PMP®

Sean Whitaker

Training Kit

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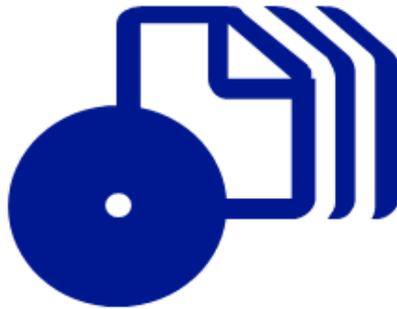
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PMP exam task map

	TASK	CHAPTER
1.0	**INITIATING THE PROJECT (13 PERCENT)**	
1.1	Perform project assessment based upon available information and meetings with the sponsor, customer, and other subject matter experts, in order to evaluate the feasibility of new products or services within the given assumptions and/or constraints.	2
1.2	Define the high-level scope of the project based on the business and compliance requirements, in order to meet the customer's project expectations.	2
1.3	Perform key stakeholder analysis using brainstorming, interviewing, and other data-gathering techniques, in order to ensure expectation alignment and gain support for the project.	11
1.4	Identify and document high-level risks, assumptions, and constraints based on current environment, historical data, and/or expert judgment, in order to identify project limitations and propose an implementation approach.	2
1.5	Develop the project charter by further gathering and analyzing stakeholder requirements, in order to document project scope, milestones, and deliverables.	2
1.6	Obtain approval for the project charter from the sponsor and customer (if required), in order to formalize the authority assigned to the project manager and gain commitment and acceptance for the project.	2
2.0	**PLANNING THE PROJECT (24 PERCENT)**	
2.1	Assess detailed project requirements, constraints, and assumptions with stakeholders based on the project charter, lessons learned from previous projects, and the use of requirement-gathering techniques (e.g., planning sessions, brainstorming, focus groups), in order to establish the project deliverables.	2, 3
2.2	Create the work breakdown structure with the team by deconstructing the scope, in order to manage the scope of the project.	3
2.3	Develop a budget plan based on the project scope using estimating techniques, in order to manage project cost.	5
2.4	Develop a project schedule based on the project timeline, scope, and resource plan, in order to manage timely completion of the project.	4
2.5	Develop a human resource management plan by defining the roles and responsibilities of the project team members in order to create an effective project organization structure and provide guidance regarding how resources will be utilized and managed.	7
2.6	Develop a communication plan based on the project organization structure and external stakeholder requirements, in order to manage the flow of project information.	8, 11
2.7	Develop a procurement plan based on the project scope and schedule, in order to ensure that the required project resources will be available.	10
2.8	Develop a quality management plan based on the project scope and requirements, in order to prevent the occurrence of defects and reduce the cost of quality.	6
2.9	Develop a change management plan by defining how changes will be handled, in order to track and manage changes.	2
2.10	Plan risk management by developing a risk management plan, and identifying, analyzing, and prioritizing project risks in the risk register and defining risk response strategies, in order to manage uncertainty throughout the project life cycle.	9
2.11	Present the project plan to the key stakeholders (if required), in order to obtain approval to execute the project.	2, 11
2.12	Conduct a kick-off meeting with all key stakeholders, in order to announce the start of the project, communicate the project milestones, and share other relevant information.	8, 11

Exam domains, tasks, and knowledge and skill statements The exam domains, tasks, and knowledge and skill statements listed here are current as of this book's publication date. Exam domains, tasks, and knowledge and skill statements are subject to change at any time without prior notice and at the sole discretion of the Project Management Institute (PMI®). Please visit the PMI webpage for the most current information about PMI's Project Management Professional (PMP®) credential: *http://www.pmi.org/en/Certification/Project-Management-Professional-PMP.aspx*.

3.0	**EXECUTING THE PROJECT (30 PERCENT)**	
3.1	Obtain and manage project resources including outsourced deliverables by following the procurement plan, in order to ensure successful project execution.	10
3.2	Execute the tasks as defined in the project plan, in order to achieve the project deliverables within budget and schedule.	2, 8, 11
3.3	Implement the quality management plan using the appropriate tools and techniques, in order to ensure that work is being performed according to required quality standards.	6
3.4	Implement approved changes according to the change management plan, in order to meet project requirements.	2
3.5	Implement approved actions and follow the risk management plan and risk register, in order to minimize the impact of negative risk events on the project.	9
3.6	Maximize team performance through leading, mentoring, training, and motivating team members.	7
4.0	**MONITORING AND CONTROLLING THE PROJECT (25 PERCENT)**	
4.1	Measure project performance using appropriate tools and techniques, in order to identify and quantify any variances, perform approved corrective actions, and communicate with relevant stakeholders.	2, 3, 4, 5, 10, 11
4.2	Manage changes to the project scope, schedule, and costs by updating the project plan and communicating approved changes to the team, in order to ensure that revised project goals are met.	2, 3, 4, 5
4.3	Ensure that project deliverables conform to the quality standards established in the quality management plan by using appropriate tools and techniques (e.g. testing, inspection, control charts), in order to satisfy customer requirements.	6
4.4	Update the risk register and risk response plan by identifying any new risks, assessing old risks, and determining and implementing appropriate response strategies, in order to manage the impact of risks on the project.	9
4.5	Assess corrective actions on the issue register and determine next steps for unresolved issues by using appropriate tools and techniques in order to minimize the impact on project schedule, cost, and resources.	2, 9
4.6	Communicate project status to stakeholders for their feedback, in order to ensure the project aligns with business needs.	8, 11
5.0	**CLOSING THE PROJECT (8 PERCENT)**	
5.1	Obtain final acceptance of the project deliverables by working with the sponsor and/or customer, in order to confirm that project scope and deliverables were met.	2
5.2	Transfer the ownership of deliverables to the assigned stakeholders in accordance with the project plan, in order to facilitate project closure.	2
5.3	Obtain financial, legal, and administrative closure using generally accepted practices, in order to communicate formal project closure and ensure no further liability.	2, 10
5.4	Distribute the final project report including all project closure-related information, project variances, and any issues, in order to provide the final project status to all stakeholders.	2
5.5	Collate lessons learned through comprehensive project review, in order to create and/or update the organization's knowledge base.	2
5.6	Archive project documents and material in order to retain organizational knowledge, comply with statutory requirements, and ensure availability of data for potential use in future projects and internal/external audits.	2
5.7	Measure customer satisfaction at the end of the project by capturing customer feedback, in order to assist in project evaluation and enhance customer relationships.	2

PMP® Training Kit

Sean Whitaker

Contents at a glance

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Introduction

This training kit is designed for project management practitioners who plan to earn the Project Management Professional (PMP®) credential offered by the Project Management Institute (PMI). It is assumed that before you begin using this kit, you have ensured that you have the necessary eligibility requirements to take the exam.

The material covered in this training kit relates to the PMP® exam based on the PMBOK® Guide, 5th Edition. The topics in this training kit cover what you need to know for the exam.

By using this training kit, you will learn how to do the following:

- Understand foundational project management concepts and terminology.
- Understand and implement tasks associated with initiating a project.
- Understand and implement tasks associated with planning a project.
- Understand and implement tasks associated with executing a project.
- Understand and implement tasks associated with monitoring and controlling a project.
- Understand and implement tasks associated with closing a project.
- Demonstrate an understanding of the PMBOK® Guide knowledge areas.

Refer to the task mapping page in the front of this book to see where in the book each exam task is covered.

Using the companion CD

A companion CD is included with this training kit. The companion CD contains the following:

- **Practice tests**   You can reinforce your understanding of the topics covered in this training kit by using electronic practice tests that you customize to meet your needs. You can practice for the PMP® certification exam by using tests created from a pool of more than 400 realistic exam questions, which give you many practice exams to ensure that you are prepared.
- **An eBook**   Instructions to download the electronic version (eBook) of this book is included for when you do not want to carry the printed book with you.

> *NOTE*   **COMPANION CONTENT FOR DIGITAL BOOK READERS**
>
> **If you bought a digital-only edition of this book, you can enjoy select content from the print edition's companion CD. Visit *http://aka.ms/PMPTK/files* to get your download-able content.**

How to install the practice tests

To install the practice test software from the companion CD to your hard disk, perform the following steps:

1. Insert the companion CD into your CD drive and accept the license agreement. A CD menu appears.

> **NOTE IF THE CD MENU DOES NOT APPEAR**
>
> If the CD menu or the license agreement does not appear, AutoRun might be disabled on your computer. Refer to the Readme.txt file on the CD for alternate installation instructions.

2. Click Practice Tests and follow the instructions on the screen.

How to use the practice tests

To start the practice test software, follow these steps:

1. Click Start | All Programs, and then select Microsoft Press Training Kit Exam Prep.

   A window appears that shows all the Microsoft Press training kit exam prep suites installed on your computer.

2. Double-click the practice test you want to use.

When you start a practice test, you choose whether to take the test in Certification Mode, Study Mode, or Custom Mode:

- **Certification Mode**   Closely resembles the experience of taking a certification exam. The test has a set number of questions. It is timed, and you cannot pause and restart the timer.
- **Study Mode**   Creates an untimed test during which you can review the correct answers and the explanations after you answer each question.
- **Custom Mode**   Gives you full control over the test options so that you can customize them as you like.

In all modes, the user interface when you are taking the test is basically the same but with different options enabled or disabled depending on the mode.

When you review your answer to an individual practice test question, a "References" section is provided that lists where in the training kit you can find the information that relates to that question and provides links to other sources of information. After you click Test Results to score your entire practice test, you can click the Learning Plan tab for a list of references for every objective.

How to uninstall the practice tests

To uninstall the practice test software for a training kit, use the Program And Features option in Windows Control Panel.

Acknowledgments

The author's name appears on the cover of a book, but I recognize that I am only one member of a much larger team. This book is the sum total of the efforts of a very skilled and dedicated team. First of all, thanks to Kenyon Brown at O'Reilly Media for allowing me to write this book. During the writing process, I also worked closely with Kathy Krause and Marlene Lambert at OTSI, and O'Reilly Media Production Editor Melanie Yarbrough. All of them contributed in significant ways to making this a great book. Dan Tuuri was the technical reviewer, and he applied a polish to my sometimes raw initial content. Each of these contributed significantly to this book, and I look forward to working with them all in the future.

Support & feedback

The following sections provide information on errata, book support, feedback, and contact information.

Errata

We've made every effort to ensure the accuracy of this book and its companion content. Any errors that have been reported since this book was published are listed on our Microsoft Press site:

http://aka.ms/PMPTK/errata

If you find an error that is not already listed, you can report it to us through the same page.

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http://www.microsoft.com/learning/booksurvey

The survey is short, and we read every one of your comments and ideas. Thanks in advance for your input!

Stay in touch

Let us keep the conversation going! We are on Twitter: *http://twitter.com/MicrosoftPress*.

Understanding foundational concepts of project management

This chapter describes foundational concepts of the PMBOK® Guide. It will introduce you to the purpose and content of the PMBOK® Guide, and provide some definitions of projects, project management, program management, portfolio management, organizational project management, operations management, organizational strategy, business value, and the project life cycle. All of these foundational concepts are important to ensure that you understand the terminology used by the PMBOK® Guide, which also appears in the PMP® exam. It is important that you take time to fully understand these foundational concepts, because they underpin many of the processes, tools, and techniques that come later in the book.

EXAM TIP

Remember that the PMP® exam is testing a lot of elements, including your understanding of the PMBOK® Guide terminology and concepts. You may come across questions that have an answer that is what you would actually call something in real life but it is not how the PMBOK® Guide would refer to it. In this instance, always answer according to the PMBOK® Guide. Also, pay close attention to not only the terms but also the various inputs and outputs.

In this chapter, you will learn how to do the following:

- Introduce and outline the key foundational terms, purpose, and contents of the PMBOK® Guide.
- Understand the differences and interrelationships between project, program, and portfolio management.
- Understand the relationship between organizational project management, operations management, and organizational strategy.

- Understand the role that business value and strategic planning have in project management.
- Define organizational process assets and their benefit to project management.
- Define enterprise environmental factors and the ways in which they can assist and constrain a project.
- Define and understand the characteristics of the project life cycle, including project phases.

The purpose of the PMBOK® Guide

> **MORE INFO**   **THE PMBOK® GUIDE**
>
> You can read more about the purpose of the PMBOK® Guide, 5th edition, in the guide itself, in Chapter 1, section 1.1.

The full title of the *PMBOK® Guide* is *A Guide to the Project Management Body of Knowledge.* If you break that down into its component parts, you can get an understanding of what sort of document it is.

First of all, it is a guide. This means that it is not a prescriptive instruction manual that must be followed to the letter, and individuals and organizations can, and do, choose to only implement appropriate portions of the PMBOK® Guide. It presents the information as a guide for you to use when and if it is useful. Obviously, it is a guide to the profession of project management. Because the profession of project management is both relatively young and also very wide in its application, any book purporting to be about it is necessarily going to be both iterative and also broad in the information contained within it. This is the fifth edition of the PMBOK® Guide and represents a major change from previous versions, with an extra knowledge area and more in-depth coverage of foundation topics. The development and updating of the PMBOK® Guide is an ongoing process, with an updated edition being released every three to four years. Make sure you have access to the latest copy of the PMBOK® Guide. It is also aligned with ISO 21500:2012.

> **EXAM TIP**
>
> ISO 21500:2012 is an international standard for project management developed by the International Organization for Standardization (the initials *ISO* come from the French way of saying this). It provides guidance and a high-level description of concepts and processes that are considered to form good or best practice in the profession of project management.

Finally, as a body of knowledge, it contains what is considered to be a fairly complete set of knowledge about the profession of project management. Many professions, including civil

engineering, software engineering, contracting, and even massage therapy have bodies of knowledge associated with them.

Overall, the PMBOK® Guide presents what is generally recognized to be good practice in the profession of project management. This means that the processes, tools, and techniques that it presents are useful to most projects most of the time. It is up to the organization or the project management team to determine which, if any, of the processes, tools, or techniques are useful for any project they are working on. This process of selecting only those processes, tools, and techniques that actually provide benefit when managing your projects is called *tailoring*.

