How to access your CD files

The print edition of this book includes a CD. To access the CD files, go to http://aka.ms/657809/files, and look for the Downloads tab.

Note: Use a desktop web browser, as files may not be accessible from all ereader devices.

Questions? Please contact: mspinput@microsoft.com

Microsoft Press
### PMP exam task map

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TASK</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1.1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1.2</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>1.3</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1.7</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>2.1</td>
<td>2, 3</td>
</tr>
<tr>
<td>3</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>2.3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>2.4</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>2.5</td>
<td>7</td>
</tr>
<tr>
<td>8, 11</td>
<td>2.6</td>
<td>8, 11</td>
</tr>
<tr>
<td>10</td>
<td>2.7</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>2.8</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>2.9</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>2.10</td>
<td>9</td>
</tr>
<tr>
<td>2, 11</td>
<td>2.11</td>
<td>2, 11</td>
</tr>
<tr>
<td>8, 11</td>
<td>2.12</td>
<td>8, 11</td>
</tr>
</tbody>
</table>

### 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](http://www.pmi.org/en/Certification/Project-Management-Professional-PMP.aspx).
<table>
<thead>
<tr>
<th>3.0 EXECUTING THE PROJECT (30 PERCENT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Obtain and manage project resources including outsourced deliverables by following the procurement plan, in order to ensure successful project execution.</td>
</tr>
<tr>
<td>3.2 Execute the tasks as defined in the project plan, in order to achieve the project deliverables within budget and schedule.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>3.4 Implement approved changes according to the change management plan, in order to meet project requirements.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>3.6 Maximize team performance through leading, mentoring, training, and motivating team members.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.0 MONITORING AND CONTROLLING THE PROJECT (25 PERCENT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>4.6 Communicate project status to stakeholders for their feedback, in order to ensure the project aligns with business needs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.0 CLOSING THE PROJECT (8 PERCENT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
<tr>
<td>5.2 Transfer the ownership of deliverables to the assigned stakeholders in accordance with the project plan, in order to facilitate project closure.</td>
</tr>
<tr>
<td>5.3 Obtain financial, legal, and administrative closure using generally accepted practices, in order to communicate formal project closure and ensure no further liability.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>5.5 Collate lessons learned through comprehensive project review, in order to create and/or update the organization's knowledge base.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
PMP® Training Kit

Sean Whitaker
# Contents at a glance

*Introduction*  

Preparing for the exam  

| CHAPTER 1 | Understanding foundational concepts of project management | 1 |
| CHAPTER 2 | Integration management | 31 |
| CHAPTER 3 | Scope management | 85 |
| CHAPTER 4 | Time management | 125 |
| CHAPTER 5 | Cost management | 187 |
| CHAPTER 6 | Quality management | 229 |
| CHAPTER 7 | Human resource management | 265 |
| CHAPTER 8 | Communications management | 311 |
| CHAPTER 9 | Risk management | 335 |
| CHAPTER 10 | Procurement management | 387 |
| CHAPTER 11 | Stakeholder management | 423 |
| CHAPTER 12 | Ethics and professional conduct | 453 |

*Glossary*  

*Index*  

xix  

xxiii  

473  

489
# Contents

**Introduction**

xxix

**Preparing for the exam**

xxiii

## Chapter 1

**Understanding foundational concepts of project management**

1

- The purpose of the PMBOK® Guide.
- What is a project, a program, and a portfolio?
- What is project management?
- Project management, operations management, and organizational strategy
- Organizational influences on project management
- The project life cycle
- Exercises
- Chapter review
- Answers

## Chapter 2

**Integration management**

31

- What is project integration management?
- Develop Project Charter
  - Inputs
  - Tools and techniques
  - Outputs

---

What do you think of this book? We want to hear from you!

Microsoft is interested in hearing your feedback so we can continually improve our books and learning resources for you. To participate in a brief online survey, please visit:

Contents

Develop Project Management Plan .............................................. 45
   Tools and techniques .................................................. 48
   Outputs ........................................................................... 50

Direct and Manage Project Work .................................................. 52
   Inputs .............................................................................. 53
   Tools and techniques .................................................... 54
   Outputs ........................................................................... 56

Monitor and Control Project Work ................................................ 58
   Inputs .............................................................................. 59
   Tools and techniques .................................................... 61
   Outputs ........................................................................... 63

Perform Integrated Change Control ............................................. 65
   Inputs .............................................................................. 67
   Tools and techniques .................................................... 68
   Outputs ........................................................................... 69

Close Project or Phase ................................................................. 70
   Inputs .............................................................................. 72
   Tools and techniques .................................................... 73
   Outputs ........................................................................... 74

Exercises .................................................................................. 75

Chapter summary ................................................................. 76

Chapter review ................................................................. 77

Answers .................................................................................. 80
   Exercises ........................................................................... 80
   Chapter review ............................................................... 81

What do you think of this book? We want to hear from you!
Microsoft is interested in hearing your feedback so we can continually improve our
books and learning resources for you. To participate in a brief online survey, please visit:
www.microsoft.com/learning/booksurvey/
Chapter 3  Scope management  85

What is project scope management? ................................................. 86

Plan Scope Management ............................................................... 88
  Inputs  ...................................................................................... 89
  Tools and techniques .......................................................... 90
  Outputs .................................................................................. 90

Collect requirements ........................................................................ 93
  Inputs ....................................................................................... 94
  Tools and techniques .......................................................... 95
  Outputs .................................................................................. 97

Define scope .................................................................................. 99
  Inputs ....................................................................................... 100
  Tools and techniques .......................................................... 101
  Outputs .................................................................................. 102

Create WBS. .................................................................................. 103
  Inputs ....................................................................................... 104
  Tools and techniques .......................................................... 105
  Outputs .................................................................................. 106

Validate scope ............................................................................... 108
  Inputs ....................................................................................... 109
  Tools and techniques .......................................................... 110
  Outputs .................................................................................. 111

Control scope ................................................................................ 112
  Inputs ....................................................................................... 113
  Tools and techniques .......................................................... 114
  Outputs .................................................................................. 114

Exercises ..................................................................................... 116

Chapter summary .......................................................................... 116

Chapter review ............................................................................ 117

Answers. ....................................................................................... 120
  Exercises ................................................................................ 120
  Chapter review ...................................................................... 121
Chapter 4  Time management  125

