsor for advice in this matter. There may be other factors, such as enterprise environmental factors, that you may not know about.

7. During an interface meeting with the client, one of your highly competent team members acts in an arrogant and disruptive manner to the point where the customer becomes upset. After the interface meeting is over, the customer requests that this person be removed from the project team so that the customer will no longer have to interface with this person.

a. Grant the customer's request and remove the person from the team.

b. Counsel the person and see if there is a way that he can change his behavior.

c. Explain the situation to the sponsor and ask for advice.

d. Talk to the functional manager first to see if a replacement exists in case this person must be removed.

8. After an interface meeting with the client from a foreign country, you and your wife along with the client and his wife are dining at an elegant restaurant celebrating how successfully the project is progressing thus far. During dinner, the client's wife presents your wife with a gift of jewelry. The gift is composed of precious stones native to the client's country. You company has a policy that all gifts under $1000 need not be reported. You believe that this gift is less than $1000 in value, but you are unsure.

a. Refuse to accept the gift since it may violate company policy.

b. Accept the gift but do not report the gift since it was given to your wife rather than you.

c. Accept the gift and report it to your company even though you do not believe its value is over the $1000 limit.

d. Explain the gift acceptance policy to you client and tell him that you cannot accept the gift until after discussions with your legal department.

9. Your external client has assigned an onsite representative to monitor the performance of the contract. All reports are provided to the onsite representative who reviews the reports for accuracy and then forwards the reports to his parent company. After reviewing one of the reports, the onsite representative asks you to make changes to one of the reports by including some false statements. The false statements will make the onsite representative look good in the eyes of his boss.

   a. Make the changes as long as no damage is done to the project but do not leave an audit trail of what happened.

   b. Make the changes and prepare an audit trail in case questions arise in the future.

   c. Refuse to make the changes.

   d. Discuss this with your sponsor and possibly corporate legal before responding to the onsite representative.

10. During project staffing activities, one of the functional managers informs you that she will not have available all of the resources she would need for your project when you need the resources because of resource requirements for other projects. When the project was initially approved, she estimated that she would use eight people, and they would be available at the right time. Now, because some of the other projects are delayed, she has only five people available.

    a. Send her a memo demanding the eight people she promised you.

    b. Ask for a meeting with her to discuss options and contingency plans.

    c. Ask your sponsor to step in and get you the resources you need.

    d. Delay the start date of the project until you have firm commitments from all functional managers.

► Answers to Challenging Questions

1. The correct answer is d. Any and all changes to the scope baseline should be in writing and approved by the change control board.

2. The correct answer is a. This is reality in project management. Before asking for help from above, you must assess the risks to your project and see what options or contingency plans are available.

3. The correct answer is c. Project managers must show a concern for people and help them satisfy their personal needs and ambitions. You must first discuss this with Paula to make sure that she can still perform her job as expected.

4. The correct answer is c. Project managers are not always professionally trained in the legalities of protecting proprietary information. Whoever the expert is in the company should brief the team on the protocols.
5. The correct answer is a. You created the problem by asking people to work extensive overtime. Extensive overtime is an invitation for mistakes. Project managers should try to protect the people on their team when mistakes are made. Answer a is what the project manager should do first to diffuse the situation. Of course, senior management may wish to dig deeper.
6. The correct answer is d. Your sponsor may view this as goodwill and desire to absorb the cost internally. Your sponsor may ask you to submit a change request to the client. But the first step would be to approach the sponsor for advice to make sure you understand all of the ramifications.
7. The correct answer is d, but answer b runs a close second. Project managers may not have the authority to remove someone from the project team without support from the functional manager. In any event, there must be a replacement.
8. The correct answer is c. It can never be wrong to report the gift to your company and let them tell you how to proceed.
9. The correct answer is d. This is a situation where your sponsor and corporate legal should be involved before you take any action. You need allies and there may be a company policy already established on how to handle these types of situations.
10. The correct answer is b. The first step should be to discuss this with the functional manager that controls the resources.

► Matching (Memory Jogger) Exercises

Memory jogger and matching the terms exercises provide you with an opportunity to "flex" your brain and help you to recall the connection between terminology, acronyms, and processes. You may have noticed that the "language" of project management is unique, and it is helpful to become very familiar with the lexicon used by most project managers.