Real world

The PMBOK® Guide is not a project management methodology. It is a framework document containing the collection of what is considered good project management practice for projects of any size, complexity, and industry. In order to build a project management methodology, you are directed to take from the PMBOK® Guide only those processes, tools, and techniques that are appropriate and add value to your project via the process of tailoring.

In addition to representing a robust body of knowledge, the PMBOK® Guide also presents standardized terminology. This means that there is generally a single word or phrase to define and describe each element of project management. It allows project managers and project team members within the same organization, and between organizations, to communicate effectively.

Real world

The benefit of a standardized terminology cannot be underestimated. I have been in many situations with people from differing organizations who make simple mistakes because they use different words for the same thing. I remember once I asked a contract manager on my team for the project schedule, and he sent me the schedule of materials. After three requests and increasing confusion on both sides, we finally figured out that I was requesting what he referred to as the project timeframe. On another occasion, I was assisting a firm that was growing rapidly and recruiting project managers every week. The biggest challenge they faced was the different terminology all these experienced project managers used. We worked on developing a common organization-wide project management vocabulary to improve communication between all the project managers and project team members.

Of course, your main interest in the PMBOK® Guide is that it is a very useful text upon which to base your study for the Project Management Professional (PMP®) certification. Passing the PMP® examination requires knowledge of the entire contents of the PMBOK® Guide, as well as knowing the "Project Management Institute Code of Ethics and Professional Conduct."

EXAM TIP

Even if you have a photographic memory and could remember every page of the PMBOK® Guide, you would not necessarily score 100 percent on the PMP® examination because the PMP® examination is based upon the results of a role delineation study about what professional attributes a project manager should have. The PMBOK® Guide presents a very useful text upon which to base your study. This is because the contents of the PMBOK® Guide are built upon the knowledge of many disciplines, and often a single phrase or sentence in the PMBOK® Guide can refer to an entire other subject area. That is why simply studying the PMBOK® Guide is not the best approach to preparing to sit the PMP® examination. This book will not only introduce you to the entire contents of the PMBOK® Guide but also present a lot of other information so you are prepared to pass the examination.

Quick check

1. How should you use the PMBOK® Guide in your projects?

2. Apart from offering a collection of good practices in project management, what other main benefit does the PMBOK® Guide provide?

Quick check answers

1. By selecting from it only those processes, tools, and techniques that are appropriate for your projects based on size, complexity, and industry.

2. It provides a standardized terminology, or lexicon, for the profession of project management.

What is a project, a program, and a portfolio?

MORE INFO   PROJECT, PROGRAM, PORTFOLIO

You can read more about the definition of a project, a program, and a portfolio in the PMBOK® Guide, 5th edition, in Chapter 1, section 1.2.

It may seem straightforward to define exactly what a *project* is, but it is important that you know how the PMBOK® Guide defines one. There are several key elements that separate project work from ongoing or operational work.

The first and most important element of a project is that it has a defined start and end, making it a temporary endeavor. On the other hand, operational, or ongoing, work is ongoing and repetitive.

A project also delivers something unique, something that hasn't been done before. Ongoing work is repetitive and delivers the same thing every day or every year.

Finally, a project delivers a product, service, or result. This allows projects to be used to deliver a range of deliverables in many industries, whether they are based on goods or services.

EXAM TIP

There are only two types of work in the world, according to the PMBOK® Guide. All work is either operational work or project work. If it is operational work, then it is repetitive and ongoing. If it is project work, then it has a defined start, middle, and end and delivers a product, service, or result.

Real world

You may find a degree of overlap between project work and operational work. There are certainly some projects that bear a striking resemblance to each other and perhaps could be construed as ongoing work. It is the unique aspect of each— and that it is done slightly differently, in a different location, to produce a slightly different product, service, or result—that makes it a project.

A *portfolio* of projects includes all the projects, whether interdependent or not, that an organization is undertaking. They are only connected by their common goal of delivering the organization's strategic goals.

A *program* of projects describes projects that have some sort of interdependency between them. They may all be part of a larger deliverable; for example, you could have several projects, each of which makes a different part of a new aircraft, but the final deliverable depends on managing the projects together as a program. The projects may also share a common goal, and the program manager needs to monitor and resolve any actual or potential conflicts in the pursuit of those goals.

A project can be part of a program and part of a portfolio. Figure 1-1 shows that all programs are part of a portfolio, but that projects can either be directly part of a portfolio or part of a program.
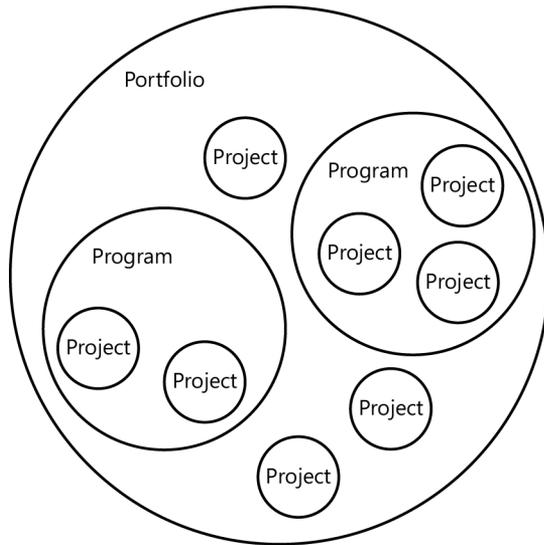
FIGURE 1-1 A portfolio encompasses all projects and programs within an organization.

Project, program, and portfolio management are separate yet interrelated elements of the profession of project management. The combination of the project management, program management, and portfolio management disciplines is viewed as integral and necessary to deliver the organizational strategy and, therefore, any action undertaken in any of the three elements should always align with the organization's strategy.

Portfolio management ensures that all projects selected to be completed by the organization align with the organizational strategy. Portfolio management has an organizational scope that reflects the organizational strategy. Often projects or programs are grouped together into a single portfolio that reflects a specific strategy.

EXAM TIP

The PMBOK® Guide places a great deal of emphasis on the alignment of organizational strategy and the profession of project management as a strategic enabler for delivering the strategy. Always assume that the default position in a question is that an organization has a strategy and is using project management to achieve that strategy.

Program management focuses on managing interdependencies within projects with a common goal or capability. Program managers are skilled at forecasting, anticipating, and dealing with real or perceived conflict between projects in the same program. All programs have projects, but not all projects are part of programs.

The *project management office* (PMO) is the part of the organization responsible for project management excellence. It provides support for the project manager, which can mean many things, depending on the level of organizational project management maturity. A project management office can simply be a place where a project management methodology is developed and stored, or at the other end of the spectrum, it can be where all the project managers are located, a place that provides common reporting and manages shared resources and it is responsible for portfolio, program, and project management across the entire organization.

The PMBOK® Guide defines three main types of project management office, differentiated by the level of control and influence they have, as shown in Figure 1-2. The supportive project management office provides templates and basic processes and captures lesson learned. The controlling project management office may take responsibility for development and implementation of a project management methodology and provide project governance as well. The directive project management office takes direct control of management of projects within the organization.

Supportive   Controlling   Directive

← _____ →

Low   *Level of control and influence*   High
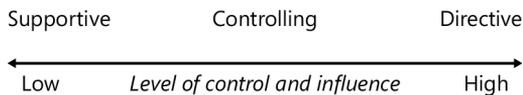
FIGURE 1-2 The types of project management office (PMO) can be shown on a spectrum from supportive to directive.

The type of project management office an organization should have also depends upon the level of organizational project management maturity the organization has attained. *Organizational project management maturity* is a way of assessing where an organization is currently with its level of sophistication and maturity around project management processes, tools, templates, and methodology, and then assessing where they should be. Organizations handling large and complex projects should be at a higher level of project management maturity than organizations managing small and simple projects. Organizations with a high level of project management maturity should have a more directive project management office.

What is project management?

Project management takes the tools, techniques, and skills contained in the PMBOK® Guide and applies them to the project to deliver the product, service, or result. It is a proactive, rather than a reactive, discipline.

The PMBOK® Guide, 5th edition, contains a description of 47 project management process in 10 knowledge areas. These 47 processes are placed within five process groups of initiating, planning, executing, monitoring and controlling, and closing to describe the stage in the project in which they are best used. Managing a project means taking the appropriate process and the tools and techniques associated with it and applying them appropriately to the work that needs to be done. Project management, then, is simply the application of any of the PMBOK® Guide knowledge areas with the goal of delivering a product, service, or result.

One of the tasks of project management is the balancing of competing constraints on a project. These constraints can be scope, quality, schedule, budget or cost, resources, and risk. If any one of these constraints changes, it will likely place additional pressure on one or more of the other constraints. For example, if you have to deliver a project in a shorter time period, you may need additional budget to complete the work, and your known risks may increase while quality decreases.

An important aspect of project management is that, generally speaking, you cannot know everything there is to know about a project at the outset and, thus, project management is highly iterative. This means that you may be able to accurately define the work to be done for the next few weeks, but you can't plan as well beyond that because there is more uncertainty. So you plan in an iterative manner, meaning that you plan many times, each time with more information. *Progressive elaboration* is an iterative process that acknowledges that you will know more the more you do. For example, at the beginning of a software project you may know the general expected outcome and the first steps on the path to delivering it, but as you move along in the project you become more aware of the magnitude of the work and can plan the project schedule, budget, and risks better.

Rolling wave planning is another type of iterative planning where you plan in detail the next appropriate time period and, as you keep progressing throughout a project, you keep planning that same length of time in detail.

Real world

It is important to let your project stakeholders know that projects are generally iterative and subject to progressive elaboration, to counter the expectation that you can plan everything at the beginning of a project.

✓ Quick check

1. How would project management differ from managing an ongoing business activity?

2. How does iterative planning differ from progressive elaboration of a project?

Quick check answers

1. Project management uses the process, tools, and techniques of the PMBOK® Guide, is subject to multiple interdependent constraints, and is subject to iterations and progressive elaboration. It is also a temporary endeavor with a defined end. Ongoing operational business activity may or may not be subject to interdependent constraints, and it does not have a defined end.

2. You can deliberately choose to plan iteratively even with a known scope of work. You can decide to focus your detailed planning actives on the immediate future and revisit the planning stages as the project progresses. Progressive elaboration, or rolling wave planning, implies that not everything is known about a project and more will become known as the project moves along.

Project management, operations management, and organizational strategy

MORE INFO   **PROJECT MANAGEMENT, OPERATIONS MANAGEMENT, AND ORGANIZATIONAL STRATEGY**

You can read more about project management, operations management, and organizational strategy in the PMBOK® Guide, 5th edition, in Chapter 1, section 1.5.

As you already know, project management is all about delivering a product, service, or result. After this product, service, or result has been delivered as part of the entire project work or simply as part of a project phase, it normally gets handed over to operational management. Operational management differs from project management in that it is a permanent part of any organization and is focused on the ongoing activities of the business, whereas project management is focused on the temporary activities of project delivery. Operational management also provides the overall strategy for the organization, which is used to help select the right projects.

Obviously, each area intersects at the point where the deliverable is handed over. At this point, the normal operations of the organization may need to change or adapt to accommodate the deliverable. This is one role of operational managers.

EXAM TIP

For the exam, you need to know the difference between operational work and project work, and that operational management often takes responsibility for the deliverable for the project when it has been completed.

Real world

An important tip for any project manager is to include the end users responsible for use and maintenance of any deliverable in the list of stakeholders to be consulted. They will often have real-world experience in the use and ongoing maintenance of the deliverable that perhaps the people who design the deliverable don't.

The *business value* is the sum of all tangible and intangible values in the organization. It can include all capital assets of an organization as well as intangible elements such as brand recognition. Organizations strive to increase their business value, and they can use project management to help them do this. The successful creation of business value is enhanced by having a clear strategy and using the strategy to select projects that deliver appropriate business value. In this way, project management can contribute to the business value of an organization.

More specifically, portfolio management selects the projects that align with organizational strategy, program management manages interconnected projects, and project management delivers unique products, service, and results, all of which contribute to greater business value. The creation of business value is the final link in the process whereby project management can be viewed as a key strategic enabler for a business.

Real world

It is important that project managers have a sound understanding of operational management objectives so they understand why their projects are important and how they fit into the overall organization strategy and add business value. In my own career I have found that a business education has helped my project management and, conversely, my project management experience has helped my operational management efforts.

✔ Quick check

1. Describe the two main points at which the worlds of operational management and project management intersect.
2. What are the key elements that make up business value?
3. How can project management contribute to the creation of business value?
4. How does portfolio management assist in the creation of business value?

Quick check answers

1. The first point of intersection is that operational management provides the overall organizational strategy that is used to select the right projects. The second main point where the two worlds meet is when operational management takes ownership of any project deliverable.
2. Business value is made up of both the tangible and intangible elements of a business.
3. Project management delivers products, services, or results that add either tangible or intangible business value.
4. Portfolio management focuses on ensuring that any projects selected are aligned with the organizational strategy and that the strategy delivers increased business value.

Organizational influences on project management

Projects are not completed in a vacuum, devoid of influence by an organization's culture, style, or structure. It is important for a project manager to recognize that each of these elements can positively or negatively influence the outcome of a project. Different organizations have different cultures. These cultures can be observed by noting such things as the values, beliefs, and expectations held by senior management; any relevant policies and procedures that the organization has; its motivation and reward systems; its tolerance toward risk; its attitudes toward hierarchy and power and authority relationships; and such things as the expected work and work hours. The organizational culture is usually established by the founders of the organization, developed by the current employees, and perpetuated through its ongoing recruitment policies.

Real world

Often in the real world you will find organizations that do the same work technically but have completely different organizational cultures. I know of several people who have left one organization to go to a competitor, only to return within a few months because they didn't like the particular organizational culture.

In addition to the internal organizational culture founded by recruitment policies and current employees, an organization's culture can also be influenced by the broader cultural environment in which it operates. This includes factors such as employment market conditions, level of competition, and external political influences. It is up to the project manager to make sure he or she assesses and understands how these cultural factors may impact the project. This creates challenges for the project manager, who must be aware of issues around multiculturalism, particularly with the increase of globalization and the use of project team members from different countries.