What is project time management? ............................................................ 126

Plan Schedule Management ................................................................. 127
  Inputs 127
  Tools and techniques 128
  Outputs 129

Define Activities. ....................................................................................... 131
  Inputs 132
  Tools and techniques 132
  Outputs 133

Sequence Activities. ................................................................................... 135
  Inputs 136
  Tools and techniques 137
  Outputs 140

Estimate Activity Resources. ................................................................. 142
  Inputs 143
  Tools and techniques 144
  Outputs 145

Estimate Activity Durations. ................................................................. 147
  Inputs 148
  Tools and techniques 149
  Outputs 155

Develop Schedule ....................................................................................... 157
  Inputs 158
  Tools and techniques 160
  Outputs 166

Control Schedule. ....................................................................................... 169
  Inputs 169
  Tools and techniques 170
  Outputs 173

Exercises ..................................................................................................... 175
## Chapter 5  Cost management  187

What is project cost management? ................................. 188

Plan Cost Management ........................................... 189
- Inputs ................................................................. 189
- Tools and techniques .......................................... 191
- Outputs ............................................................ 192

Estimate Costs ...................................................... 193
- Inputs ................................................................. 195
- Tools and techniques .......................................... 196
- Outputs ............................................................ 200

Determine Budget .................................................. 201
- Inputs ................................................................. 202
- Tools and techniques .......................................... 203
- Outputs ............................................................ 205

Control Costs ....................................................... 207
- Inputs ................................................................. 208
- Tools and techniques .......................................... 209
- Outputs ............................................................ 215

Exercises .................................................................. 217

Chapter summary ................................................... 218

Chapter review ....................................................... 219

Answers .................................................................. 222
- Exercises ............................................................ 222
- Chapter review .................................................... 225
Chapter 6  Quality management  229

What is project quality management? ................................. 230

Plan Quality Management .................................................. 232
  Inputs 233
  Tools and techniques 234
  Outputs 240

Perform Quality Assurance ............................................. 243
  Inputs 244
  Tools and techniques 245
  Outputs 249

Control Quality ............................................................. 250
  Inputs 251
  Tools and techniques 252
  Outputs 253

Exercise ........................................................................... 256

Chapter summary ............................................................ 257

Chapter review .................................................................. 257

Answers ........................................................................... 260
  Exercises 260
  Chapter review 261

Chapter 7  Human resource management  265

What is project human resource management? ................. 266

Plan Human Resource Management .................................. 267
  Inputs 267
  Tools and techniques 268
  Outputs 278

Acquire Project Team ....................................................... 279
  Inputs 279
  Tools and techniques 280
  Outputs 282
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop Project Team</td>
<td>284</td>
</tr>
<tr>
<td>Inputs</td>
<td>284</td>
</tr>
<tr>
<td>Tools and techniques</td>
<td>285</td>
</tr>
<tr>
<td>Outputs</td>
<td>294</td>
</tr>
<tr>
<td>Manage Project Team</td>
<td>296</td>
</tr>
<tr>
<td>Inputs</td>
<td>296</td>
</tr>
<tr>
<td>Tools and techniques</td>
<td>297</td>
</tr>
<tr>
<td>Outputs</td>
<td>299</td>
</tr>
<tr>
<td>Exercises</td>
<td>301</td>
</tr>
<tr>
<td>Chapter summary</td>
<td>302</td>
</tr>
<tr>
<td>Chapter review</td>
<td>303</td>
</tr>
<tr>
<td>Answers</td>
<td>306</td>
</tr>
<tr>
<td>Exercises</td>
<td>306</td>
</tr>
<tr>
<td>Chapter review</td>
<td>307</td>
</tr>
</tbody>
</table>

### Chapter 8  Communications management

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is project communications management?</td>
<td>311</td>
</tr>
<tr>
<td>Plan Communications Management</td>
<td>313</td>
</tr>
<tr>
<td>Inputs</td>
<td>313</td>
</tr>
<tr>
<td>Tools and techniques</td>
<td>314</td>
</tr>
<tr>
<td>Outputs</td>
<td>318</td>
</tr>
<tr>
<td>Manage Communications</td>
<td>320</td>
</tr>
<tr>
<td>Inputs</td>
<td>320</td>
</tr>
<tr>
<td>Tools and techniques</td>
<td>321</td>
</tr>
<tr>
<td>Outputs</td>
<td>322</td>
</tr>
<tr>
<td>Control Communications</td>
<td>324</td>
</tr>
<tr>
<td>Inputs</td>
<td>324</td>
</tr>
<tr>
<td>Tools and techniques</td>
<td>325</td>
</tr>
<tr>
<td>Outputs</td>
<td>326</td>
</tr>
<tr>
<td>Exercises</td>
<td>328</td>
</tr>
<tr>
<td>Chapter summary</td>
<td>328</td>
</tr>
<tr>
<td>Chapter review</td>
<td>329</td>
</tr>
</tbody>
</table>
Chapter 9 Risk management 335

What is project risk management? 336

Plan Risk Management 338

Identify Risks 343

Perform Qualitative Risk Analysis 351

Perform Quantitative Risk Analysis 357

Plan Risk Responses 364

Control Risks 368

Exercises 374
Chapter 10  Procurement management  387

What is project procurement management? ........................ 388

Plan Procurement Management ................................. 389
  Inputs 389
  Tools and techniques 392
  Outputs 394

Conduct Procurements ........................................ 397
  Inputs 397
  Tools and techniques 399
  Outputs 401

Control Procurements ........................................ 405
  Inputs 406
  Tools and techniques 407
  Outputs 409

Close Procurements ........................................ 411
  Inputs 411
  Tools and techniques 412
  Outputs 413