The following items are three matching terms or memory jogger exercises. In each exercise, select a letter from the right hand column that best matches the left hand column. Although it may appear that more than one answer is correct, select one and only one answer. At the end of the exercise, make sure that each of the letters A–U appears once and only once. You may wish to review the *PMBOK® Guides'* dictionary of terms for precise definitions.

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■ Matching (Memory Jogger) Exam A

1. Progress, status and forecast	A. Request for quotation
2. Reduce functionality	B. A risk reduction process
3. Assumptions	C. Information gathering process
4. RFQ	D. Time a task can slip
5. Code of accounts	E. Person/organization providing project funding
6. Mitigation	F. Project management information system
7. Workaround	G. Factors considered to be true
8. PMO	H. Accelerate task start time
9. Delphi technique	I. Soft logic
10. Float	J. Performance reports
11. Virtual team	K. Total quality management
12. CV	L. Project or program management office
13. Discretionary dependency	M. Grouping of charge numbers
14. RAM	N. Acquirer of goods or services
15. Lead	O. Responsibility assignment matrix
16. CCB	P. Detailed project description
17. Scope statement	Q. Schedule compression technique
18. TQM	R. Change control board
19. Buyer	S. Remotely located team members
20. PMIS	T. Response mechanism to an unfavorable risk
21. Sponsor	U. Cost variance

■ Matching (Memory Jogger) Exam B

1. Project charter	A. Cost performance index
2. Mandatory dependency	B. Required delay or elapsed time
3. EAC	C. Total quality management
4. Acceptance criteria	D. Schedule variance
5. Bottom up and parametric	E. Restriction
6. Scope baseline	F. Schedule compression technique
7. Constraint	G. Characterization of the product/scope
8. COQ	H. Cost estimating techniques
9. Contract	I. Initiates the project

(Continued)

10. Lag	J. Enterprise environmental factors
11. Crashing	K. Precedence networks
12. SV	L. Ordered frequency of occurrence
13. Politics, culture and infrastructure	M. Estimated cost at completion
14. FS, FF, SS, and SF	N. Cost of quality
15. CPI	O. Hard logic
16. Pareto chart	P. Mutually binding agreement
17. Dependencies	Q. A system of practices
18. TQM	R. Relationships
19. Methodology	S. Scope statement, WBS and WBS dictionary
20. Deliverable	T. Conditions of acceptance
21. Product scope	U. End result

■ Matching (Memory Jogger) Exam C

1. Activity duration	A. Ability to do something without having authority
2. Authority	B. Number of work periods
3. RACI	C. People with vested interest in the project
4. Baseline	D. Expected monetary value
5. Analogy or budgetary	E. A provision to mitigate risk
6. SPI	F. A reusable document
7. Fast-tracking	G. Type of responsibility chart
8. Critical path	H. Smoothing out manpower peaks and valleys
9. Duration	I. Cost variance
10. Forward pass	J. Calendar dates of an activity
11. SWOT	K. Legal right to do something
12. S-curve	L. Estimation techniques for cost
13. Reserve	M. Firm-Fixed-Price Contract
14. Template	N. Cumulative cost versus time
15. CV	O. Schedule compression technique
16. Power	P. Estimation techniques for duration
17. Three-point or triangular distribution	Q. Early start and early finish
18. FFP	R. An approved plan
19. Resource leveling	S. Strengths, weaknesses, opportunities and threats
20. EMV	T. Longest path in a network
21. Stakeholders	U. Schedule performance index

▶ Matching Memory Jogger Answer key:

Exam A

1. J
2. Q
3. G
4. A
5. M
6. B
7. T
8. L
9. C
10. D
11. S
12. U
13. I
14. O
15. H
16. R
17. P
18. K
19. N
20. F
21. E

Exam B

1. I
2. O
3. M
4. T
5. H
6. S
7. E
8. N
9. P
10. B
11. F
12. D
13. J
14. K
15. A
16. L
17. R
18. C
19. Q
20. U
21. G

Exam C

1. J
2. K
3. G
4. R
5. L
6. U
7. O
8. T
9. B
10. Q
11. S
12. N
13. E
14. F

15. I
16. A
17. P
18. B
19. H
20. D
21. C

▶ Crashing the Schedule Exercises

■ Crashing the Schedule (Part 1)

1. Your client has asked you to look at the additional cost for compressing the schedule by a given number of weeks. The information you need is shown below in Exhibits 1 and 2. First, complete the network diagram by determining the earliest and latest start and finish times, as well as the critical path:

Table 1 Network Start and Finish Information

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A					
B					
C					
D					
E					

2. In Table 2, complete the column for determining the crashing cost per week.

Table 2 Possible Compression Times for Table 1

Activity	Normal Time, Weeks	Maximum Compression Time, Weeks	Normal Cost, $	Maximum Crashing Cost, $	Crashing Cost per Week, $
A	7	6	$20,000	$23,000	
B	12	10	$30,000	$32,000	
C	12	8	$30,000	$36,000	
D	18	16	$50,000	$56,000	
E	11	6	$40,000	$50,000	

3. Using the data in Table 2, what is the total normal cost for the project?
4. If the client wants the project completed in 29 weeks rather than 30 weeks, how much additional cost will be expended and which activities are crashed and by how many weeks?
5. If the client wants the project completed in 28 weeks rather than 30 weeks, how much additional cost will be expended and which activities are crashed and by how many weeks?
6. If the client wants the project completed in 27 weeks rather than 30 weeks, how much additional cost will be expended and which activities are crashed and by how many weeks?
7. If the client wants the project completed in 26 weeks rather than 30 weeks, how much additional cost will be expended and which activities are crashed and by how many weeks?
8. If the client wants the project completed in 25 weeks rather than 30 weeks, how much additional cost will be expended and which activities are crashed and by how many weeks?

► Crashing the Schedule (Part 2)

1. Part 2 is a continuation of Part 1. Use the same data from Part 1. Let's assume that the client wants the project done in the shortest possible time. Crash all the activities to their maximum compression time and identify the critical path.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A					
B					
C					
D					
E					

2. Which activities had to be crashed the maximum amount to get to a 22-week schedule and which activities did not have to be crashed the maximum amount?
3. Determine the early start and finish times, as well as the critical path elements, for the cheapest maximum crash.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A					
B					
C					
D					
E					

4. Determine the cheapest total cost for the project for a maximum compression.

Activity	Normal Time, Weeks	Compression Time, Weeks	Normal Cost, $	Additional Cost for Crashing, $	Total Activity Cost, $
A	7	6	$20,000	$1,500	
B	12	12	$30,000	0	
C	12	8	$30,000	$6,000	
D	18	16	$50,000	$6,000	
E	11	8	$40,000	$6,000	
			$170,000	**$189,500**	

5. If an activity is crashed for two weeks and the crashing cost per week is $2,000, does that mean that each week incurs an expense of $2,000?

▶ Analyzing the Schedule

1. In the network below, determine the early start and finish times, as well as the critical path activities.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A					
B					
C					
D					
E					
F					
G					
H					

2. What is the impact on the end date if Activity B slips by two weeks?
3. What is the impact on the end date if Activity F slips by three weeks?
4. What is the most any activity can slip without extending the end date of the project?

► Analyzing Yet Another Schedule

1. In the network below, determine the early start and finish times, as well as the critical path activities.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					
K					

2. What is the impact on the end date if Activity B slips by two weeks?
3. By how much can Activity F slip before it is also on the critical path?
4. By how much can Activity C slip before a new critical path is created?
5. What is the most any activity can slip before the end date of the project may be extended?

▶ Answers

■ Crashing the Schedule (Part 1)

1. Network Start and Finish Information

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A	0	7	0	7	Yes
B	0	12	7	19	No
C	7	19	7	19	Yes
D	7	25	12	30	No
E	19	30	19	30	Yes

2. Table 2: Possible Compression Times for Table 1

Activity	Normal Time, Weeks	Maximum Compression Time, Weeks	Normal Cost, $	Maximum Crashing Cost, $	Crashing Cost per Week, $
A	7	6	$20,000	$23,000	$3,000
B	12	10	$30,000	$32,000	$1,000
C	12	8	$30,000	$36,000	$1,500
D	18	16	$50,000	$56,000	$3,000
E	11	6	$40,000	$50,000	$2,000

3. $170,000
4. Activity C is the lowest crashing cost per week activity on the critical path. Compress it by one week at an additional cost of $1,500. Activity B has a lower crashing cost per week than Activity C, but it is not on the critical path.
5. You must crash Activity C by two weeks for an additional cost of $3,000.
6. You must crash Activity C by three weeks at an additional cost of $4,500.
7. You must crash Activity C by four weeks at an additional cost of $6,000.
8. Activity C can be crashed for only four weeks. Therefore, you must crash Activity E by one week at an additional cost of $8,000. Activity E is crashed because it is cheaper than Activity A.