EXAM TIP

Both the organization's culture and its structure are enterprise environmental factors because they sit outside of the direct realm of the project and can assist or constrain the project.

So far this chapter has looked at the impact of organizational culture upon projects. Other important aspects of organizational influence upon projects are organizational process assets and enterprise environmental factors.

Organizational process assets, as the name suggests, are any existing plans, procedures, policies, templates, and knowledge bases that the organization owns that can be used to assist the project. Organizational process assets appear as inputs into most of the 47 planning processes in the PMBOK® Guide. Specific examples of organizational process assets include the project management methodology, any blank templates, any change control processes and procedures, any financial control reporting requirements, any defined communication methods, any standardized approach to risk management the organization has, and any project closure guidelines, requirements, or checklists.

Enterprise environmental factors are always external to the project but not necessarily external to the organization; they are just not under the control of the project team. Enterprise environmental factors feature as inputs into most of the 47 planning processes in the PMBOK® Guide. Specific examples of enterprise environmental factors include the organizational culture and structure, any relevant government or industry standards that can affect the project, any personnel administration requirements, any external marketplace conditions, the stakeholder risk tolerances, the external political climate, and any project management information systems, including any software owned by the organization. Many people assume that project management software is an organizational process asset; however, it is generally considered to be an enterprise environmental factor because it is usually licensed rather than owned.

Real world

The most common form of organizational process asset that most project managers encounter is the project management methodology that an organization has. A project management methodology itself can mean many things. It can be as simple as a range of blank templates available to the project manager, or at the other end of the spectrum it can be a fully defined set of processes, procedures, templates, and databases that must be used for all projects.

EXAM TIP

A general rule of thumb for remembering the difference between organizational process assets and enterprise environmental factors is that, generally speaking, organizational process assets can be used to assist a project, whereas enterprise environmental factors will often constrain a project. Additionally, as the name suggests, with organizational process assets the organization must own the assets.

The project life cycle

MORE INFO **PROJECT LIFE CYCLE**

You can read more about the project life cycle in the PMBOK® Guide, 5th edition, in Chapter 2, section 2.4.

The *project life cycle* is central to the PMBOK® Guide. It forms the basis for the five PMBOK® Guide process groups. The project life cycle provides a framework and also describes the generally sequential activities undertaken in any project, beginning with the process of starting or initiating the project, organizing and preparing to do the work of the project, then carrying out the defined project work, and finally recognizing the closeout of a project.

The concept of the project life cycle moving from a project's beginnings to its closure can be applied to an entire project or to the different *phases* within the project. Project phases are best used when there is a clear and defining milestone between activities. For example, a project may have a design phase that requires signoff on the design (which would be the milestone) before the project is allowed to proceed to the implementation phase. Project phases can be performed in a linear, sequential fashion, with successive phases having to wait until a predecessor phase is complete before proceeding. Alternatively, phases can also overlap, with the successive phase able to start prior to the completion of the predecessor phase.

A project management *methodology* takes an approach based on the project life cycle and perhaps its phases, and describes the processes that will be followed and the tools and templates to be used. Most project management methodologies are built upon the concept of the project life cycle and have different procedures that reflect different parts of the project life cycle.

Real world

There are many different types of project management methodologies in existence. They range from the highly iterative agile methodologies used in information technology projects to the more predictive methodologies also known as waterfall methodologies, where there is a clear linear progression from start-up through to closure of a project. In developing an appropriate project management methodology for an organization, consideration must be given to the type of projects, the size of projects, the organizational culture, the timeframe for project delivery, and the maturity of the organization. The development of a project management methodology is not a one-size-fits-all proposition. In fact, a good methodology will always be flexible enough to accommodate different projects.

The concept of the project life cycle incorporating the initiation, planning, execution, and closing phases of the project is based upon the Shewhart and Deming *Plan-Do-Check-Act (PDCA) cycle*. This cycle stars with making a plan, then doing what you planned, then checking that what you are doing is what you planned, then acting if you find any variance between what you are doing and what you planned to do, and then going back and planning again. Figure 1-3 shows the Shewhart and Deming Plan-Do-Check-Act (PDCA) cycle.
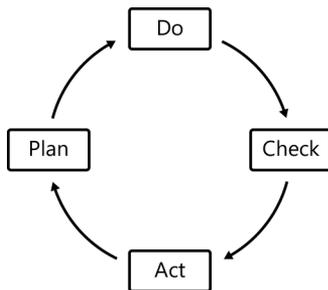
FIGURE 1-3 The Shewhart and Deming Plan-Do-Check-Act cycle shows the iterative nature of project management.

This cycle forms the basis of the initiating, planning (Plan), executing (Do), monitoring and controlling (Check and Act), and closing process groups of the PMBOK® Guide. Figure 1-4 shows the PMBOK® Guide process groups.
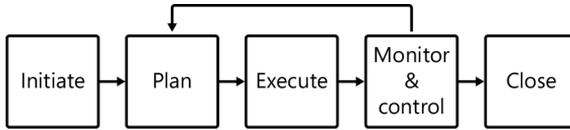
FIGURE 1-4 The PMBOK® Guide process groups can be shown as an iterative cycle of activity.

EXAM TIP

Take care to read any questions about life cycles to determine whether they are referring to the project life cycle or the product life cycle. The project life cycle refers to the project from initiation to closing. The product life cycle refers to the design, manufacturing, use, and obsolescence of the product. The product life cycle can be many years longer than the project life cycle.

The five PMBOK® Guide process groups describe work to be done in each of the 10 specific knowledge areas. Table 1-1 shows how the five process groups and the 10 knowledge areas from the PMBOK® Guide overlap.

TABLE 1-1 The PMBOK® Guide process groups and knowledge areas

	Initiating processes	Planning processes	Executing processes	Monitoring and Controlling processes	Closing processes
Project Integration management	■ Develop Project Charter	■ Develop Project Management Plan	■ Direct and Manage Project Work	■ Monitor and Control Project Work ■ Perform Integrated Change Control	■ Close Project or Phase
Project Scope management		■ Plan Scope Management ■ Collect Requirements ■ Define Scope ■ Create WBS		■ Validate Scope ■ Control Scope	

	Initiating processes	Planning processes	Executing processes	Monitoring and Controlling processes	Closing processes
Project Time management		■ Plan Schedule Management ■ Define Activities ■ Sequence Activities ■ Estimate Activity Resources ■ Estimate Activity Durations ■ Develop Schedule		■ Control Schedule	
Project Cost management		■ Plan Cost Management ■ Estimate Costs ■ Determine Budget		■ Control Costs	
Project Quality management		■ Plan Quality Management	■ Perform Quality Assurance	■ Control Quality	
Project Human Resource management		■ Plan Human Resource Management	■ Acquire Project Team ■ Develop Project Team ■ Manage Project Team		
Project Communications management		■ Plan Communications Management	■ Manage Communications	■ Control Communications	
Project Risk management		■ Plan Risk Management ■ Identify Risks ■ Perform Qualitative Risk Analysis ■ Perform Quantitative Risk Analysis ■ Plan Risk Responses		■ Control Risks	

	Initiating processes	Planning processes	Executing processes	Monitoring and Controlling processes	Closing processes
Project Procurement management		■ Plan Procurement Management	■ Conduct Procurement	■ Control Procurements	■ Close Procurements
Project Stakeholder management	■ Identify Stakeholders	■ Plan Stakeholder Management	■ Manage Stakeholder Engagement	■ Control Stakeholder Engagement	

EXAM TIP

Try memorizing this table to help you remember the sequence of processes in the exam. An easy way to remember the knowledge areas is to use a mnemonic. My favorite, after you remove the word *Project* from each one, is*: In Summer The Cruel Queen Hates Cold Runny Porridge Snacks*. Notice that the first letter of each word in the sentence links to the first letter in each of the knowledge areas. Try making up your own mnemonic. If you are a numbers sort of person, try remembering the following number sequence 2 - 24 - 8 - 11 - 2. Those numbers are the number of processes in the Initiating, Planning, Executing, Monitoring and Controlling, and Closing process groups, respectively. Another set of numbers is 6 - 6 - 7 - 4 - 3 - 4 - 3- 6 - 4 - 4, which are the numbers of processes in each knowledge area from Integration Management through Stakeholder Management.

✔ **Quick check**

1. What sort of projects benefit from a phased approach?
2. What are the four parts of the Shewhart and Deming cycle?
3. What are the five PMBOK® Guide process groups?

Quick check answers

1. Projects that have well-defined milestones are suitable for a phased approach.
2. The four parts are Plan, Do, Check, and Act.
3. The five PMBOK® Guide process groups are Initiating, Planning, Executing, Monitoring and Controlling, and Closing a project.

Exercises

The answers for these exercises are located in the "Answers" section at the end of this chapter.

1. Consider the following scenarios. For each scenario, decide whether it is a project, a program, a portfolio, or ongoing work.

    A. The implementation of a new piece of software to run an organization's payroll

    B. The construction of a new house

    C. The development of a new housing subdivision

    D. Filming the first movie of a movie trilogy

    E. Increasing sales from the previous year

    F. The design phase of a new piece of software

    G. The range of projects an organization is undertaking to increase market share

    H. The installation of new servers as part of a major upgrade to an organization's software and hardware systems

    I. A new marketing campaign designed to bring in more business

    J. The development of a new product that will increase operational profit

    K. Several different pieces of software being developed that use the same developers

    L. All the new house projects being undertaken by a construction company

2. Practice filling out the following blank table with process groups, knowledge areas, and processes.

The PMBOK® Guide process groups

The PMBOK Guide knowledge area					

Chapter summary

- This chapter introduced you to many foundational concepts of the PMBOK® Guide. It began by looking at the purpose and contents of the PMBOK® Guide and then went on to define a project and the unique characteristics that differentiate projects from ongoing or repetitive work. It is important that you understand how project work is different from ongoing or operational work.

- The chapter then looked at the differences between and the relationships among project management, program management, and portfolio management. The link to portfolio management also includes consideration of the link between projects and strategic planning and how project management can be a strategic enabler for an organization. Ultimately, the strategic decisions made and the way in which project management can support them will deliver increased business value.

- The role of the project management office (PMO) in any organization is an important one and reflects the level of organizational project management maturity that the organization has attained. The primary function of a PMO and whether it is supportive, controlling, or directive is a direct reflection of the level of maturity of the organization.

- The role of organizational process assets and enterprise environmental factors in the success or failure of project management is important. Additionally, organizational process assets and enterprise environmental factors feature in many of the 47 processes of the PMBOK® Guide as inputs.

- The concept of the project life cycle, which begins with the start of a project and moves through the organization, preparation, and execution of the planned project work, and finally the closing of the project, is a central concept to many of the processes and knowledge areas in the PMBOK® Guide. The concept of the project life cycle can also be applied to separate project phases.

Chapter review

Test your knowledge of the information in Chapter 1 by answering these questions. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. What is the primary role of the portfolio manager?

   A. To deliver the unique product, service, or result of the project

   B. To provide project governance and sponsorship

   C. To assess all potential projects against known organizational strategic goals

   D. To directly manage people assigned to several different projects

2. What is the primary purpose of the PMBOK® Guide?

   A. To provide a flexible methodology for all projects, no matter how large or small

   B. To identify a project management framework based on what is generally recognized as good practice

   C. To define a prescriptive approach to managing projects

   D. To present all the known project management information in a concise manner

3. What is the best description of rolling wave planning?

   A. Project management planning activities that become more detailed as you move through the project

   B. Only planning the first phase of a project

   C. Planning the entire project before starting execution

   D. Only planning the next phase in a project

4. What is the relationship between successful projects and an organization's strategic goals?

   A. There is no relationship between the two, because they are separate and distinct parts of an organization.

   B. The successful delivery of projects can be a strategic enabler and deliver strategic goals.

   C. The project selection methodology will determine what an organization's strategic goals are.

   D. Projects deliver programs, which in turn deliver portfolios, which in turn deliver strategy.

5. What is the best role for a project management office in an organization with a low level of project management maturity?

   A. Directive

   B. Controlling

   C. Supportive

   D. Enabling

6. What is the name for a group of related projects managed in a coordinated way to obtain a synergy not found by managing them individually?

   A. Multi projects

   B. Portfolio

   C. Program

   D. Strategy

7. The PMBOK® Guide process groups are based upon which life cycle model?

   A. The Check-Plan-Do-Act cycle

   B. The Plan-Do-Check-Act cycle

   C. The Plan-Check-Act-Do cycle

   D. The Do-Check-Act-Plan cycle

8. How many processes are there in the Risk Management knowledge area?

   A. Three

   B. Four

   C. Five

   D. Six

9. How many processes are there in the Monitoring and Controlling process group?

   A. 9

   B. 10

   C. 11

   D. 12

10. Which knowledge area does not have a Monitoring and Controlling process?

   A. Cost Management

   B. Initiating

   C. Human Resource Management

   D. Closing

Answers

This section contains the answers to the questions for the "Exercises" and "Chapter review" sections in this chapter.

Exercises

1. Consider the following scenarios. For each scenario, decide whether it is a project, a program, a portfolio, or ongoing work.

    A. The implementation of a new piece of software to run an organization's payroll

    This is an example of a project.

    B. The construction of a new house

    This is an example of a project.

    C. The development of a new housing subdivision

    This would generally been viewed as either a very large project or a program. This demonstrates that there is a grey area between projects, programs, and portfolios.

    D. Filming the first movie of a movie trilogy

    The first movie will be viewed as a project; the entire trilogy would be viewed as a program.

    E. Increasing sales from the previous year

    This is an example of ongoing work.

    F. The design phase of a new piece of software

    Because this is a phase, it would best be viewed as part of a program.

    G. The range of projects an organization is undertaking to increase market share

    This is an example of a program with a common goal of increasing market share.

    H. The installation of new servers as part of a major upgrade to an organization's software and hardware systems

    This is an example of a project that is part of a broader program.

    I. A new marketing campaign designed to bring in more business

    Marketing is generally considered to be an ongoing activity rather than a project.