Exercises .......................................................... 414

Chapter summary ............................................ 415

Chapter review ................................................. 415

Answers ........................................................... 418
  Exercises 418
  Chapter review 418
Chapter 11  Stakeholder management  423
  What is project stakeholder management? ................................. 424
  Identify Stakeholders ................................................................. 425
    Inputs .................................................................................. 426
    Tools and techniques ................................................................. 426
    Outputs ............................................................................... 428
  Plan Stakeholder Management ..................................................... 431
    Inputs .................................................................................. 432
    Tools and techniques ................................................................. 433
    Outputs ............................................................................... 434
  Manage Stakeholder Engagement .................................................. 436
    Inputs .................................................................................. 437
    Tools and techniques ................................................................. 437
    Outputs ............................................................................... 439
  Control Stakeholder Engagement .................................................. 441
    Inputs .................................................................................. 441
    Tools and techniques ................................................................. 442
    Outputs ............................................................................... 443
  Exercises .................................................................................. 445
  Chapter summary ........................................................................ 446
  Chapter review ........................................................................... 446
  Answers .................................................................................... 449
    Exercises .............................................................................. 449
    Chapter review ....................................................................... 449

Chapter 12  Ethics and professional conduct  453
  Responsibility, respect, fairness, and honesty ................................. 454
  Responsibility ........................................................................... 454
  Respect .................................................................................... 457
  Fairness ..................................................................................... 458
  Honesty .................................................................................... 460
  Exercise ..................................................................................... 461
Chapter summary .......................... 462
Chapter review .............................. 462
Answers ........................................ 467
   Exercise 467
   Chapter review 468

Glossary 473

Index 489
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 downloadable 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.

If you need additional support, email Microsoft Press Book Support at:

mspinput@microsoft.com

Please note that product support for Microsoft software is not offered through the addresses above.
We want to hear from you

At Microsoft Press, your satisfaction is our top priority, and your feedback our most valuable asset. Please tell us what you think of this book at:

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.
CHAPTER 1

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

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.
CHAPTER 1

Understanding foundational concepts of project management

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.
EXAM TIP
An interesting distinction made by the PMBOK® Guide is that if the relationship between separate projects is based upon having a shared client or seller, or shared technology or resources, then the projects should be managed as a portfolio rather than a program.

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.

![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.

EXAM TIP
If you find a reference to OPM3 in the exam, it is referring to the Organizational Project Management Maturity Model, which is a tool from the Project Management Institute (PMI) for assessing an organization’s level of portfolio, program, and project management maturity.
Quick check

1. What are the three key elements that distinguish project work from ongoing work?

2. What are the key differences between a program and a portfolio of projects?

3. How would you describe the main differences between project, program, and portfolio management?

4. What function would a project management office play in an organization with a high level of project management maturity?

Quick check answers

1. First, a project has a temporal element defining a start and an end, making it temporary rather than ongoing. Second, it delivers something unique and never done before. Finally, it involves delivery of a product, service, or result.

2. In a program of projects the projects share an interdependency, whereas in a portfolio of projects the projects are only united by the fact that they are all being completed by the same organization.

3. Portfolio management is the top-level selection process of projects to ensure that they deliver the organization’s strategy. A program of projects contains projects that share a common goal or capability, and individual projects are focused on delivering a product, service, or result that will contribute to achievement of the organizational strategy. Remember that all programs have projects, but not all projects are part of programs.

4. An organization with a high level of project management maturity will use a directive project management office to take control of the way in which all projects are selected, managed, reported on, and communicated about within the organization.

What is project management?

More info  Project management

You can read more about the definition of project management in the PMBOK® Guide, 5th edition, in Chapter 1, section 1.3.

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.
What is project management?

EXAM TIP

Being proactive is a key point about professional project management. If there is any question in the exam that gives you the option to be proactive, it is probably the correct answer.

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.

EXAM TIP

You should know that one important aspect of project management is about recognizing and navigating your way through competing constraints on a project. This is evident in planning a project and also when considering a request for a change to a project, where a request for more time may impact schedule, risk, or quality.

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.
EXAM TIP
If you find the term “progressive elaboration” or “rolling wave planning” in the examination, it is referring to the concept of knowing more about the project the more work you do.

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 activities 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.
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.
Quick check

1. What are some of the main defining characteristics of an organization’s culture?
2. Why should a project manager be aware of the organizational culture?
3. How is an organization’s culture established and perpetuated?

Quick check answers

1. The main defining characteristics of an organizational culture can be observed in the organization’s visions and values, beliefs, policies, procedures, reward systems, tolerance for risk, work ethic, and view of authority relationships.

2. A project manager needs to be aware of the overall organizational culture and specific elements within it because these will affect the projects he or she is working on, and it is best to leverage those parts of the organizational culture that contribute to project success and mitigate those parts of the organizational culture that may increase the chances of project failure.

3. The culture of an organization generally reflects the values of its founding members. It is then perpetuated and reproduced by both senior managers and leaders, and the organization’s recruitment policies.

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.
**EXAM TIP**

Be prepared to find terms such as “milestone,” “stage gate,” “phase gate,” “kill point,” or “stop/go point” in questions relating to phases of a project.

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 starts 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.

![Diagram showing the process groups of the PMBOK® Guide](image)

**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

<table>
<thead>
<tr>
<th>Knowledge Areas</th>
<th>Initiating processes</th>
<th>Planning processes</th>
<th>Executing processes</th>
<th>Monitoring and Controlling processes</th>
<th>Closing processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Integration management</td>
<td>■ Develop Project Charter</td>
<td>■ Develop Project Management Plan</td>
<td>■ Direct and Manage Project Work</td>
<td>■ Monitor and Control Project Work</td>
<td>■ Close Project or Phase</td>
</tr>
<tr>
<td>Project Scope management</td>
<td>■ Plan Scope Management ■ Collect Requirements ■ Define Scope ■ Create WBS</td>
<td></td>
<td>■ Validate Scope ■ Control Scope</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The project life cycle  CHAPTER 1  17
<table>
<thead>
<tr>
<th>Project Time management</th>
<th>Initiating processes</th>
<th>Planning processes</th>
<th>Executing processes</th>
<th>Monitoring and Controlling processes</th>
<th>Closing processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plan Schedule Management</td>
<td>Define Activities</td>
<td>Sequence Activities</td>
<td>Estimate Activity Resources</td>
<td>Develop Schedule</td>
</tr>
<tr>
<td></td>
<td>Control Schedule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Cost management</td>
<td>Plan Cost Management</td>
<td>Estimate Costs</td>
<td>Determine Budget</td>
<td>Control Costs</td>
<td></td>
</tr>
<tr>
<td>Project Quality management</td>
<td>Plan Quality Management</td>
<td>Perform Quality Assurance</td>
<td>Control Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Human Resource management</td>
<td>Plan Human Resource Management</td>
<td>Acquire Project Team</td>
<td>Develop Project Team</td>
<td>Manage Project Team</td>
<td></td>
</tr>
<tr>
<td>Project Communications management</td>
<td>Plan Communications Management</td>
<td>Manage Communications</td>
<td>Control Communications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Risk management</td>
<td>Plan Risk Management</td>
<td>Identify Risks</td>
<td>Perform Qualitative Risk Analysis</td>
<td>Plan Risk Responses</td>
<td>Control Risks</td>
</tr>
</tbody>
</table>
The project life cycle

CHAPTER 1

19

Initiating processes
Planning processes
Executing processes
Monitoring and Controlling processes
Closing processes

Project Procurement management
- Plan Procurement Management
- Conduct 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.