■ Crashing the Schedule (Part 2)

1. The critical path is now 22 weeks rather than 30 weeks, and there is a new critical path.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A	0	6	0	6	Yes
B	0	10	6	16	No

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
C	6	14	8	16	No
D	6	22	6	22	Yes
E	14	20	16	22	No

2. Activities A and D are on the new critical path and therefore had to be crashed to the maximum. Activities B, C, and E are not on the critical path and have some slack.

   For the activities that are not on the critical path, namely Activities B, C, and E, they may not need to be crashed. To determine whether or not they need to be crashed, at least from a financial point of view, you must be willing to allow multiple critical paths to exist. Therefore, by working backward, determine the cheapest way to allow the paths B-E and A-C-E to be 22 weeks in length. It is possible that an activity may not need to be crashed at all, thus saving money. There are algorithms for these calculations, but more often than not they are trial-and-error solutions.

   Out of the remaining activities, B, C, and E, Activity E is the most expensive to crash. Therefore you must look at ways to minimize the cost of crashing. Since Activity E has two weeks of slack according to the answer to Question 1 Activity E can be crashed from 11 weeks to 8 weeks only, thus saving $4000. If we do this, then Activity B does not have to be crashed at all.

   There are other types of problems where eliminating slack in Activities B and C may be the cheapest way to do a maximum compression. But this is not the case for this problem.

3. We now have two critical paths and Activity B did not need to be crashed at all.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A	0	6	0	6	Yes
B	0	12	2	14	No
C	6	14	6	14	Yes
D	6	22	6	22	Yes
E	14	22	14	22	Yes

4. The project's cost of $170,000 has now increased $19,500 to $189,500 for the cheapest possible maximum crash.

Activity	Normal Time, Weeks	Compression Time, Weeks	Normal Cost, $	Additional Cost for Crashing, $	Total Activity Cost, $
A	7	6	$20,000	$1,500	$21,500
B	12	12	$30,000	0	$30,000
C	12	8	$30,000	$6,000	$36,000
D	18	16	$50,000	$6,000	$56,000
E	11	8	$40,000	$6,000	$46,000
			$170,000		$189,500

5. We generally assume linearity, but it is entirely possible that crashing the first week will be $1,000 and crashing the second week will be $3,000 because the compression of the second week is more difficult than the compression of the first week. However, most people just use linearity in making the calculations.

Analyzing the Schedule

1. In the network below, determine the early start and finish times, as well as the critical path activities.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A	0	9	0	9	Yes
B	9	12	13	16	No
C	9	15	9	15	Yes
D	12	20	16	24	No
E	15	27	15	27	Yes
F	15	21	18	24	No
G	21	24	24	27	No
H	15	21	21	27	No

2. Activity B has four weeks of slack. There is no impact on the end date.
3. If Activity F slips by three weeks, then both Activities F and G are now critical path activities and there are two critical paths in the network.
4. Activity H has the most, six weeks of slack. If Activity H were to slip by more than six weeks, then the new critical path would be A-C-H.

Analyzing Yet Another Schedule

1.

Activity	Early Start	Early Finish	Latest Start	Latest Finish	On the Critical Path
A	0	5	0	5	Yes
B	0	4	5	9	No
C	0	3	4	7	No
D	5	13	5	13	Yes
E	5	9	9	13	No
F	3	9	7	13	No
G	13	20	13	20	Yes
H	13	20	13	20	Yes
I	9	12	19	22	No
J	20	29	20	29	Yes
K	20	27	22	29	No

There are two critical paths: A-D-G-J and A-D-H-J.

2. There is no impact on the end date of the project.
3. Activity F can slip by four weeks.
4. Activity C must slip by more than four weeks.
5. Activity I has 10 weeks of slack. A slippage of more than 10 weeks will extend the end date of the project.

▶ Earned Value Problems

Remember

Earned value analysis provides the project manager and the key stakeholders to assess the condition or "health" of a project by determining the level of variance from the scheduled work and budgeted cost of project activities. The three main elements for determining the condition of the project are: planned value (work that was scheduled to be accomplished), earned value (the planned budget for the work that was accomplished), and actual cost (the amount paid for the work that was accomplished). Typically earned value analysis is reported in dollars or other currency but other methods of measurement can be used. Review Chapter 15 in the workbook or in *Project Management: A Systems Approach to Planning, Scheduling, and Closing* (12th edition) for detailed information about earned value management.