J. The development of a new product that will increase operational profit

This is an example of a project that will be handed over to the operations side of the organization.

K. Several different pieces of software being developed that use the same developers

Merely using the same developers doesn't mean that these projects are part of a program. Instead, they should be considered as individual projects that are part of a portfolio.

L. All the new house projects being undertaken by a construction company

This is an example of a portfolio of projects.

2. Practice filling out the following blank table with process groups, knowledge areas, and processes.

The PMBOK® Guide process groups

	Initiating processes	Planning processes	Executing processes	Monitoring and Controlling processes	Closing processes
Project Integration management	■ Develop Project Charter	■ Develop Project Management Plan	■ Direct and Manage Project Work	■ Monitor and Control Project Work ■ Perform Integrated Change Control	■ Close Project or Phase
Project Scope management		■ Plan Scope Management ■ Collect Requirements ■ Define Scope ■ Create WBS		■ Validate Scope ■ Control Scope	
Project Time management		■ Plan Schedule Management ■ Define Activities ■ Sequence Activities ■ Estimate Activity Resources ■ Estimate Activity Durations ■ Develop Schedule		■ Control Schedule	

The PMBOK Guide knowledge area

The PMBOK® Guide process groups

	Initiating processes	Planning processes	Executing processes	Monitoring and Controlling processes	Closing processes
Project Cost management		■ Plan Cost Management ■ Estimate Costs ■ Determine Budget		■ Control Costs	
Project Quality management		■ Plan Quality Management	■ Perform Quality Assurance	■ Control Quality	
Project Human Resource management		■ Plan Human Resource Management	■ Acquire Project Team ■ Develop Project Team ■ Manage Project Team		
Project Communications management		■ Plan Communications Management	■ Manage Communications	■ Control Communications	
Project Risk management		■ Plan Risk Management ■ Identify Risks ■ Perform Qualitative Risk Analysis ■ Perform Quantitative Risk Analysis ■ Plan Risk Responses		■ Control Risks	
Project Procurement management		■ Plan Procurement Management	■ Conduct Procurement	■ Control Procurements	■ Close Procurements
Project Stakeholder management	■ Identify Stakeholders	■ Plan Stakeholder Management	■ Manage Stakeholder Engagement	■ Control Stakeholder Engagement	

The PMBOK Guide knowledge area

Chapter review

1. **Correct answer: C**

   A. **Incorrect:** The project manager takes responsibility for delivering the product, service, or result of a project.

   B. **Incorrect:** It may be that on occasion a portfolio manager may provide some governance and sponsorship advice, but it is not the portfolio manager's primary role.

   C. **Correct:** The portfolio manager operates at a strategic level within the organization.

   D. **Incorrect:** It would be the program manager or even a functional manager who would take responsibility for managing people on several projects, depending on the type of organizational structure in place.

2. **Correct Answer: B**

   A. **Incorrect:** The PMBOK® Guide does not provide a methodology. You are able to build a methodology from the contents of the PMBOK® Guide via the process of tailoring.

   B. **Correct:** The PMBOK® Guide collects and presents what is generally considered to be good practice across a wide range of industries and presents this information as a framework rather than a methodology.

   C. **Incorrect:** The PMBOK® Guide emphasizes in several places that, through the process of tailoring, you should only take from the PMBOK® Guide what is appropriate to your project.

   D. **Incorrect:** The PMBOK® Guide does not claim to present all known project management information, only that which is generally considered good practice across a wide range of industries.

3. **Correct Answer: A**

   A. **Correct:** Rolling wave planning acknowledges that you will iteratively plan the project as you move along the project life cycle.

   B. **Incorrect:** Only planning the first phase of a project is typical for phased projects, because there may be an important milestone between phases that prevents further planning.

   C. **Incorrect:** Planning the entire project before starting is a very rare occurrence and probably only suitable for small, easily defined projects.

   D. **Incorrect:** Iteratively planning a phase of a project is not an example of rolling wave planning.

4.   **Correct Answer: B**

   A.   **Incorrect:** There is a strong relationship between successful projects and an organization achieving its strategic goals.

   B.   **Correct:** By selecting projects that deliver strategic goals and then successfully delivering these projects, an organization can achieve its strategic goals.

   C.   **Incorrect:** It is the organization's strategy that dictates which projects get selected.

   D.   **Incorrect:** There is not always a direct linear connection between projects, programs, portfolios, and strategy.

5.   **Correct answer: C**

   A.   **Incorrect:** Directive project management offices are generally best in an organization with a high level of project management maturity.

   B.   **Incorrect:** Controlling project management offices are generally a sign of an organization improving its organizational project management maturity.

   C.   **Correct:** Supportive project management offices are generally a sign of a low level of project management maturity, because they do not support a lot of complexity.

   D.   **Incorrect:** This is a made-up term and is not from the PMBOK® Guide.

6.   **Correct Answer: C**

   A.   **Incorrect:** Multi projects is a made-up term that does not describe a coordinated approach to interrelated projects.

   B.   **Incorrect:** Portfolios are groups of projects related only by the fact that they are being performed by a single organization.

   C.   **Correct:** A program is a group of projects related in some way and that are managed to achieve benefits not gained by managing them independently.

   D.   **Incorrect:** Strategy is the organization's future direction and how it is going to achieve this.

7.   **Correct Answer: B**

   A.   **Incorrect:** The correct order requires planning to come first and checking to come after doing.

   B.   **Correct:** The Plan-Do-Check-Act cycle by Shewhart and Deming describes an iterative approach to management.

   C.   **Incorrect:** The correct order requires checking to come after doing and before acting.

   D.   **Incorrect:** The correct order requires planning to come first.

8. **Correct Answer: D**

    A. **Incorrect:** There are six processes, not three, in the Risk Management knowledge area.

    B. **Incorrect:** There are six processes, not four, in the Risk Management knowledge area.

    C. **Incorrect:** There are six processes, not five, in the Risk Management knowledge area.

    D. **Correct:** The six processes in the Risk Management knowledge area are Plan Risk Management, Identify Risks, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Plan Risk Responses, and Control Risks.

9. **Correct Answer: C**

    A. **Incorrect:** There are 11 processes, not 9, in the Monitoring and Controlling process group.

    B. **Incorrect:** There are 11 processes, not 10, in the Monitoring and Controlling process group.

    C. **Correct:** The 11 processes in the Monitoring and Controlling process group are Monitor and Control Project Work, Perform Integrated Change Control, Validate Scope, Control Scope, Control Schedule, Control Costs, Control Quality, Control Communications, Control Risks, Control Procurements, and Control Stakeholder Engagement.

    D. **Incorrect:** There are 11 processes, not 12, in the Monitoring and Controlling process group.

10. **Correct Answer: C**

    A. **Incorrect:** The Cost Management knowledge area has the Control Costs process, which is part of the Monitoring and Controlling process group.

    B. **Incorrect:** The Initiating process group is not a knowledge area.

    C. **Correct:** The Human Resource Management knowledge area does not have a Monitoring and Controlling process, because it is usually the functional manager who monitors and controls project staff.

    D. **Incorrect:** The Closing process group is not a knowledge area.

Cost management

This chapter focuses on project cost management. Project cost management, like the other knowledge areas, begins with a process of planning that produces a cost management plan. Then there is an iterative process that produces and updates the cost estimates and cost baseline. After these have been developed, a monitoring and controlling process is used to measure actual versus planned cost performance and to manage any change requests.

You may need to pay particular attention in this chapter to those activities of calculating earned value management; there is quite a bit of technical information that you will need to learn.

The PMBOK® Guide processes

Project Cost Management knowledge area

The four processes in the Project Cost Management knowledge area are:

- **Plan Cost Management (Planning process)**
- **Estimate Costs (Planning process)**
- **Determine Budget (Planning process)**
- **Control Costs (Monitoring and Controlling process)**

Domain tasks in this chapter:

- Plan Cost Management, Estimate Costs, and Determine Budget processes:
  - 2.3 Develop a budget plan based on the project scope using estimating techniques, in order to manage project cost.
- Control Costs process:
  - 4.1 Measure project performance using appropriate tools and techniques, in order to identify and quantify any variances, perform approved corrective actions, and communicate with relevant stakeholders.
  - 4.2 Manage changes to the project scope, schedule, and costs by updating the project plan and communicating approved changes to the team, in order to ensure that revised project goals are met.

What is project cost management?

Project cost management is focused upon the processes of developing a cost management plan, the processes of estimating costs for activities and the overall project, preparing your project budget or cost baseline, recording performance, and influencing and assessing any changes to the project budget.

The processes contained in this knowledge area present a logical and sequential flow of information from estimating the costs through to controlling changes to your project budget. Figure 5-1 shows the general flow through this linear process without the general initial Plan Cost Management process.
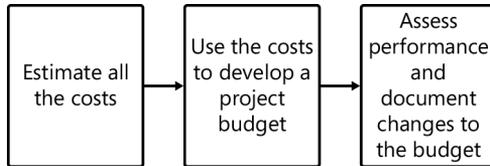
FIGURE 5-1 This flow shows the process of developing project costs, then a project budget, and then monitoring the budget.

Real world

I have always found that the development of the project cost estimates and the approved cost budget is one of the most iterative parts of project management. You start out with high-level estimates based on incomplete information and constantly revise and refine both the information you have and the estimates that are based on the information. When you check how progress is going, you may need to revisit your estimates and revise individual costs estimates. It is because of this iterative nature and the high expectations that stakeholders have upon project costs that I pay extra attention to the cost management processes.

Plan Cost Management

TABLE 5-1 Plan Cost Management process

Inputs	Tools and techniques	Outputs
■ Project management plan ■ Project charter ■ Enterprise environmental factors ■ Organizational process assets	■ Expert judgment ■ Analytical techniques ■ Meetings	■ Cost management plan

EXAM TIP

Did you notice that the inputs, tools, and techniques for the Plan Cost Management process are identical to the inputs, tools, and technique for the Plan Schedule Management process? The only difference between the two processes is the single output.

The Plan Cost Management process is a planning process with a single output—the cost management plan. Like all other planning documents, the cost management plan will guide your efforts in defining and controlling the project budget. It will form a subsidiary plan to the overall project management plan.

The Plan Cost Management process covers the following domain tasks:

■ 2.3 Develop a budget plan based on the project scope using estimating techniques, in order to manage project cost.

Inputs

The Plan Cost Management process uses some or all of the following inputs as part of the development of the cost management plan for the project.

Project management plan

The distinct elements of the project management plan that will be useful in developing your own cost management plan are the scope and schedule information contained in the scope baseline and schedule baseline, respectively. After it is created, the cost management plan will become part of the project management plan. The project management plan is an output from the Develop Project Management Plan process.

Project charter

The project charter contains the approved initial budget for the project at the time of project initiation. It also contains known constraints, assumptions, and risks that may affect project costs and their management. The project charter is an output from the Develop Project Charter process.

Enterprise environmental factors

Particular enterprise environmental factors that may assist with development of your cost management plan include the particular organizational culture and structure, any external market conditions that may affect project costs, and any published commercially available cost information that you may use to develop and check your cost estimates.

Organizational process assets

Organizational process assets that may play an important part in the development of your cost management plan include any historical information, and any established financial control procedures, policies, and templates for defining and controlling project costs and budget.

EXAM TIP

It is important to note that in your day-to-day work you may use the terms "cost" and "budget" interchangeably. However, for the purposes of this examination you must understand that the two words have separate meanings. "Cost" refers to the actual costs of each activity or work package which, when aggregated, form a total project cost. "Budget," on the other hand, refers to costs over time.

Real world

One way to keep your accounts people very happy is to be proactive with the development of your project budget. If you are able to tell them clearly when you expect to spend money, and when you expect to have money come in, they are able to better plan the organization's cash flow requirements. It is important that you realize that as a project manager your project may impose serious cash flow problems upon the wider organization, and it is the accounts people who have to figure out how to make sure money is available when you need it. I have always found that giving the accounts people information early and often about when I plan to use money is a great way of managing this particular group of stakeholders.

Tools and techniques

The following tools and techniques are available to be used to develop the inputs into this process in order to produce the cost management plan.

Expert judgment

Expert judgment is used as a tool and technique in the Plan Cost Management process as again we rely on the experience, opinion, and expertise of individuals to assist the development of a cost management plan. The experts that you consult may be members of your project team, other employees in your organization, or people from outside your organization with particular experience in putting together an appropriate cost management plan.

Analytical techniques

The use of analytical techniques in the development of your cost management plan is an important tool because you, or your financial department, will have to analyze options and make decisions about how the project will be funded. You may be able to fund the project with cash reserves, bank loans, funding with equity from shareholders, or funding with debt from other sources. Each of these options has its own benefits and drawbacks. In making the decision, you're able to use a number of techniques, such as payback period, return on investment, internal rate of return, discounted cash flow, and net present value. Each of these terms was discussed in more detail in the Develop Project Charter process as part of the project selection process.

> ## Real world
>
> I have often found that many project managers are completely oblivious to how the project is going to be funded. I believe an important skill that any project manager should have is to have an understanding of project financing methods and the implications that the different finance sources have upon project costs. One of the first places you will look for guidance about funding criteria and sources of potential funding is the project charter.

Meetings

Meetings are a great way to bring together members of the project team who have expertise and skill in development of the cost management plan because they are the people completing the work. You may also choose to invite selected stakeholders from outside the project team who have specialist knowledge and skills in this particular area. An example of this would be inviting members of your organization's financial or accounts department to contribute to the development of the cost management plan.

Outputs

After the appropriate tools and techniques have been applied to the selected inputs, the Plan Cost Management process has the following output.

Cost management plan

The Plan Cost Management process has only a single output—the cost management plan. The *cost management plan* is a subsidiary plan of the project management plan and is used as a guide for the other cost management processes. The purpose of the cost management plan is to provide guidance to the project manager and the project team on how the organization expects costs to be estimated, budgets to be determined, cost performance to be assessed, and any potential changes assessed, documented, and reported upon. It will also outline the process of reporting progress in relation to forecast cost versus actual cost on the project and will prescribe acceptable tools, techniques, processes, and any other relevant information relating to how costs will be managed on the project.