<table>
<thead>
<tr>
<th>The PMBOK® Guide process groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
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 be 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

<table>
<thead>
<tr>
<th>The PMBOK Guide knowledge area</th>
<th>Initiating processes</th>
<th>Planning processes</th>
<th>Executing processes</th>
<th>Monitoring and Controlling processes</th>
<th>Closing processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Integration management</td>
<td>■ Develop Project Charter</td>
<td>■ Develop Project Management Plan</td>
<td>■ Direct and Manage Project Work</td>
<td>■ Monitor and Control Project Work</td>
<td>■ Close Project or Phase</td>
</tr>
<tr>
<td>Project Scope management</td>
<td>■ Plan Scope Management</td>
<td>■ Collect Requirements</td>
<td>■ Define Scope</td>
<td>■ Create WBS</td>
<td>■ Validate Scope</td>
</tr>
<tr>
<td>Project Time management</td>
<td>■ Plan Schedule Management</td>
<td>■ Define Activities</td>
<td>■ Sequence Activities</td>
<td>■ Estimate Activity Resources</td>
<td>■ Estimate Activity Durations</td>
</tr>
</tbody>
</table>
The PMBOK® Guide process groups

<table>
<thead>
<tr>
<th>The PMBOK Guide knowledge area</th>
<th>Initiating processes</th>
<th>Planning processes</th>
<th>Executing processes</th>
<th>Monitoring and Controlling processes</th>
<th>Closing processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost management</td>
<td></td>
<td></td>
<td></td>
<td>Control Costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Quality management</td>
<td></td>
<td></td>
<td></td>
<td>Control Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Human Resource manage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Communications manage</td>
<td></td>
<td></td>
<td></td>
<td>Control Communications</td>
<td></td>
</tr>
<tr>
<td>Project Risk management</td>
<td></td>
<td></td>
<td></td>
<td>Control Risks</td>
<td></td>
</tr>
<tr>
<td>Project Procurement manage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Stakeholder manage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ment</td>
<td>Identify Stakeholders</td>
<td>Plan Stakeholder</td>
<td>Manage Stakeholder</td>
<td></td>
<td>Close Procure-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Management</td>
<td>Engagement</td>
<td></td>
<td>ments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.
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.

**EXAM TIP**

Although presented as discrete processes, the two processes of estimating costs and determining budget are usually done concurrently.

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.

**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

**MORE INFO PLAN COST MANAGEMENT**

You can read more about the Plan Cost Management process in the PMBOK® Guide, 5th edition, in Chapter 7, section 7.1. Table 5-1 identifies the process inputs, tools and techniques, and outputs.

**TABLE 5-1 Plan Cost Management process**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Tools and techniques</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project management plan</td>
<td>Expert judgment</td>
<td>Cost management plan</td>
</tr>
<tr>
<td>Project charter</td>
<td>Analytical techniques</td>
<td></td>
</tr>
<tr>
<td>Enterprise environmental factors</td>
<td>Meetings</td>
<td></td>
</tr>
<tr>
<td>Organizational process assets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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**

MORE INFO  ESTIMATE COSTS

You can read more about the Estimate Costs process in the PMBOK® Guide, 5th edition, in Chapter 7, section 7.2. Table 5-2 identifies the process inputs, tools and techniques, and outputs.

**TABLE 5-2 Estimate Costs process**

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

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

<table>
<thead>
<tr>
<th>Estimate type</th>
<th>Estimate range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order of Magnitude Estimate</td>
<td>-50% to +100%</td>
</tr>
<tr>
<td>Rough Order of Magnitude Estimate</td>
<td>-25% to +75%</td>
</tr>
<tr>
<td>Conceptual Estimate</td>
<td>-30% to +50%</td>
</tr>
<tr>
<td>Estimate type</td>
<td>Estimate range</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Preliminary Estimate</td>
<td>-20% to +30%</td>
</tr>
<tr>
<td>Definitive Estimate</td>
<td>-15% to +20%</td>
</tr>
<tr>
<td>Control Estimate</td>
<td>-10% to +15%</td>
</tr>
</tbody>
</table>

### 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

\[
\text{SD} = \frac{c_P - c_O}{6}
\]

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

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Tools and techniques</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost management plan</td>
<td></td>
<td>Cost baseline</td>
</tr>
<tr>
<td>Scope baseline</td>
<td>Cost aggregation</td>
<td></td>
</tr>
<tr>
<td>Activity cost estimates</td>
<td>Reserve analysis</td>
<td></td>
</tr>
<tr>
<td>Basis of estimates</td>
<td>Expert judgment</td>
<td>Project funding requirements</td>
</tr>
<tr>
<td>Project schedules</td>
<td>Historical relationships</td>
<td></td>
</tr>
<tr>
<td>Resource calendars</td>
<td>Funding limit reconciliation</td>
<td>Project documents updates</td>
</tr>
<tr>
<td>Risk register</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational process assets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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, because 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](image)

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.
EXAM TIP

Individual contingency reserve figures are added to the individual activity cost estimates. These are then aggregated and rolled up to work package level, with the aggregated contingency reserve applied against individual work packages. The management reserve is added to the total cost baseline. The only way that you’re able to use funds from the management reserve is to obtain approval by the documented and approved change control process. Management reserves are not usually part of the project budget.

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.
Quick check

1. Why is the project schedule an important input into the Determine Budget process?

2. How would you describe cost aggregation?

3. Why are funding limits reconciliations and the project funding requirements important aspects of any project cost baseline?