The following problems will provide you with practice in the use of earned value analysis.

A small contractor wins a contract to lay tiles on the floors of all 40 offices in a small office complex. All 40 offices are the same dimensions. The contractor expects to work five days per week and to complete one office per day. The duration of the project is expected to be eight weeks. Labor is estimated at $1,000 per day. The raw material costs were paid by the client and are not part of the contract.

The customer has asked for an earned value report to be prepared at the end of the sixth week of the project. At the end of the sixth week of the project 24 offices had been completed at a cost of $27,000. This included a freak accident where the tiles for two of the offices had to be removed and replaced. Answer the following questions using the formulas for the end of week 6 report.

1. SV($) = EV – PV
2. CV($) = EV – AC
3. EAC = (AC / EV) × BAC = BAC / CPI
4. VAC = BAC – EAC
5. ETC = EAC – AC
6. SV(%) = SV($) / PV

7. CV(%) = CV($) / EV
8. CPI = EV / AC
9. SPI = EV / PV
10. EV = % COMPLETE × BAC, or % COMPLETE = EV / BAC
11. % MONEY SPENT = AC / BAC
12. NEW TIME = ORIGINAL TIME / SPI

■ Earned Value Questions

1. What is PV?
2. What is EV?
3. What is AC?
4. What is BAC?
5. What is SV($)?
6. What is CV($)?
7. What is EAC?
8. What is ETC?
9. What is VAC?
10. What is the % complete?
11. What is the % money spent?
12. What is CPI?
13. What is SPI?
14. If the critical path is the duration of the project, eight weeks, then what is the new time to complete the project?
15. What are the values for SV(%) and CV(%), and how are they actually used during status reporting?
16. There are often multiple formulas that can be used to express some of the earned value elements. Formula 3 was used to calculate the estimated cost at completion (EAC). In that formula, (AC/EV) is the rate at which you are burning or spending money. But what if the freak accident that occurred was a one-time occurrence? It may be better to use another formula for EAC. Use the formula below for EAC and compare your results to your answer to Question 7.

    EAC = [Actual to date] + [all remaining work and work in progress to be completed as planned.]
17. Most earned value calculations are based upon labor hours and labor dollars rather, and do not consider the cost of materials. If materials are considered, there are separate earned value calculations for materials, such as procurement of raw materials, and then the earned value calculations for materials and labor are added together to get a complete picture of the project's health. What is the main issue with using earned value for procurement?

■ Earned Value Answers

1. PV was estimated at 30 offices completed at the end of the sixth week for a labor cost of $30,000.
2. EV is based upon only 24 offices being completed for a cost $24,000.
3. AC is $27,000.
4. BAC is 40 offices at $1000 each for a cost of $40,000.
5. SV from Formula 1 = $24,000 – $30,000 = <$6000>.
6. CV from Formula 2 = $24,000 – $27,000 = <$3000>.
7. EAC from Formula 3 = ($27,000/$24,000) × $40,000 = $45,000
8. ETC from Formula 5 = $45,000 – $27,000 = $18,000 to finish the work.
9. VAC from Formula 4 = $40,000 – $45,000 = <$5000>.
10. % complete from Formula 10 = ($24,000 / $40,000) × 100% = 60%. This is not good because you had planned to be 75% complete by this time.
11. % money spent from Formula 11 = ($27,000 / $40,000) × 100% = 67.5%. You have spent 67.5% of the money and completed 60% of the work.
12. CPI from Formula 8 = $24,000 / $27,000 = 0.88
13. SPI from Formula 9 = $24,000 / $30,000 = 0.80
14. Using Formula 12, New time = 8 weeks / 0.80 = 10 weeks. You will finish 2 weeks late.
15. Using Formulas 6 and 7, SV(%) = <20%> and CV(%) = <12.5%>. This indicates that you are behind schedule by 20% and over budget by 12.5%. CV(%) is used frequently for status reporting, especially if your company's project management methodology requires that an exception report be prepared if you are above or below a certain financial envelop, but SV(%) has limitations. Although a negative SV(%) indicates that you are behind schedule, it may be the result of activities that are not on the critical path and the original end date may still be workable. If you prepared a schedule where activities that were not on the critical path were assumed to start as early as possible, you could be using up slack without altering the critical path.
16. Assuming you have 16 offices left to complete, EAC = $27,000 + $16,000, or $43,000. This is $2000 less than your answer to Question 7 and probably closer to the true EAC.
17. The main issue is in the determinate of EV for raw materials. EV can be calculated when the materials are ordered, when they are received, when they are placed in inventory, when they are used, or when they are paid for. The number of choices for calculating EV makes it a little complicated for standard earned value calculations

► Estimating the Budget at Completion Questions

A company is undertaking a project internal to their organization. Only one functional department will be involved and the functional manager has estimated that 10,000 hours will be required to complete the work. The project is scheduled to begin in two weeks.