The cost management plan is then a key input into the Estimate Costs and Determine Budget processes, both of which are planning processes.

✔ Quick check

1. What is the main purpose of the cost management plan?

2. What is the main reason for using analytical techniques during the Plan Cost Management process?

3. What sort of organizational process assets would be useful as inputs into the Plan Cost Management process?

Quick check answers

1. The main purpose of the cost management plan is to provide guidance on further planning of project costs, estimating costs, developing a project budget, checking planned cost performance against actual cost performance, and managing any potential changes to the cost baseline.

2. Analytical techniques are used as a tool to help assess the different options, and the pros and cons of each, for funding or financing the project.

3. The types of organizational process assets that would be useful as inputs into the Plan Cost Management process include any existing organizational financial control procedures, blank templates, established processes, gathered historical cost information, and any internal financial databases.

Estimate Costs

TABLE 5-2 Estimate Costs process

Inputs	Tools and techniques	Outputs
■ Cost management plan ■ Human resource management plan ■ Scope baseline ■ Project schedule ■ Risk register ■ Enterprise environmental factors ■ Organizational process assets	■ Expert judgment ■ Analogous estimating ■ Parametric estimating ■ Bottom-up estimating ■ Three-point estimating ■ Reserve analysis ■ Cost of quality ■ Project management software ■ Vendor bid analysis ■ Group decision-making techniques	■ Activity cost estimates ■ Basis of estimates ■ Project documents updates

The Estimate Costs process is a planning process that uses the cost management plan for guidance and takes the defined activities and work packages, and assigns a cost estimate for each one using a variety of tools and techniques. In order to easily track which estimates are for which particular work package, you can use the numbering systems from the work breakdown structure (WBS). This process is a highly iterative process that is repeated throughout the life of the project.

The Estimate Costs process covers the following domain task:

■ 2.3 Develop a budget plan based on the project scope using estimating techniques, in order to manage project cost.

In assessing the estimate for each activity, it is important to have a basic understanding of different types of costs that may be estimated.

■ **Variable costs**   These are costs that change with the amount of production. The more you produce, the more costs you incur. For example, if you increase the amount of homes you are building, you will use more home building materials. If you use more electricity as a result of greater amounts of work, then your costs will increase.

■ **Fixed costs**   These are costs that are fixed no matter how much you produce. For example, the rental you pay for your warehouse storage space is constant whether or not the warehouse is full or empty. Also, the costs you pay for any consents you require or equipment needed to complete the job are fixed costs.

- **Direct costs**   These are costs attributable directly to the actions of the project. For example, the materials you use on your project are direct costs.
- **Indirect costs**   These are costs that are not incurred directly by the project but which the project may have to account for. For example, the project may have to make provision for paying a share of corporate overheads such as office rental space and shared services. Your cost management plan may contain guidelines on what portion, if any, of indirect costs you must account for in your cost estimates. These are often referred to as overheads.

> **Real world**
>
> Indirect costs, or overheads, are often overlooked by project managers when preparing their cost estimates. Unless there are clear guidelines from the organization about what portion, if any, of indirect costs the project must account for, a lot of project managers simply do not think about this. Many organizations will account for indirect costs in required margins or profits. Hopefully, your organizational process assets include guidance on how you are expected to manage this issue.

- **Sunk costs**   These are costs spent on the project to date that cannot be recovered if the project was to stop. For example, the money you have spent developing code for a new piece of software is sunk cost if you stop halfway through, because it has no recoverable value. Your cost management plan may contain guidelines on how sunk costs are treated in determining whether to continue on a troubled project.

All estimates are simply your best guess at the future, based on the information you have available to you. The better the information you have, the better the estimates will be. Thus, there is nearly always an element of uncertainty inherent in any estimate. It is often important to express this range of uncertainty inherent in any estimate. As a rule, the accuracy of cost estimates will improve as the project progresses, and your organization may have, as part of its organizational process assets, guidelines on the necessary level of accuracy required before proceeding. Table 5-3 shows the typical description of a variety of estimate ranges.

TABLE 5-3 Range of estimates

Estimate type	Estimate range
Order of Magnitude Estimate	-50% to +100%
Rough Order of Magnitude Estimate	-25% to +75%
Conceptual Estimate	-30% to +50%

Estimate type	Estimate range
Preliminary Estimate	-20% to +30%
Definitive Estimate	-15% to +20%
Control Estimate	-10% to +15%

Inputs

The Estimate Costs process uses some, or all, of the following seven inputs.

Cost management plan

The cost management plan is obviously a key input into the Estimate Costs process because it provides the guidance for how you are going to complete this process and, therefore, without it you would not be able to complete the process. The cost management plan is an output from the Develop Cost Management Plan process.

Human resource management plan

The *human resource management plan* is used as an input into the Estimate Costs process because it contains information about the project staff who will be working on the project and the chargeout rates, remuneration packages, and any other financial rewards to be paid to them. In order to develop the project cost, you will need to know this information. The human resource management plan is an output from the Plan Human Resource Management process.

Scope baseline

The scope baseline is composed of the project scope statement, the work breakdown structure (WBS), and the WBS dictionary, and it contains a full and detailed description of all the work to be done on the project. By using this information you can then attribute costs to each of the work packages and also the activities taken from the project schedule, and aggregate these costs into a total project cost estimate. The scope baseline is an output from the Create WBS process.

Project schedule

The project schedule is an important input into the Estimate Costs process because it gives an indication of when the work packages and activities are to be completed. The sequencing, timing, and duration of distinct project work packages and activities will affect the costs. The project schedule is an output from the Develop Project Schedule process, which in itself is the culmination of the other schedule management planning processes.

Risk register

The risk register is used as an input into the Estimate Costs process because it contains information around defined and documented uncertainty relating to specific work packages. This uncertainty is captured in the contingency reserve for each activity work package and needs to be taken into account in developing the project cost estimates. The risk register is an output from the Identify Risks process.

Enterprise environmental factors

The specific types of enterprise environmental factors that are useful as inputs into the Estimate Costs process are external market conditions that will affect the prices of products and services being procured for the project, and any published commercially available estimating data.

> ### Real world
>
> It is worthwhile to carefully subscribe to, and pay for access to, reputable published estimating databases. These databases are usually very accurate sources of information about the costs of particular materials and resources, and they are often separated into regional areas to determine variances at a local level. Many organizations, industry associations, and professional bodies compile these databases and will allow access for a fee.

Organizational process assets

The specific types of organizational process assets that are useful as inputs into the Estimate Costs process are any relevant templates and processes useful in the development of project cost estimates, including any historical information and lessons learned owned by the organization.

Tools and techniques

The following 10 tools and techniques are used upon the inputs to deliver the process outputs.

Expert judgment

The use of experts is an acknowledged tool in the preparation of project cost estimates. It is the experts, or people working on the project, who have an intimate knowledge of the work to be done and the likely cost of that work. In addition to project team members with expert judgment on the work to be done, you may also choose to consult external experts, such as those involved in the quantity surveying profession, who can provide expert advice on the expected costs of materials and resources to be used.

Analogous estimating

Analogous estimating is a quick means of estimating what a likely cost is to be for a particular material or resource by comparing your current requirements with the requirements of a previous project that you have information on, and then looking at the similarities between the two instances to determine what your current estimate will be. For example, if on a previous project you used a particular amount of concrete and it cost you $1,500, and on this project you expect to use twice as much, you would assume that your cost estimate is $3,000, by using analogous estimating. Because you are using an analogy from previous experience, there is a certain degree of expected inaccuracy in this form of estimating.

Parametric estimating

Parametric estimating is generally considered to be more accurate than analogous estimating because it uses known quantities of materials for resources and multiplies them by known financial rates. For example, you may know that you require 50 hours of work to be done by a business analyst, and that a business analyst costs $80 an hour; therefore, multiplying 50 hours by $80 an hour, you will arrive at a cost estimate of $4,000 by using parametric estimating.

Bottom-up estimating

Bottom-up estimating is generally considered to be quite an accurate form of estimating, because what you are doing is taking cost estimates from lower-level information—for example, the bottom level of the WBS—and then adding up, or rolling up, to higher levels and aggregating those costs to report a total cost.

Three-point estimating

You saw the use of three-point estimating in Chapter 4, "Time Management," in the discussion of the Estimate Activity Durations process from the Schedule Management knowledge area. Here it is used again as a method of determining an estimate where there is a most likely (cM), optimistic (cO), and pessimistic (cP) cost estimate for an activity.

EXAM TIP

Although the correct name for the formula is the "three-point estimate," and it is part of the Program Evaluation and Review Technique (PERT), it is often simply called the "PERT formula."

To get a *simple average* you take these three figures and add them together and divide by three. However, if you want to get a *weighted average* that gives greater weight to the most likely (cM) figure, then the formula to use is

$$\frac{cO + (4 \times cM) + cP}{6}$$

For example, if you have an optimistic cost estimate of $10, a most likely cost estimate of $16, and a pessimistic cost estimate of $25, then the weighted average using three-point estimating is $16.50.

You can also calculate the standard deviation which indicates how far from the average the optimistic and pessimistic figures are. A smaller standard deviation means they are closer to the average than a larger standard deviation. The formula for standard deviation is

$$\frac{cP - cO}{6}$$

For example, using the numbers from the previous example, the standard deviation would be $2.50.

After you have determined the standard deviation, you can then express your certainty about a cost estimate range. You express this certainty as a confidence interval where one standard deviation either side of the mean represents a confidence interval of 68 percent, two standard deviations either side of the mean gives a confidence interval of 95 percent, and three standard deviations either side of the mean gives a confidence interval of 99.7 percent.

For example, using the numbers from the previous example, you could say that you have a 95 percent certainty that the cost for the activity will be between $11.50 and $21.50.

Real world

In reality, when you are completing any sort of estimating process in the project, you are going to use a variety of estimating techniques. The type of estimating technique that you choose to use will depend on how much information you have. At the beginning of a project, when information is generally less available, you may choose to use less accurate forms of estimating. As the project progresses and you have more information available, you may choose to use more accurate and time-consuming forms of estimating for that work that you have greater information for, and still use less-accurate forms of estimating. In relation to rolling wave planning, you will most likely use more accurate forms of estimating on the work to be done in the immediate future, and less accurate forms of estimating on work to be done further off in the future.

Reserve analysis

Reserve analysis looks at the contingency reserves, or contingency allowances, provided for in the project cost estimates. The contingency reserve is an amount that reflects and allows for identified uncertainty in estimating particular costs. It is commonly known as "accounting for the known unknowns" in any project and is usually calculated during quantitative risk analysis performed as part of the Risk Management knowledge area. For example, you may determine that a particular activity has a 10 percent chance of experiencing a $1,750 cost overrun,

and therefore you would allow a $175 figure ($1750 x 10 percent) in the contingency reserve. By aggregating, or adding up, all of the individual amounts allowed for in the contingency reserve analysis, you will arrive at a total contingency reserve for the entire project.

The management reserve for unknown unknowns is also able to be calculated during risk assessment, or by expressing the range of uncertainty in your estimates as a total amount. The management reserve is controlled by senior managers, and the project manager must apply to use it; it is not part of the approved budget.

Real world

In theory, the contingency reserve should be part of the approved project budget and under the control of the project manager, and the management reserve under the control of senior management or members of the steering group. In reality, you may find that your approved budget may just be for known costs and that sponsors can sometimes be reluctant to approve reserve budgets, because they view it as endorsing inaccuracy and sloppy estimating practices. My argument is that I would prefer to go forward on a "no surprises" basis and release the reserves once the identified uncertainty has been defined or has been passed.

Cost of quality

As part of the preparation of your quality management plan, you will consider the issue of cost of quality, because any decisions made about what this means to you will affect cost on the project immediately, and for the organization after the project is handed over. *Cost of quality* refers to the quality attributes of the project and the product over the life of the product. For example, you may need to take into account the cost of future product returns or warranty claims because of decisions made to manufacture lower quality to lower the project costs.

Project management software

Project management software should be considered essential for any large and complex projects because trying to collect and aggregate many cost estimates manually is simply not possible.

Vendor bid analysis

The *vendor bid analysis* process is a way of double-checking the bids received from vendors to make sure that they are neither overinflated nor underinflated. You can think of vendor bid analysis as your quality check on the prices people are submitting to you.

Group decision-making techniques

Good cost estimates are prepared by people familiar with the activities being estimated, and when you get a group of these people together you are going to need some effective group decision-making techniques to make sense of the expert opinions supplied. These techniques are also used when estimating elements of the project schedule and include brainstorming, nominal group techniques, and the Delphi technique.

Outputs

The Estimate Costs process produces some, or all, of the following outputs.

Activity cost estimates

The activity cost estimates are the individual estimates for each activity identified. They are the entire focus of this process and will be used to put together your cost baseline. The activity cost estimates are used as an input into the Determine Budget process.

Basis of estimates

The *basis of estimates* is a useful document, because it outlines the assumptions made, the type of estimating technique used, any known constraints, and an indication of the range of uncertainty and of the confidence level of the final estimates for each activity, and indeed the entire project. The basis of estimates is used as an input into the Determine Budget process.

> **EXAM TIP**
>
> There are several supporting documents that provide additional information to summary documents. For the requirements documentation you have the requirements traceability matrix. For the WBS, you have the WBS dictionary, providing additional information. For the activity list, you have the activity attributes, providing more detailed information. For the activity cost estimates, you have the basis of estimates. You can recognize that the summary document and the document containing greater detail are both important to provide a full picture.

Project documents updates

The specific project documents that may be updated as a result of estimating costs will include such things as the statement of work, which may be updated as a result of the cost estimates, and elements of the risk register that are refined and updated as a result of specific cost estimates.

Quick check

1. What is the difference between a simple average and a weighted average?

2. What is the difference between a contingency reserve and a management reserve?

3. What information does the basis of estimates contain?

Quick check answers

1. A simple average divides the most likely (cM), the optimistic (cO), and the pessimistic (cP) cost estimates by 3, whereas a weighted average gives a higher weighting of 4 to the most likely cost estimate and then divides by 6.