Quick check answers

1. The project schedule allows you to view the time period within which the project activities will be performed and their costs incurred.

2. Cost aggregation is the process of adding up individual activity cost estimates up to the work package level, then the sub-deliverable level, and then the deliverable level.

3. Both the technique of funding limits reconciliation and the output of project funding requirements recognize that funds for the project may be incremental while spending may be continuous, and therefore there may be times when there are not enough funds to pay accrued expenses.

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

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Tools and techniques</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project management plan</td>
<td>Earned value management</td>
<td>Work performance information</td>
</tr>
<tr>
<td>Project funding requirements</td>
<td>Forecasting</td>
<td>Cost forecasts</td>
</tr>
<tr>
<td>Work performance data</td>
<td>To-complete performance index (TCPI)</td>
<td>Change requests</td>
</tr>
<tr>
<td>Organizational process assets</td>
<td>Performance reviews</td>
<td>Project management plan updates</td>
</tr>
<tr>
<td></td>
<td>Project management software</td>
<td>Project documents updates</td>
</tr>
<tr>
<td></td>
<td>Reserve analysis</td>
<td>Organizational process assets updates</td>
</tr>
</tbody>
</table>
EXAM TIP
Did you notice that the outputs from the Control Costs process are the same as the outputs from the Control Schedule process, with the exception of the cost forecasts instead of schedule forecasts?

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.
CHAPTER 5  Cost management

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:

\[ CPI = \frac{EV}{AC} \]

- **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:

\[ SPI = \frac{EV}{PV} \]

**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.

**EXAM TIP**
Memorize all these formulas, and as soon as you are allowed to start the exam, write them all down.

**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:

\[ \text{ETC} = \text{EAC} - \text{AC} \]

■ **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:

\[ \text{VAC} = \text{BAC} - \text{EAC} \]
EXAM TIP
There are occasions when the three-letter acronyms used here to outline the earned value management system are represented by an older set of four-letter acronyms as follows:

Planned value (PV) = Budgeted cost of work scheduled (BCWS)
Actual cost (AC) = Actual cost of work performed (ACWP)
Earned value (EV) = Budgeted cost of work performed (BCWP)

EXAM TIP
In the exam you will often be presented with a scenario that requires you to work out one set of figures before you can work out another set of figures. For example, you may be required to work out the EAC by using either CPI or SPI but will not be given the CPI figures or SPI figures. You will instead be given figures for EC, AC, and PV, and be expected to work out either the CPI or the SPI first. Also, when looking at a question that requires you to calculate any formula, be on the lookout for any irrelevant information because sometimes not all the information presented in the scenario is relevant.

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:

\[ TCPI = \frac{(BAC-EV)}{(BAC-AC)} \]

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

\[ TCPI = \frac{(BAC-EV)}{(EAC-AC)} \]

EXAM TIP
When doing any calculations in the exam, round your answer to two decimals places but be prepared for an answer that is slightly different due to slight differences in the approach to rounding of decimal places.
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.
Quick check

1. What is the difference between work performance data and work performance information?

2. If a project has a CPI of 1.1 and an SPI of .90, how is it performing in relation to time and cost?

3. What is the key difference between each of the four formulas for estimate at completion?

Quick check answers

1. Work performance data is the raw information collected by checking on cost and time performance. Work performance information applies filters to this data to make it useful information.

2. This project is under budget because the CPI is greater than 1, but behind schedule because the SPI is less than 1.

3. Each of the four formulas uses different historical information about the project to forecast a likely future outcome.

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 per-
formance 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): \( \text{CPI} = \frac{\text{EV}}{\text{AC}} \): $434,000 / $406,000 = 1.07

G. Schedule variance (SV): \( \text{SV} = \text{EV} - \text{PV} \): $434,000 - $344,100 = $89,900

H. Schedule performance index (SPI): \( \text{SPI} = \frac{\text{EV}}{\text{PV}} \): $434,000 / $344,100 = 1.26

I. Estimate at completion (EAC)
   1. \( \text{EAC} = \frac{\text{BAC}}{\text{CPI}} \): $930,000 / 1.07 = $869,158.88
   2. \( \text{EAC} = \text{AC} + \text{ETC} \): $406,000 + $464,158.88 = $870,158.88
   3. \( \text{EAC} = \text{AC} + (\text{BAC} - \text{EV}) \): $406,000 + ($930,000 - $434,000) = $902,000
   4. \( \text{EAC} = \text{AC} + \frac{(\text{BAC} - \text{EV})}{(\text{CPI} \times \text{SPI})} \): $406,000 + ($930,000 - $434,000)/ (1.07 \times 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 \( \text{ETC} = \text{EAC} - \text{AC} \). 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 \( \text{VAC} = \text{BAC} - \text{EAC} \). 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. \( \text{TCPI for EAC} = \frac{(\text{BAC} - \text{EV})}{(\text{EAC} - \text{AC})} = 1.07 \)
   2. \( \text{TCPI for BAC} = \frac{(\text{BAC} - \text{EV})}{(\text{BAC} - \text{AC})} = 0.95 \)

(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**
   - **Incorrect:** Analogous estimating uses similar activities from the past and extrapolates from them a likely current cost estimate.
   - **Incorrect:** Parametric estimating multiplies a known quality by a known dollar amount to arrive at a cost estimate.
   - **Incorrect:** Three-point estimating takes the weighted average of a most likely, optimistic, and pessimistic cost estimate.
   - **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**
   - **Incorrect:** The contingency reserve is for known unknowns on the project.
   - **Incorrect:** The funding limit reconciliation is an output from the Determine Budget process.
   - **Correct:** The management reserve is available for truly unforeseen costs that arise on a project and is controlled by senior management.
   - **Incorrect:** Cost aggregation is the technique of adding up lower-level costs to obtain higher-level cost estimates.