The functional manager states that he has six people already selected to be assigned to your project, and their average hourly pay rate is $44.80. The functional pay grade system for the department is shown below. The overhead rate for this department is 125%.

Pay Grade	Number of Employees	Low End of Pay Grade	High End of Pay Grade	Average Pay Grade Salary
6	4	$31.40	$41.50	$36.20
7	7	$36.55	$48.75	$45.40
8	5	$44.90	$52.70	$49.10
9	6	$50.65	$62.33	$58.25

1. What is the fully burdened cost for completing the 10,000 hours of work?
2. Senior management has approved the budget for your project according to your answer to Question 1. Unfortunately, the start date of the project had been delayed by three months and the functional manager does not know whom he will be able to assign. How will you now price out the 10,000 hours?
3. Assume the functional manager tells you that he will assign two Grade 6 workers, two Grade 7 workers, and two Grade 8 workers but is unsure exactly who they will be. How will you price out the 10,000 hours now?
4. Assume that the functional manager tells you that he will assign Grade 8 and Grade 9 workers only, but is not sure about how many from each of the pay grades. How will you price out the 10,000 hours now?
5. If you compare your answers to the above four questions, what are your conclusions?

► Estimating the Budget at Completion Answers

1. The fully burdened cost will be $1,120,000.
2. Using weighted averages, the weighted average salary would be:

$$\frac{4(\$36.20)+7(\$45.40)+5(\$49.10)+6(\$58.25)}{22}=\$48.07$$

The fully loaded cost of 10,000 hours at this rate = $1,201,818

3. Using weighted averages, the weighted average salary would be:

$$\frac{2(\$36.20)+2(\$45.40)+2(\$49.10)}{6}=\$45.57$$

The fully loaded cost of 10,000 hours at this rate = $1,089,166

4. Using weighted averages again, the weighted average salary would be:

$$\frac{5(\$49.10)+6(\$58.25)}{11}=\$54.09$$

The fully loaded cost of 10,000 hours at this rate = $1,352,273

5. The most accurate budgetary estimates are made from the actual salary of the workers to be assigned. If weighted averaging of salaries is used, then the project manager must be prepared to tell senior management that the budget they approved at the initiation stage of the project may have to be adjusted.

▶ Decision Trees

Remember

To be an effective project manager, you must know how to solve problems and make decisions. Several factors influence decision making, such as the number of alternatives, the favorable or unfavorable result of each alternative, the probabilities assigned to each alternative, the risk associated with each alternative, and enterprise environmental factors that may not be able to be quantified but identify possible opportunities and threats. Most executives prefer a discussion regarding your decision explained to them in financial terms. Fortunately, there are tools that can be used such as expected monetary value (EMV) and decision tree analysis.

Calculating the EMV for each possible decision path is a way to quantify each decision in monetary terms. EMV and decision trees can be used throughout the project's life cycle but they are most frequently used as part of project risk management. As an example, you conduct a SWOT analysis to determine whether an idea is worth pursuing. Unfortunately, there may be a lack of sufficient data to reach a decision. Decision tree analysis is a means by which you can quantify the data that exists, arrive at a decision, and convince management that your decision is worth considering.

Decision tree analysis is a four-step process usually accomplished in the following order:

1. Prepare a decision tree outlining all decisions that are required.
2. Assign a probability of occurrence to the risk, impact or outcome of that decision.
3. Assign a monetary value to the risk, impact or outcome of that decision should it occur.
4. Calculate the EMV for each decision that must be made.

There are three standard symbols or nodes that are commonly used in decision tree diagrams:

1. Decision nodes commonly represented by a rectangle.
2. Chance nodes commonly represented by a circle.
3. Outcome nodes commonly represented by a triangle.