2. A contingency reserve is prepared for the known uncertainty, or known unknowns on a project, and should be under the control of the project manager. A management reserve is prepared for the unknown uncertainty, for unknown unknowns, and is generally under the control of senior management.

3. The basis of estimates contains information about the assumptions made in preparing cost estimates, the types of estimating techniques used, and the amount of uncertainty in the final activity cost estimates.

Determine Budget

MORE INFO   DETERMINE BUDGET

You can read more about the Determine Budget process in the PMBOK® Guide, 5th edition, in Chapter 7, section 7.3. Table 5-4 identifies the process inputs, tools and techniques, and outputs.

TABLE 5-4 Determine Budget process

Inputs	Tools and techniques	Outputs
■ Cost management plan ■ Scope baseline ■ Activity cost estimates ■ Basis of estimates ■ Project schedules ■ Resource calendars ■ Risk register ■ Agreements ■ Organizational process assets	■ Cost aggregation ■ Reserve analysis ■ Expert judgment ■ Historical relationships ■ Funding limit reconciliation	■ Cost baseline ■ Project funding requirements ■ Project documents updates

The Determine Budget process is a planning process that takes the individual activity cost estimates and aggregates them into a total project cost, then applies the project schedule to determine the timing of when costs will be incurred in order to develop the project budget, or cost baseline.

The Determine Budget process covers the following domain task:

- 2.3 Develop a budget plan based on the project scope using estimating techniques, in order to manage project cost.

Inputs

The inputs used in this process take the individual cost estimates and aggregate them into the project budget.

Cost management plan

The cost management plan is used as a key input into the Determine Budget process because it is the cost management plan that sets out the processes, policies, rules, and regulations that you are going to apply in order to determine a project budget. The cost management plan is an output from the Plan Cost Management process.

Scope baseline

The scope baseline is a very important input into this process because it outlines all the work to be done, and the work not to be done, as part of the project. It is by breaking the scope baseline down into its component parts via the work breakdown structure (WBS), and subsequently down to activity level with the schedule work, that you are then able to estimate individual activity costs. The scope baseline consists of the project scope statement, the work breakdown structure, and the WBS dictionary, and it is an output from the Create WBS process.

Activity cost estimates

The activity cost estimates provide you with individual estimates of cost for identified activities by using a variety of tools and techniques from the Estimate Costs process. In order to put together your project budget you will take these individual activity estimates, aggregate them, and determine the time period in which those costs will be incurred. The activity cost estimates are an output from the Estimate Costs process.

Basis of estimates

The basis of estimates is an important input because it provides further information about each of the estimates you have determined for the individual activities. The basis of estimates is an output from the Estimate Costs process.

Project schedule

The project schedule is used as an input into the Determine Budget process because you need to know when each activity will be performed so that you can determine when the costs of activity will be incurred. This is the essence of developing a project budget, which is taking the project costs and applying them over time. The project schedule is an output from the Develop Schedule process.

Resource calendars

The resource calendars are used as an input into the Determine Budget process because they provide additional and more detailed information about when specific resources are available to work on the project. They are an output from the Acquire Project Team process.

Risk register

The risk register is used as an input into this process because it will identify risks associated with both individual activity cost estimates and elements of the project schedule that need to be taken into account when developing the project budget. It is an output from the Identify Risks process.

Agreements

Any existing agreements are used by the project manager as an input into this process, be-cause they will outline any agreement between parties to the project about costs, payments, and any other matters, such as retention payments, that need to be included in the project budget. For example, you may have an agreement for paying suppliers that requires payment regularly each month, or one that requires progress payments at certain project milestones. These agreements are an output from the Conduct Procurements process.

Organizational process assets

The specific organizational process assets that can assist in the development of the project budget include any organizational policies and procedures relating to the development and presentation of the project budget, and any blank templates for preparing budgets and for reporting the budget.

Tools and techniques

The five tools and techniques of this process are all used upon the separate inputs to deliver the process outputs.

Cost aggregation

Cost aggregation is the process of taking the individual estimates for each of the activities and aggregating upward to work package level, then rolling these estimates up to high level, sub-deliverable level, and deliverable level, in order to arrive at a bottom-up estimate for portions of the project or the entire project. Figure 5-2 shows how individual activities are added up, or aggregated.
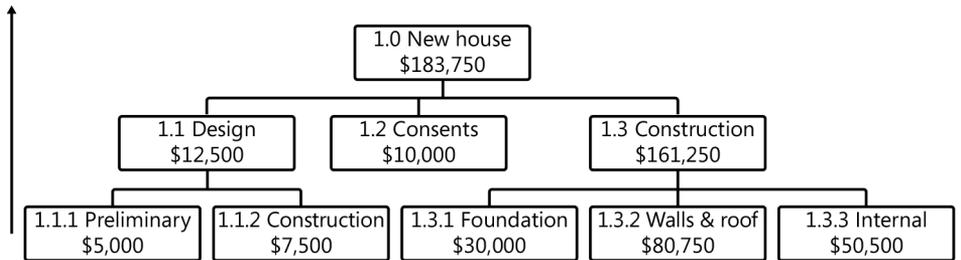
FIGURE 5-2 In bottom-up cost aggregation, individual activities are added up, or aggregated.

Reserve analysis

The reserve analysis is the method of looking at both the contingency reserve and the management reserve required for the project and the timing of access to those reserves. Contingency reserves will be identified for specific activities, and access to the contingency reserve for this will be required when the activity is being performed. Access to the management reserve could be required at any time in the project because it is for the purpose of unknown unknowns, or for elements that could not reasonably have been foreseen.

Expert judgment

Again expert judgment is a key tool and technique in determining the budget. The experts should be from the project team and also from outside the project team; for example, from the organization's finance or accounts department.

Historical relationships

If the organization is mature enough to have been recording information about *historical relationships* and the reliability and range of uncertainty in its cost estimating process, it can then use this information to further refine its current cost estimates, or to acknowledge a quantifiable amount of uncertainty in those estimates.

Funding limit reconciliation

As part of the Determine Budget process, you may find that there are *funding limit reconciliation* issues that need to be considered. For example, you may want to do a great amount of work but simply might not have the funds until a later period in time; therefore, you will have to limit the activity on the project until funds to complete the work become available.

> ### Real world
>
> **Is it important that you are able to determine how the project will be funded early on, and whether this funding process imposes any constraints upon your project schedule. I have often found that there are constraints on when funds will be available, which is generally related to the financial years into which the funds are allocated. This is the reason why the finance department of an organization is so interested in how much of your project budget you are spending, how much you are carrying over to the next financial year, or how much you want to bring forward into this financial year. You may not realize that someone has to find the finances to complete not only your project but all other projects that the organization is completing.**

Outputs

The major outputs from the Determine Budget process are the following.

Cost baseline

The *cost baseline* is one of four baselines that you will use to measure progress on the project. The other three are the scope baseline, the time baseline, and the quality baseline. The key element of the cost baseline is that it takes the aggregated individual estimates of cost for each activity and applies them to the time periods in which the costs will be accrued. This is the baseline against which you are going to measure project cost performance. Figure 5-3 shows an example of a cost baseline represented graphically. It shows the total amount of spend for each time period, in this case in months. Additionally, it shows the cumulative spend over the life of the project. This is represented by the line, which is often referred to as the "S-curve" (it is in the shape of the letter S) because there is little spend at the beginning of a project, a lot of spend in the middle section of the project, and a decrease in spending toward the end of the project.
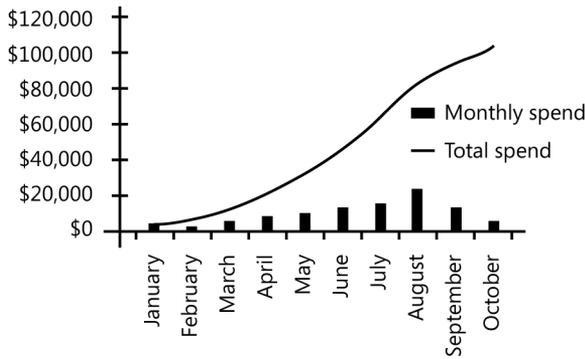
FIGURE 5-3 This cost baseline shows the total amount of spend for each month.

Project funding requirements

The *project funding requirements* acknowledge when the funding for the project will be available; for example, annually, quarterly, or monthly. This recognizes that funding for a project often occurs in incremental amounts, whereas expenditure on a project may be continuous.

> **Real world**
>
> Matching up when funds will be available against when money will be spent is an important aspect of sound and prudent financial management for the project. You do not want to be in a situation where you have spent more than your ability to pay, because this may mean delays in paying creditors and ultimately delays to the project.

Project documents updates

The types of project documents that may be updated as a result of the Determine Budget process are the individual cost estimates, project schedule, and risk register.

Control Costs

MORE INFO **CONTROL COSTS**

You can read more about the Control Costs process in the PMBOK® Guide, 5th edition, in Chapter 7, section 7.4. Table 5-5 identifies the process inputs, tools and techniques, and outputs.

TABLE 5-5 Control Costs process

Inputs	Tools and techniques	Outputs
■ Project management plan ■ Project funding requirements ■ Work performance data ■ Organizational process assets	■ Earned value management ■ Forecasting ■ To-complete performance index (TCPI) ■ Performance reviews ■ Project management software ■ Reserve analysis	■ Work performance information ■ Cost forecasts ■ Change requests ■ Project management plan updates ■ Project documents updates ■ Organizational process assets updates

The Control Costs process is focused mainly on measuring actual against planned cost performance, forecasting likely future cost performance, and managing any changes to the cost baseline. The Control Costs process covers the following domain tasks:

- 4.1 Measure project performance using appropriate tools and techniques, in order to identify and quantify any variances, perform approved corrective actions, and communicate with relevant stakeholders.

- 4.2 Manage changes to the project scope, schedule, and costs by updating the project plan and communicating approved changes to the team, in order to ensure that revised project goals are met.

Inputs

The Control Costs process uses the following inputs.

Project management plan

The project management plan, and its subsidiary plans, guide you in the process of controlling any potential changes to your cost baseline or any of the individual estimates that were prepared. As such, it is an important input into the Control Costs process. The project management plan is an output from the Develop Project Management Plan process.

Project funding requirements

The project funding requirements are an important input into the Control Costs process because they enable you to determine when expenditures will be incurred and when funding for the project will be available, and to therefore assess actual versus planned project funding requirements and control any changes to these elements. The project funding requirements are an output from the Determine Budget process.

Work performance data

By now you should have picked up that work performance data is an important input into several controlling processes. Work performance data is the information you gather about what is actually occurring on the project down to the level of which activities have started, the costs associated with completing those activities, and any estimates for completing the remainder of the work to be done. Work performance data is an output from the Direct and Manage Project Work process.

Organizational process assets

The types of organizational process assets that will be useful as inputs into the Control Costs process are any existing organizational policies, procedures, templates, or any other element relating to how costs will be monitored and reported on in your project.

Tools and techniques

The following tools and techniques can be used upon the inputs into the Control Costs process.

Earned value management

The earned value management (EVM) system provides you with an effective and efficient way to establish what has occurred in the past and use this information to forecast likely future scenarios by using a range of mathematical equations. It is better than simply taking one or two elements of past performance and simply expecting that performance to continue. For example, imagine that you are a project sponsor on a project, and your project manager tells you that the project is 50 percent of the way through and has spent only 40 percent of the budget. Is this a good situation or not? It might be, but without knowing how much of the actual work has been completed and how much value has been earned, you don't really know if this is a positive statement or not. This is exactly the scenario that earned value management is able to get around.

Earned value management takes the original project cost baseline, the planned value of the work you had expected to have completed by now, the earned value of the work you have completed now, and the actual cost of delivering that value to determine what the project cost and schedule performance to date is, and then forecast what the likely costs at completion will be. It does this by using the following formulas:

- ***Budget at completion (BAC)***   The original forecast budget for the project.
- **Planned value (PV)**   The amount of value that you should have earned by this time in the project. Because the total *planned value (PV)* for a project equals the budget at completion (BAC), you can determine the planned value by simply determining how far through the project you are in relation to time, and mapping this back to the approved cost baseline to establish the planned value. Figure 5-4 demonstrates how to determine the PV from the BAC.
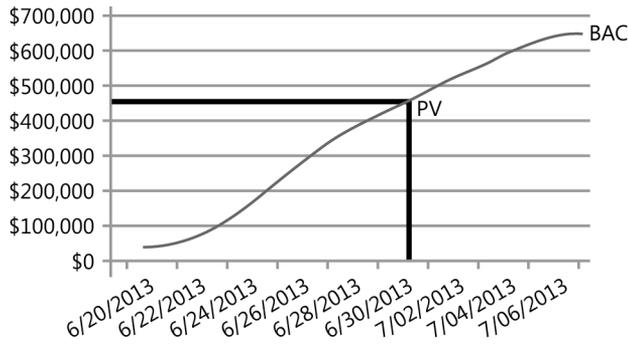
FIGURE 5-4 The project cost baseline shows Planned value (PV) and budget at completion (BAC).

- *Earned value (EV)*   The value of the work that has been completed. This is not the actual cost of the work that has been completed but rather the original ascribed value from your approved cost baseline for the value of the work.

- *Actual cost (AC)*   The actual realized cost you incurred for the work that you have done to date. You will be able to get a record of this from your accounts system.

Figure 5-5 shows the budget at completion (BAC), planned value (PV), earned value (EV), and actual cost (AC) on a single graph. Incidentally, it shows a project in trouble in terms of both time and cost because the actual cost is above the planned value, and the earned value is less than the planned value.
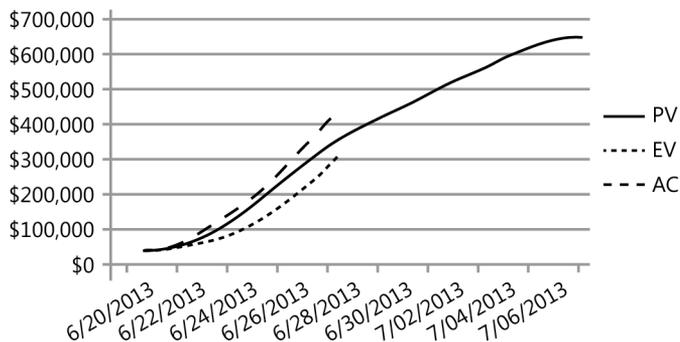
FIGURE 5-5 This graph shows a record of project planned value, earned value, and actual cost.