7. **Correct answer: B**
   - **Incorrect:** The project would need a CPI less than 1 and an SPI less than 1 to be over budget and behind schedule.
   - **Correct:** A CPI less than 1 and an SPI greater than 1 indicate that the project is over budget and ahead of schedule.
   - **Incorrect:** The project would need a CPI greater than 1 and an SPI less than 1 to be under budget and behind schedule.
   - **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**
   - **Incorrect:** $70,000 is the budget at completion.
   - **Incorrect:** You would arrive at this figure if you reversed the calculation for cost performance index (CPI).
   - **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.
   - **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 to 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.
Index

Symbols
80:20 rule, 237
360-degree feedback method, 294

A
AC (actual cost), 210
accepted deliverables
   Close Project or Phase process, 73
   Validate Scope process, 111
accuracy, 150, 230–231
Acquire Project Team process, 143, 203
   inputs, 279–280
   outputs, 282–283
   overview, 279
   tools and techniques, 280–281
acquisition, 281
active listening technique, 316
activity attributes
   Define Activities process, 134
   Develop Schedule process, 158
   Estimate Activity Durations process, 148
   Estimate Activity Resources process, 143
   Sequence Activities process, 136
activity cost estimates
   Determine Budget process, 202
   Estimate Activity Resources process, 144
   Estimate Costs process, 200
   Identify Risks process, 345
   Plan Procurement Management process, 390
activity duration estimates
   Develop Schedule process, 159
   Estimate Activity Durations process, 155
   Identify Risks process, 346
activity list
   Define Activities process, 133
   Develop Schedule process, 158
   Estimate Activity Durations process, 148
   Estimate Activity Resources process, 143
   Sequence Activities process, 136
activity network diagrams, 247
activity-on-arrow (AOA) diagrams, 140, 141
activity-on-node (AON) diagrams, 137, 140, 161, 247
activity resource requirements
   Develop Schedule process, 158
   Estimate Activity Durations process, 148
   Estimate Activity Resources process, 145
   Plan Human Resource Management process, 268
   Plan Procurement Management process, 390
actual cost (AC), 210
ACWP (actual cost of work performed), 214
adjusting leads, 172
administrative closure, 74
advertising, 400
affinity diagrams, 245
agreements
   Conduct Procurements process, 401–403
   Control Procurements process, 406
   Determine Budget process, 203
   Develop Project Charter process, 40–41
alternative analysis, 144
alternatives generation, 101
analogous estimating
   Estimate Activity Durations process, 150
   Estimate Costs process, 197
analytical techniques
   Close Project or Phase process, 73
   Conduct Procurements process, 400
   Monitor and Control Project Work process, 61–63
   Plan Cost Management process, 191
   Plan Risk Management process, 339
AOA (activity-on-arrow) diagrams

Plan Schedule Management process, 129
Plan Stakeholder Management process, 433–434
AOA (activity-on-arrow) diagrams, 140, 141
AON (activity-on-node) diagrams, 137, 140, 161, 247
applying leads, 172
approved change requests
  Control Procurements process, 406
  Control Quality process, 253
Direct and Manage Project Work process, 54
Perform Integrated Change Control process
  updates, 69
arbitration, 412
audits, 407, 412

B

BAC (budget at completion), 209
backward pass, 161
balanced matrix organization, 275
bar charts, 238
basis of estimates
  Determine Budget process, 202
  Estimate Costs process, 200
BCR (Benefit-Cost Ratio), 37
BCWP (budgeted cost of work performed), 214
BCWS (budgeted cost of work scheduled), 214
benchmarking
  Collect requirements process, 97
  Plan Quality Management process, 235–239
Benefit-Cost Ratio (BCR), 37
beta distributions, 359
bidder conference, 399–400
bottom-up estimating
  Estimate Activity Resources process, 145
  Estimate Costs process, 197
brainstorming, 42, 49, 153, 347
Budget at completion (BAC), 209
budgeted cost of work performed (BCWP), 214
budgeted cost of work scheduled (BCWS), 214
budget vs. cost, 190
buffer time, 164
business case
  Develop Project Charter process, 39–40
  vs. project charter, 43
business value, 11
buyers, 388

C

cause-and-effect diagram, 235
CEO (chief executive officer), 272, 274
change control board, 68
change control meetings, 68
change control tools, 69
change log
  Manage Stakeholder Engagement process, 437
  Perform Integrated Change Control process
  updates, 69
change requests
  Conduct Procurements process, 403
  Control Communications process, 327
  Control Costs process, 216
  Control Procurements process, 409
  Control Quality process, 251, 254
  Control Risks process, 372
  Control Schedule process, 174
  Control Scope process, 114
  Control Stakeholder Engagement process, 443
  Direct and Manage Project Work process
  updates, 57
  Manage Project Team process, 299
  Manage Stakeholder Engagement process, 439
  Monitor and Control Project Work process, 63
  Perform Integrated Change Control process, 67–68
  Perform Quality Assurance process, 249
  Plan Procurement Management process, 396
  Validate Scope process, 111
checksheets, 236
claim, 408
claims administration, 408
closed procurements, 413
Close Procurements process, 72
  inputs, 411
  outputs, 413–414
  overview, 411
tools and techniques, 412–413
Close Project or Phase process
accepted deliverables, 73
analytical techniques, 73
expert judgment, 73
final product, service, or result transition, 74
meetings in, 73
organizational process assets, 73
organizational process assets updates, 74–75
overview, 70–72
project management plan, 72
Collect Requirements process, 233
inputs, 94–95
outputs
overview, 97
requirements documentation, 97–98
requirements traceability matrix, 98–99
overview, 93–94
tools and techniques
benchmarking, 97
context diagrams, 97
document analysis, 97
facilitated workshops, 95
focus groups, 95
group creativity techniques, 95
group decision-making techniques, 96
interviews, 95
observations, 96
overview, 95
prototypes, 96
questionnaires and surveys, 96
coco-location, 293
communications
Manage Project Team process, 298
Manage Stakeholder Engagement process, 438
communications management
Control Communications process, 324–327
defined, 312–313
Manage Communications process, 320–323
overview, 311–312
Plan Communications Management process, 313–318
inputs, 313–314
outputs, 318–319
overview, 313
tools and techniques, 314–317
communications management plan
Manage Communications process, 320
Manage Stakeholder Engagement process, 437
Plan Communications Management process, 318–319
communications methods
Manage Communications process, 322
Plan Communications Management process, 317–318
communications models
Manage Communications process, 321
Plan Communications Management process, 316–317
communications requirements analysis, 314–315
communications technology
Manage Communications process, 321
Plan Communications Management process, 315
Conduct Procurements process, 203, 394–395
inputs
make or buy decisions, 398
organizational process assets, 399
overview, 397
procurement management plan, 397
procurement statement of work, 398–399
project documents, 398
seller proposals, 398
source selection criteria, 398
outputs
agreements, 401–403
change requests, 403
overview, 400–401
project documents updates, 403–404
project management plan updates, 403
resource calendars, 403
selected sellers, 400–401
overview, 397
tools and techniques
advertising, 400
analytical techniques, 400
bidder conference, 399–400
expert judgment, 400
independent estimates, 400
overview, 399
procurement negotiations, 400–401
conflict management, 298–299
colocation, 293
colocation, 293
communications
Conflict Communications process, 322
Plan Communications Management process, 322
inputs, 324–325
outputs, 326–327
conflict of interest, 458, 459
conflict resolution
defined, 43
importance of, 49
context diagrams, 97
contingency plan, 366
contingency reserve, 154
contingent response strategies, 366
continuous improvement, 230
contract change control system, 407
contracts, 388
contractual closure, 74, 388
curbers, 238–239
Conflict Communications process, 322
Control Costs process