■ Problem

For the past several years, your company has been purchasing a product from a supplier and selling it to your customers at a somewhat lower price than your customers could get by purchasing it directly from your supplier. Although you have made money doing this, your customers believe that the quality of the product can be improved. Your supplier has indicated that they have no plans to improve the quality of the product in the near term. Management in your company wants to know if the idea of purchasing some equipment and manufacturing it yourself to improve quality will increase profits over the next year. The purchase price of the necessary equipment is $500,000 and training your workers will required an added cost of $100,000. Your marketing team says that the chances of a good market for the product next year is 60% and the chances of a poor market are 40%. If you manufacture the product yourself and improve the quality of the product, you estimate that a good market will generate $1,000,000 in gross revenue and a poor market will bring in $200,000. If you continue selling the product provided by your supplier, a good market will generate $300,000 in gross revenue and a poor market will bring in $50,000. The procurement costs associated with working with your supplier are estimated at $30,000 yearly.

The decision tree for this problem is shown in the sample decision tree on page 528. The decision to be made is whether to manufacture it yourself or continue purchasing the product from your supplier. Decision trees are analyzed from right to left. First, we must calculate the EMV at chance nodes A and B:

$$\text{EMV}_{\text{A}} = (60\% * \$1{,}000{,}000) + (40\% * \$200{,}000) = \$680{,}000$$

$$\text{EMV}_{\text{B}} = (60\% * \$300{,}000) + (40\% * \$50{,}000) = \$200{,}000$$

Looking at these two amounts, it appears that significantly more revenue is generated by manufacturing it ourselves. But this is not necessarily the best choice because we must subtract our costs from the gross revenue in order to arrive at profits. We must continue working from right to left and calculate EMV for decision node C.

$$\text{EMV}_{\text{MANUFACTURING}} = \$680{,}000 - \$600{,}000 = \$80{,}000$$

$$\text{EVM}_{\text{PURCHASING}} = \$200{,}000 - \$30{,}000 = \$170{,}000$$

Therefore, in this example here, the best decision for next year appears to be the continuation of purchasing the components from our supplier and selling them to our customers.

Even though the example provided in Exhibit 1 is relatively simple, there are modifications that could be made to this problem:

- Rather than using a good or poor market for the product, we could use optimistic, most likely, and pessimistic outcomes such as with a beta distribution, or we could use the triangular distribution. This adds some complexity to the problem.

- The probabilities of good and poor occurring when manufacturing the product could be different than the probabilities for purchasing the product. For example, with a higher-quality product, the probabilities of a good market might be 80% or 90%. In the above example, if the probabilities of a good/poor market for manufacturing are 80% and 20%, and the probabilities of a good/poor market using procurement remain the same at 60% and 40%, then the EMV for manufacturing would be $240,000 and would be the better choice.
- The probabilities could be based upon the chances of a specific revenue stream occurring rather than the chances of the market being good or poor.
- In the example in Exhibit 1, the best decision was purchasing the product from a supplier. But if we consider the profitability over several years with the cost of the equipment and training spread over several years, purchasing the equipment now may be the better choice.
- Additional decision points can be included, such as whether to conduct a marketing survey on market demand should we decide to manufacture the product. There can be several decision points in one decision tree diagram.
- Exhibit 1 did not consider the cost of raw material procurement as an addition expense when manufacturing a product.
- The final decision is highly dependent upon the accuracies of the probabilities and impacts.
- In many situations the EMV calculation can indicate negative numbers.
- The more assumptions we make and the more scenarios that are added into the decision tree, the more cautious we should be over the end result.

SAMPLE DECISION TREE

We can see the advantages and disadvantages of using decision trees.

The advantages are:

- Easy to create, understand, and interpret
- Can be enhanced to include several different scenarios
- Has significant value
- Can be combines with other decision-making tools

The disadvantage are:

- The decision tree identifies a possible decision that is based upon future rather than present outcomes.
- The more complex the decision tree becomes, and the more assumptions that must be made, the greater the chance that the final result may be suspect.
- Outcomes and EMV calculations are based upon an "average" result, which may be unrealistic.
- Management may become more enamored with the possibility of one highly favorable outcome that overshadows the possibilities of unfavorable outcomes that can occur. The corollary is also true.

While decision trees have value for project managers, there are other tools that can be used. The information in a decision tree can be represented more compactly as an influence diagram, focusing attention on the issues and relationships between events. However, this could add complexity to the decision-making process.

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