EXAM TIP

On most questions you will be challenged to extract the BAC, PV, EV, and AC from the scenario given. Take your time to ensure that you are extracting the correct figures.

> **Real world**
>
> I've often found that when calculating the actual cost it is important to remove from this calculation the value of any material held in stock. On some projects, you may decide to procure a lot of required materials early to avoid potential cost increases over time. Therefore, you will have paid for these materials, and this will show up in your accounts. However, incorporating this amount into your actual cost figure for the purposes of earned value management will skew the results negatively. Therefore, I recommend that you do regular stock takes and remove the value of material held in stock from the actual cost figure that you use for the earned value management calculations.

- *Cost variance (CV)*   This is simply the difference between the value of what you expected to have earned (EV) at this point and the actual cost (AC) at this point. A positive *cost variance* is good and shows that the project is under budget, a negative cost variance is bad and shows that the project is over budget. The formula is:

  $CV = EV - AC$

- *Cost performance index (CPI)*   One of the limitations of the cost variance equation is that it gives you a simple gross figure. You are not able to tell whether a $10,000 cost variance is significant on your project. If you are working on a $50,000 project it would be significant; if you are working on a $10 million contract, it may not be so significant. The *cost performance index* calculation tells you the magnitude of the variance. A cost performance index of more than 1 is good because it means that the project is under budget; a cost performance index of less than 1 is bad because it means that the project is over budget. For example, if you have a cost performance index of 1.1, it means that for every dollar you spend on the project you are getting a $1.10 return. The formula is:

  $CPI = EV/AC$

- **Schedule variance (SV)**   This tells you whether you are ahead or behind your planned schedule. It is the difference between the earned value (EV) and the planned value (PV). A positive schedule variance is good and means that you are ahead of schedule; a negative schedule variance is bad and means that you are behind schedule. The formula is:

  $SV = EV-PV$

- **Schedule performance index (SPI)**   This is a ratio of the earned value and planned value that allows you to better determine the magnitude of any variance. A schedule performance index of more than 1 is good because it means that the project is ahead of time; a schedule performance index of less than 1 is bad because it means that the

project is behind schedule. For example, if you have a schedule performance index of 0.95, it means that every day you spend working on the project you are getting a 0.95 day return. The formula is:

$SPI = EV/PV$

EXAM TIP

A quick and easy way to remember the formula for CV, CPI, SP, and SPI is that each of the formula starts with EV. If it is a formula relating to variance, CV or SV, then the next symbol is a minus sign. If it is a formula relating to a performance index, CPI or SPI, then the next symbol is a divide sign. If the formula is in relation to cost, CV or CPI, then the final part of the formula is AC. If the formula is in relation to schedule, SV or SPI, the final part of the formula is PV.

Forecasting

Forecasting is the process of taking time and cost performance to date and using this information to forecast a likely future scenario. The time and cost performance measurements are the cost variance (CV), schedule variance (SV), cost performance index (CPI), and schedule performance index (SPI). You can use these measurements and the following formulas to forecast a likely project cost at completion, the amount of money required to complete the project, and the difference between what you originally thought it would cost and what you now think it will cost.

- **Estimate at completion (EAC)**   There are many ways to calculate a forecast estimate at completion (EAC). Keep in mind that in order to forecast a likely future cost or time frame for the project, you are going to be using historical information. Therefore, the quality of your EAC calculation will depend entirely on the quality of the historical information that you are using. The following four formulas use different inputs to calculate the EAC. Each one will give a difference answer for the same project.

    - **EAC = BAC/CPI**   This is perhaps the simplest of the estimate at completion calculations because it simply takes your original budget at completion (BAC) and divides that by your cost performance index (CPI). Obviously, this is a useful calculation if your cost performance to date is indicative of your likely cost performance going forward, and by the same measure will not be a great calculation to use if your cost performance to date is not indicative of your cost performance in the future.

    - **EAC = AC+ ETC**   Simply adding your estimate to complete (ETC) to your actual cost (AC) spent to date is an effective way to determine your estimate at completion (EAC). However, the method by which you determine your estimate to complete calculation will have a great effect on whether or not this formula is accurate.

    - **EAC = AC + (BAC–EV)**   This formula takes the actual costs (AC) spent to date and adds to them the total budget at completion (BAC) with your current earned value (EV) subtracted.

- **EAC = AC + ((BAC−EV)/(CPI × SPI))** This formula takes into account both your cost performance and your schedule performance and applies it to the value of the work you have left to complete.

> *NOTE* **CUMULATIVE VERSUS NON-CUMULATIVE**
>
> When using either the CPI or SPI formula you are able to choose whether you use cumulative or non-cumulative variations of these. The cumulative calculation calculates right from the start of the project to where you are now in the project, and obviously if you use this you are assuming that that particular range is indicative and typical of your cost or schedule performance going forward. If, however, for some reason there have been some atypical variances experienced in either time or cost on your project in the past, you may want to avoid using these when you use either CPI or SPI for forecasts. In this case, you will use non-cumulative CPI or SPI calculations taken from a specific period of time that you feel is a more accurate representation of likely future performance.

> **Real world**
>
> When using an EAC formula, as a general rule of thumb, I tend to use the BAC divided by CPI calculation for the first third of the project because the information coming out at this point tends to be less accurate. After I get past the halfway point on a project, I will use the AC + ((BAC-EV)/(CPI × SPI)) formula because it takes into account all parameters and is generally more accurate.

- **Estimate to complete (ETC)** The estimate to complete calculation is simply your forecast of the remaining costs to be incurred on the project. The easiest way to calculate this is simply to subtract your actual cost (AC) spent to date from your estimate at completion (EAC). The formula is:

  ETC = EAC − AC

- **Variance at completion (VAC)** The *variance at completion* calculation is simply the difference between what you originally thought the project was going to cost (BAC) and what you now think it is going to cost (EAC). A negative variance is bad, and a positive variance is good. The formula is:

  VAC = BAC − EAC

To-complete performance index (TCPI)

The *to-complete performance index* (TCPI) tells you the rate at which you have to work to achieve either your estimate at completion (EAC) or your budget at completion (BAC), depending on which one you are targeting. A to-complete performance index of less than 1 is good, whereas a to-complete performance index of more than 1 is bad. If you are using the original budget at completion as your target, the formula is:

$TCPI = (BAC-EV)/ (BAC-AC)$

If you are using the estimate at completion as the target, the formula for TCPI is:

$TCPI = (BAC-EV)/ (EAC-AC)$

Performance reviews

Performance reviews are conducted via a variety of means, including earned value management variances and trend analysis. You already have learned about the use of earned value management variances for the calculation of both the cost variance (CV) and schedule variance (SV) using earned value management. These are the most frequently used methods of determining variance and performance.

In addition to earned value management variances as a performance review tool, you can also use trend analysis, which looks at past performance and extrapolates from that a likely future performance, usually by using graphs and linear regression.

Project management software

Project management software is very useful in monitoring the performance of cost on a project as it is able to quickly do what would take a lot of time if done manually. Additionally, it can take both the original data and any data from calculations and display it graphically for easy interpretation and communication.

Reserve analysis

Reserve analysis in this monitoring and controlling process is the process of re-examining the original reserves calculated, both the contingency and management reserves, and checking whether the assumptions made when calculating them are still valid, and also releasing any unused portions of contingency reserves from the approved project budget in order to enable other projects to access the pool of funds.

Outputs

The Control Costs process produces the following outputs.

Work performance information

The easiest way to display work performance information based on the work performance data is by using the earned value calculations for cost variance (CV), schedule variance (SV), cost performance index (CPI), schedule performance index (SPI), and the to-complete performance index (TCPI). The work performance information goes on to be used as an input into the Monitor and Control Project Work process.

Costs forecasts

Cost forecasts are obtained from the estimate at completion (EAC) values. Cost forecasts go on to be used as an input into the Monitor and Control Project Work process.

> ### Real world
>
> **It is important to emphasize to project stakeholders that any estimate at completion calculation is just that, it is your estimate about what it will cost to complete the project. When calculating the estimate at completion, you are using historical information to try to forecast a likely future outcome. If project stakeholders consider that your estimate at completion figure is an absolute figure that you definitely achieve, this will create unrealistic expectations.**

Change requests

One of the key outputs from any controlling process is change requests that arise as a result of either variances detected or additional information provided. Change requests may include preventive or corrective actions. All change requests are processed as per your documented and approved change control process.

Change requests go on to be used as an input into the Perform Integrated Change Control process from the Integration Management knowledge area.

Project management plan updates

Specific parts of the project management plan that may be updated as a result of the Control Costs process include the cost baseline and the cost management plan. Project management plan updates are used in turn as an input into the Develop Project Plan process.

Project documents updates

Specific project documents that may be updated as a result of the Control Costs process include any documentation relating to how you build up your cost estimates, such as the cost baseline and the basis of estimates document.

Organizational process assets updates

Specific organizational process assets that may be updated as a result of the Control Cost process are historical information, records of financial information kept, lessons learned, records of corrective actions, and updates to any organizational financial templates and policies in order to ensure that they are still relevant.

Exercises

The answers for these exercises are located in the "Answers" section at the end of this chapter.

1. (A) You are the project manager on a project to build 10 identical offices. You expect to spend $50,000 per office to complete the work and take 20 months to finish. You are 12 months into the work and have completed five offices and spent $310,000 in total. Use this information to calculate the following:

   A. Budget at completion (BAC)

   B. Actual cost (AC)

   C. Planned value (PV)

   D. Earned value (EV)

   E. Cost variance (CV)

   F. Cost performance index (CPI)

   G. Schedule variance (SV)

   H. Schedule performance index (SPI)

   I. Estimate at completion (EAC)

J. Estimate to complete (ETC)

K. Variance at completion (VAC)

L. To-complete performance index (TCPI)

(B) Based on the information gained from the calculations you have performed, how is the project performing in terms of both cost and time?

2. (A) You are the project manager on a project to complete 15 miles of road. Your approved budget for the project is $930,000, and you have forecast that the project will take 35 weeks to complete. You are 13 weeks into the project, and have constructed 7 miles of road at a cost of $58,000 per mile. Use this information to calculate the following:

A. Budget at completion (BAC)

B. Actual cost (AC)

C. Planned value (PV)

D. Earned value (EV)

E. Cost variance (CV)

F. Cost performance index (CPI)

G. Schedule variance (SV)

H. Schedule performance index (SPI)

I. Estimate at completion (EAC)

J. Estimate to complete (ETC)

K. Variance at completion (VAC)

L. To-complete performance index (TCPI)

(B) Based on the information gained from the calculations you have performed, how is the project performing in terms of both cost and time?

Chapter summary

- The Cost Management knowledge area is focused upon the development and checking of the project costs and begins with a planning process that produces the cost management plan, which then guides the individual cost estimating process and development of the cost baseline. It also provides guidance on monitoring actual versus planned cost performance and managing any changes to the cost baseline.

- The Plan Cost Management process focuses on the production of the cost management plan, which is a subsidiary plan of the project management plan.

- The Estimate Costs process is a highly iterative process repeated throughout the project that uses a variety of estimating techniques to developed individual activity cost estimates.

- The Determine Budget process aggregates the individual activity cost estimates and determines exactly when the costs will be incurred to produce a time-phased project budget, or cost baseline.

- The Control Costs process assesses planned cost performance against actual cost performance and forecasts a likely future state by using the earned value management systems. Any changes to the project cost baseline or individual activity cost estimates are managed through the approved change control process.

Chapter review

Test your knowledge of the information in Chapter 5 by answering these questions. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. What is the correct order of processes in the Cost Management knowledge area?

    A. Plan Cost Management, Estimate Costs, Determine Budget, Control Costs

    B. Plan Cost Management, Determine Budget, Estimate Costs, Control Costs

    C. Plan Cost Management, Control Costs, Estimate Costs, Determine Budget

    D. Plan Cost Management, Estimate Costs, Control Costs, Determine Budget

2. What is the single output from the Plan Cost Management process?

    A. Activity cost estimates

    B. Cost baseline

    C. Cost management plan

    D. Cost forecasts

3. All of the following could be included in the cost management plan EXCEPT?

    A. A description of the accuracy of estimating.

    B. The cost reporting formats to be used.

    C. A description of the units of measure used to estimate costs.

    D. The dates each activity will occur.

4. If you are estimating the cost for an activity by comparing the current activity with similar ones you have completed in the past, what sort of estimating technique are you using?

   A. Analogous estimating

   B. Parametric estimating

   C. Three-point estimating

   D. Bottom–up estimating

5. If you are aggregating the individual activity cost estimates up to the work package level, then the sub-deliverable level, and then the deliverable level to arrive at a total project cost estimate, what sort of estimating technique are you using?

   A. Analogous estimating

   B. Parametric estimating

   C. Three-point estimating

   D. Bottom–up estimating

6. If you are applying to senior management to obtain extra funds for unforeseen costs on your project, what are you using?

   A. Contingency reserve

   B. Funding limit reconciliation

   C. Management reserve

   D. Cost aggregation

7. If you have a project with a schedule performance index (SPI) of 1.05 and a cost performance index (CPI) of 0.92, how is your project performing?

   A. The project is over budget and behind schedule.

   B. The project is over budget and ahead of schedule.

   C. The project is under budget and behind schedule.

   D. The project is under budget and ahead of schedule.

8. If the budget at completion for your project is $70,000, the earned value is $30,000, and the actual cost is $32,000, what is your estimate at completion?

   A. $70,000.00

   B. $65,625.00

   C. $74,468.08

   D. $62,000.00

9. If the budget at completion for your project is $70,000, the earned value is $30,000, and the actual cost is $32,000, what is your variance at completion?

   A. $0.00

   B. $7,375.00

   C. −$4 468.08

   D. $8 000.00

10. If the to-complete performance index calculated for the budget at completion for your project is 1.1, what does this mean?