overview, 324
tools and techniques, 325–326

Control Costs process
change requests, 216
costs forecasts, 60, 216
earned value management, 209–211
forecasting, 212–214
organizational process assets, 208
organizational process assets updates, 216–217
overview, 207
performance reviews, 215
project document updates, 216
project funding requirements, 208
project management plan, 208
project management plan updates, 216
project management software, 215
reserve analysis, 215
TCI, 214
work performance data, 208
work performance information, 215
control limits, 238

Control Procurements process
inputs, 406
outputs, 409–410
change requests, 409
organizational process assets updates, 410
overview, 409
project documents updates, 410
project management plan updates, 409
work performance information, 409
overview, 405
tools and techniques
claims administration, 408
contract change control system, 407
inspections and audits, 407
overview, 407
payment systems, 408
performance reporting, 407
procurement performance reviews, 407
records management system, 408–409

Control Quality process, 56, 60
inputs, 251–252
outputs, 253–256
overview, 250–251
tools and techniques, 252–253

Control Risks process
inputs
overview, 369
project management plan, 369
risk register, 369
work performance data, 369
outputs
change requests, 372
organizational process assets updates, 372–373
overview, 371
project documents updates, 372
project management plan updates, 372
work performance information, 371
overview, 368
tools and techniques
overview, 370
reserve analysis, 371
risk audits, 370
risk reassessment, 370
status meetings, 371
technical performance measurement, 371
variance and trend analysis, 370

Control Schedule process, 60
inputs, 169–170
outputs, 173–175
overview, 169
tools and techniques, 170–172

Control Scope process, 98, 112–115

Control Stakeholder Engagement process
inputs
issue log, 441
overview, 441
project documents, 442
project management plan, 441
work performance data, 442
outputs
change requests, 443
organizational process assets updates, 443–444
overview, 443
project documents updates, 443
work performance information, 443
overview, 441
tools and techniques
expert judgment, 443
meetings, 443
overview, 442
reporting systems, 442
control tools, 245–248
conversation, 298
corrective action, 57, 63
cost aggregation, 204
cost baseline, 205–206
cost-benefit analysis, 234
cost forecasts
  Control Costs process, 216
  Monitor and Control Project Work process, 60
cost management plan
  Determine Budget process, 202
  Estimate Costs process, 195
  Identify Risks process, 344–345
  Perform Quantitative Risk Analysis process, 358
  Plan Cost Management process, 192
cost of quality
  Estimate Costs process, 199
  Plan Quality Management process, 234–235
cost performance index (CPI), 211
cost plus fixed-fee contract (CPFF), 402
cost plus incentive fee contract (CPIF), 402
cost-reimbursable contract, 402
cost variance (CV), 211
cost vs. budget, 190
CPFF (cost plus fixed-fee contract), 402
CPI (cost performance index), 211
CPIF (cost plus incentive fee contract), 402
crashing technique, 166
Create WBS process, 91, 98, 132, 195, 346
inputs
  enterprise environmental factors, 104
  organizational process assets, 105
  overview, 104
  project scope statement, 104
  requirements documentation, 104
  scope management plan, 104
outputs
  overview, 106
  project document updates, 108
  scope baseline, 106–107
  overview, 103–104
tools and techniques
  decomposition, 105
  expert judgment, 106
  overview, 105
critical chain method, 164
critical path method, 160–163
CV (cost variance), 211

D
data gathering and representation techniques, 359
decision tree analysis, 361
decomposition
  Create WBS process, 105
  Define Activities process, 133
defect repair, 57, 63
Define Activities process
inputs, 132
outputs
  activity attributes, 134
  activity list, 133
  milestone list, 134–135
  overview, 133
  overview, 131
tools and techniques
  decomposition, 133
  expert judgment, 133
  overview, 132
  rolling wave planning, 133
defined, 62
Define Scope process, 91, 99–103
deliverables, 110
  Control Quality process, 252
  Direct and Manage Project Work process, 56
Delphi technique, 153–154, 347
Deming, William Edwards, 232
dependency determination, 139
design of experiments tool, 240
Determine Budget process
inputs
  activity cost estimates, 202
  agreements, 203
  basis of estimates, 202
  cost aggregation, 204
  cost baseline, 205–206
  cost management plan, 192, 202
  expert judgment, 204
  funding limit reconciliation, 205
  historical relationships, 204
  overview, 201–202
  project document updates, 206–207
  project funding requirements, 206
  project schedule, 203
  reserve analysis, 204
  resource calendars, 203
  risk register, 203
  scope baseline, 202
Develop Project Charter process

Develop Project Charter process, 89
agreements, 40–41
business case, 39–40
tools and techniques, 41
expert judgment, 42
facilitation techniques, 42–43
organizational process assets, 41–42
overview, 35–38
project charter output, 43–44
SOW, 39
Develop Project Management Plan process, 89, 233, 441
expert judgment, 48–49
facilitation techniques, 49
organizational process assets, 48
outputs from other processes as inputs, 46–47
overview, 45–46
project charter input, 46
project management plan output, 50–52
Develop Project Team process, 284–294
inputs, 284–285
outputs, 294
overview, 284
tools and techniques, 285–294
collaboration, 293
ground rules, 293
interpersonal skills, 285–290
overview, 285
personnel assessment tools, 293
recognition and rewards, 293
team-building activities, 291–293
Develop Schedule process, 157–168
inputs, 158–160
outputs, 166–168
overview, 157
tools and techniques, 160–166
critical chain method, 164
critical path method, 160–163
leads and lags, 165
modeling techniques, 165
overview, 160
resource optimization techniques, 164
schedule compression, 165–166
schedule network analysis, 160
scheduling tool, 166
Direct and Manage Project Work process, 442
approved change requests, 54
change requests, 57
direct costs, 194
Delegation, 129
discretionary dependencies, 139
document analysis, 97
documentation reviews, 347