   A. Your project is doing well and you can slow down and still achieve the budget at completion.

   B. Your project is right on track to achieve the budget at completion.

   C. You need to produce $1.10 worth of effort for every $1.00 spent to achieve the budget at completion.

   D. You need to speed up the schedule but slow down the spending.

11. Which of the following is an example of work performance information?

   A. Reserve analysis

   B. Activity cost estimates

   C. Project funding requirements

   D. Schedule variance

Answers

This section contains the answers to the questions for the "Exercises" and "Chapter review" sections in this chapter.

Exercises

1. (A) You are the project manager on a project to build 10 identical offices. You expect to spend $50,000 per office to complete the work and take 20 months to finish. You are 12 months into the work and have completed five offices and spent $310,000 in total. Use this information to calculate the following:

A. **Budget at completion (BAC):** 10 offices × $50,000 each = $500,000

B. **Actual cost (AC):** You have spent $310,000 in total so this is your actual cost.

C. **Planned value (PV):** You are 12 months into a 20-month work program, so you planned to have created value equivalent to 12/20, or 60%, of your total planned value, or budget at completion. Therefore, your planned value (PV) is $500,000 × 60% = $300,000.

D. **Earned value (EV):** You have built five offices, each with a value to you of $50,000, so your earned value is 5 × $50,000 = $250,000.

E. **Cost variance (CV): CV = EV – AC:** $250,000 – $310,000 = –$60,000

F. **Cost performance index (CPI): CPI = EV/AC:** $250,000/$310,000 = 0.81

G. **Schedule variance (SV): SV = EV – PV:** $250,000 – $300,000 = –$50,000

H. **Schedule performance index (SPI): SPI = EV/PV:** $250,000/$300,000 = 0.83

I. Estimate at completion (EAC)

    1. **EAC= BAC/CPI:** $500,000/0.81 = $617,283.95

    2. **EAC = AC + ETC:** $310,000 + $307,283.95 = $617,283.95

    3. **EAC = AC + (BAC – EV):** $310,000 + ($500,000 – $250,000) = $560,000

    4. **EAC = AC + ((BAC–EV)/(CPI × SPI)):** $310,000 + (($500,000 – $250,000)/(0.81 × 0.83)) = $681,857.80

J. **Estimate to complete (ETC):** The estimate to complete answer will depend on which estimate at completion figure you choose to use in the formula ETC = EAC – AC. If you use the estimate at completion (EAC) from the BAC/CPI formula, the answer is $307,283.95.

K. **Variance at completion (VAC):** The variance at completion answer will depend on which estimate at completion you choose to use in the formula VAC = BAC – EAC. If you use the estimate at completion (EAC) from the BAC/CPI formula, the answer is –$117,283.95.

L. **To-complete performance index (TCPI):** The to-complete performance index answer will depend on whether your target is your budget at completion (BAC) or the estimate at completion (EAC), and if it is the estimate at completion (EAC), it will depend on which formula you use to calculate that. The following example uses BAC/CPI to calculate EAC.

    1. TCPI for EAC = (BAC – EV)/(EAC – AC) = 0.81

    2. TCPI for BAC = (BAC – EV)/(BAC – AC) = 1.31

(B) Based on the information gained from the calculations you have performed, how is the project performing in terms of both cost and time?

Based on the information calculated, the project is over budget because the cost variance (CV) is negative and the cost performance index (CPI) is less than 1. The project is behind schedule, because the schedule variance (SV) is negative and the schedule performance index (SPI) is less than 1.

2. (A) You are the project manager on a project to complete 15 miles of road. Your approved budget for the project is $930,000, and you have forecast that the project will take 35 weeks to complete. You are 13 weeks into the project, and have constructed seven miles of road at a cost of $58,000 per mile. Use this information to calculate the following:

A. **Budget at completion (BAC):** $930,000

B. **Actual cost (AC):** You have built seven miles of road at a cost of $58,000 so your actual cost is 7 × $58,000 = $406,000.

C. **Planned value (PV):** You are 13 weeks into a 35-week work program, so you planned to have created value of 13/35, or 37%, of your total planned value, or budget at completion. Therefore, your planned value (PV) is $930,000 × 37% = $344,100.

D. **Earned value (EV):** You are building 15 miles of road for $930,000, so each mile of road has a value of $930,000/15 = $62,000. You have built seven miles of road each with a value to you of $62,000, so your earned value is 7 × $62,000 = $434,000.

E. **Cost variance (CV): CV = EV – AC:** $434,000 – $406,000 = $28,000

F. **Cost performance index (CPI): CPI = EV/AC:** $434,000/$406,000 = 1.07

G. **Schedule variance (SV): SV = EV – PV:** $434,000 – $344,100 = $89,900

H. **Schedule performance index (SPI): SPI = EV/PV:** $434,000/$344,100 = 1.26

I. Estimate at completion (EAC)

    1. **EAC= BAC/CPI:** $930,000/ 1.07 = $869,158.88

    2. **EAC = AC + ETC:** $406,000 + $464, 158.88 = $870,158.88

    3. **EAC = AC + (BAC – EV):** $406,000 + ($930,000 – $434,000) = $902,000

    4. **EAC = AC + ((BAC – EV)/(CPI × SPI)):** $406,000 + (($930,000 – $434,000)/ (1.07 × 1.26)) = $773,407.41

J. **Estimate to complete (ETC):** The estimate to complete answer will depend on which estimate at completion figure you choose to use in the formula ETC = EAC – AC. If you use the estimate at completion (EAC) from the BAC/CPI formula, the answer is $463,158.88.

K. **Variance at completion (VAC):** The variance at completion answer will depend on which estimate at completion you choose to use in the formula VAC = BAC – EAC. If you use the estimate at completion (EAC) from the BAC/CPI formula, the answer is $60,841.12.

L. **To-complete performance index (TCPI):** The to-complete performance index answer will depend on whether your target is your budget at completion (BAC) or the estimate at completion (EAC), and if it is the estimate at completion (EAC), it will depend on which formula you use to calculate that. The following example uses BAC/CPI to calculate EAC.

    1. TCPI for EAC = (BAC – EV)/(EAC – AC) = 1.07

    2. TCPI for BAC = (BAC – EV)/(BAC – AC) = 0.95

(B) Based on the information gained from the calculations you have performed, how is the project performing in terms of both cost and time?

Based on the information from the earned value calculations, the project is ahead of schedule because the schedule variance (SV) is positive and the schedule performance index (SPI) is greater than 1. The project is also under budget because the cost variance (CV) is positive and the cost performance index (CPI) is greater than 1.

Chapter review

1. **Correct answer: A**
    A. **Correct:** First plan your approach to cost management, then estimate costs, then determine your budget, then control the costs.
    B. **Incorrect:** Estimate Costs occurs before Determine Budget.
    C. **Incorrect:** Control Costs occurs after Determine Budget.
    D. **Incorrect:** Control Costs occurs after Determine Budget.

2. **Correct answer: C**
    A. **Incorrect:** Activity cost estimates are an output from the Estimate Costs process.
    B. **Incorrect:** The cost baseline is an output from the Determine Budget process.
    C. **Correct:** The cost management plan is the sole output from the Plan Cost Management process.
    D. **Incorrect:** Cost forecasts are an output from the Control Costs process.

3. **Correct answer: D**
    A. **Incorrect:** A description of the accuracy of estimating would be included in the cost management plan.
    B. **Incorrect:** A description of the cost reporting formats to be used would be included in the cost management plan.
    C. **Incorrect:** A description of the units of measure used to estimate costs would be included in the cost management plan.
    D. **Correct:** The dates each activity will occur would be included as part of your project schedule, not the cost management plan.

4. **Correct answer: A**
    A. **Correct:** Analogous estimating uses similar activities from the past and extrapolates from them a likely current cost estimate.
    B. **Incorrect:** Parametric estimating multiplies a known quality by a known dollar amount to arrive at a cost estimate.
    C. **Incorrect:** Three-point estimating takes the weighted average of a most likely, optimistic, and pessimistic cost estimate.
    D. **Incorrect:** Bottom-up estimating aggregates lower-level cost estimates.

5. **Correct answer: D**

   A. **Incorrect:** Analogous estimating uses similar activities from the past and extrapolates from them a likely current cost estimate.

   B. **Incorrect:** Parametric estimating multiplies a known quality by a known dollar amount to arrive at a cost estimate.

   C. **Incorrect:** Three-point estimating takes the weighted average of a most likely, optimistic, and pessimistic cost estimate.

   D. **Correct:** Bottom-up estimating aggregates lower-level cost estimates up to higher levels to arrive at a total project cost estimate.

6. **Correct answer: C**

   A. **Incorrect:** The contingency reserve is for known unknowns on the project.

   B. **Incorrect:** The funding limit reconciliation is an output from the Determine Budget process.

   C. **Correct:** The management reserve is available for truly unforeseen costs that arise on a project and is controlled by senior management.

   D. **Incorrect:** Cost aggregation is the technique of adding up lower-level costs to obtain higher-level cost estimates.

7. **Correct answer: B**

   A. **Incorrect:** The project would need a CPI less than 1 and an SPI less than 1 to be over budget and behind schedule.

   B. **Correct:** A CPI less than 1 and an SPI greater than 1 indicate that the project is over budget and ahead of schedule.

   C. **Incorrect:** The project would need a CPI greater than 1 and an SPI less than 1 to be under budget and behind schedule.

   D. **Incorrect:** The project would need a CPI greater than 1 and an SPI greater than 1 to be under budget and ahead of schedule.

8. **Correct answer: C**

   A. **Incorrect:** $70,000 is the budget at completion.

   B. **Incorrect:** You would arrive at this figure if you reversed the calculation for cost performance index (CPI).

   C. **Correct:** If you calculate the cost performance index (CPI) first by dividing the earned value (EV) by the actual cost (AC), then divide the budget at completion (BAC) by the cost performance index (CPI), this is the answer you get.

   D. **Incorrect:** This is the answer you get if you add the earned value (EV) to the actual cost (AC).

9. **Correct answer: C**

  A. **Incorrect:** There is a variance at completion, according the formula VAC = BAC – EAC.

  B. **Incorrect:** This is the answer you arrive at if you calculate estimate at completion (EAC) incorrectly.

  C. **Correct:** Variance at completion (VAC) equals budget at completion (BAC) minus estimate at completion (EAC), which is -$4 468.08.

  D. **Incorrect:** If you got this answer, you probably guessed or used the wrong equation.

10. **Correct answer: C**

  A. **Incorrect:** A to-complete performance index (TCPI) of 1.1 is a bad thing and means you need to work faster or more efficiently to achieve your goal of either budget at completion (BAC) or estimate at completion (EAC).

  B. **Incorrect:** A to-complete performance index (TCPI) of 1.1 shows that the project is not on track.

  C. **Correct:** A to-complete performance index (TCPI) of 1.1 means that you have to work harder or more efficiently to achieve the goal of the budget at completion (BAC).

  D. **Incorrect:** A to-complete performance index (TCPI) of 1.1 means that you must pay attention to both schedule and spending, but neither one is in a good position because the index is greater than 1.

11. **Correct answer: D**

  A. **Incorrect:** Reserve analysis is the process of determining and monitoring contingency and management reserves.

  B. **Incorrect:** Activity cost estimates are an output of the Estimate Costs process.

  C. **Incorrect:** Project funding requirements are an output of the Determine Budget process.

  D. **Correct:** Schedule variance, cost variance, schedule performance index, and cost performance index are all examples of work performance information.

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About the author

SEAN WHITAKER is an experienced project manager, author, and trainer who has successfully delivered projects in the construction, telecommunications, and IT industries, making him a truly professional project manager. He began his project management career as a residential land developer, then moved on to the construction of wireless telecommunications networks, and then mission-critical hardware and software projects for large infrastructure organizations before returning to the construction industry. What began as a part-time teaching opportunity has now become his full time occupation as teacher, trainer, speaker, and author about project management. He holds the Project Management Professional (PMP®) credential in addition to Bachelor of Arts (BA), Master of Science (MSc), and Master of Business Administration (MBA) academic degrees. He regularly attends and presents at national and international project management conferences, and he currently provides project management training and teaching across a wide range of industries and at all levels. He gives back to the profession via his regular blogs and mentoring and is the author of several project management books, including *PMP® Rapid Review* (Microsoft Press, 2013). He has been a volunteer leader with the Project Management Institute for many years.
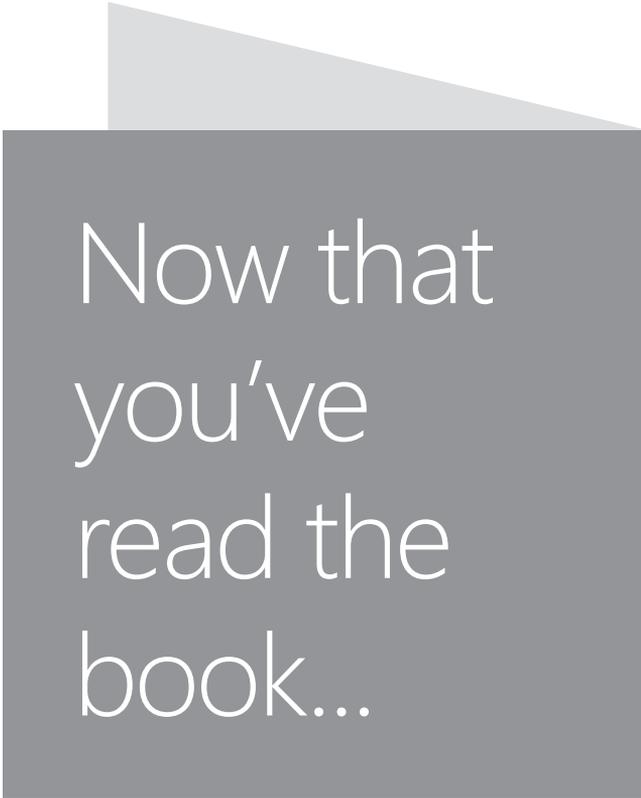
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