E

effective listening technique, 317
EMV (expected monetary value) analysis, 361
economic value add (EVA), 37
EF (early finish), 161
earned value management, 209–211
EAC = AC + ((BAC - EV)/(CPI × SPI)) formula, 213
EAC = AC + (BAC - EV) formula, 212
EAC = BAC/CPI formula, 212
EAC (estimate at completion), 173, 212
early finish (EF), 161
early start (ES), 161
EPEM (earned plan expected monetary) analysis, 361
EVA (Economic Value Add), 37
project management information system, 55
project management plan, 53–54
project management plan updates, 57
work performance data, 56
Enterprise environmental factors, 14
Acquire Project Team process, 280
Create WBS process, 104
Define Activities process, 132
Develop Project Charter process, 41
Develop Project Management Plan process, 47
Develop Project Team process, 294–295
Develop Schedule process, 159
Direct and Manage Project Work process, 54
Estimate Activity Duration process, 149
Estimate Activity Resources process, 144
Estimate Costs process, 196
Identify Risks process, 346
Identify Stakeholders process, 426
Manage Communications process, 321
Manage Project Team process, 300
Monitor and Control Project Work process, 61
Perform Integrated Change Control process, 68
Perform Qualitative Risk Analysis process, 353
Perform Quantitative Risk Analysis process, 358
Plan Communications Management process, 314
Plan Cost Management process, 190
Plan Human Resource Management process, 268
Plan Procurement Management process, 391
Plan Quality Management process, 233–234
Plan Risk Management process, 338–339
Plan Schedule Management process, 128
Plan Scope Management process, 89
Plan Stakeholder Management process, 432
Sequence Activities process, 136
EOI (expression of interest), 394
equation models, 62
ES (early start), 161
Estimate Activity Duration process, 346
inputs, 148–149
outputs, 155–156
overview, 147
tools and techniques
  analogous estimating, 150
  expert judgment, 149
  group decision-making techniques, 153–154
  overview, 149
  parametric estimating, 150
  reserve analysis, 154–155
  three-point estimating, 150–153
Estimate Activity Resources process, 142–146, 268
estimate at completion (EAC), 173, 212
Estimate Costs process, 278, 346
activity cost estimates, 200
analogous estimating, 197
basis of estimates, 200
bottom-up estimating, 197
cost management plan, 192, 195
cost of quality, 199
tenterprise environmental factors, 196
expert judgment, 196
group decision-making techniques, 200
human resource management plan, 195
organizational process assets, 196
overview, 193–195
parametric estimating, 197
project document updates, 200–201
project management software, 199
project schedule, 195
reserve analysis, 198–199
risk register, 196
scope baseline, 195
three-point estimating, 197–198
vendor bid analysis, 199
estimates
  accuracy of, 150
  Estimate Activity Durations process, 150–153
  Estimate Activity Resources process, 144–145
  padding, 154
  estimate to complete (ETC), 173, 213
  ETC (estimate to complete), 173, 213
ethics and professional conduct
  fairness, 458–459
  honesty, 460–461
  overview, 453–454
  respect, 457–458
  responsibility, 454–456
EVA (Economic Value Add), 37
EV (earned value), 210. See also earned value management
expected monetary value (EMV) analysis, 361
expert judgment
  Close Project or Phase process, 73
  Conduct Procurements process, 400
  Control Communications process, 326
  Control Stakeholder Engagement process, 443
  Create WBS process, 106
  Define Activities process, 133
  Define scope process, 101
  Determine Budget process, 204
  Develop Project Charter process, 42
  Develop Project Management Plan process, 48–49
  Direct and Manage Project Work process, 55
  Estimate Activity Durations process, 149
  Estimate Activity Resources process, 144
  Estimate Costs process, 196
  Identify Risks process, 349
  Identify Stakeholders process, 428
  Monitor and Control Project Work process, 61
  Perform Integrated Change Control process, 68
  Perform Qualitative Risk Analysis process, 355
  Perform Quantitative Risk Analysis process, 363
  Plan Cost Management process, 191
  Plan Human Resource Management process, 277
  Plan Procurement Management process, 393
  Plan Risk Management process, 339
exploratory study

Plan Risk Responses process, 366
Plan Schedule Management process, 129
Plan Scope Management process, 90
Plan Stakeholder Management process, 433
exploratory study, 62
expression of interest (EOI), 394
external dependencies, 139

G
Gantt (graphical analysis and numerical tracking tool), 50, 127, 166–167
Gardner grid, 427
gold plating, 66, 102
grade, 231
graphical analysis and numerical tracking tool (Gantt), 50, 127, 166–167
ground rules, 293
group creativity techniques, 95
group decision-making techniques
Collect requirements process, 96
Estimate Activity Durations process, 153–154
Estimate Costs process, 200
Validate Scope process, 110
grouping methods, 62

H
Herzberg’s Motivation-Hygiene Theory, 287
histograms, 238
historical information, 128
historical relationships, 204
honesty, 460–461
human resource management
Acquire Project Team process, 279–283
defined, 267–278
Develop Project Team process
inputs, 284–285
outputs, 294
overview, 284
tools and techniques, 285–293
Manage Project Team process
inputs, 296–297
outputs, 299–300
overview, 296
tools and techniques, 297–299
Plan Human Resource Management process
inputs, 267–268
outputs, 278
overview, 267
tools and techniques, 268–277
Human Resource Management knowledge area, 143
human resource management plan, 278
Acquire Project Team process, 279–280
Develop Project Team process, 284
Identify Risks process, 203, 233
inputs
  activity cost estimates, 345
  activity duration estimates, 346
  cost management plan, 344–345
  enterprise environmental factors, 346
  human resource management plan, 345
  organizational process assets, 346
output, 344
procurement documents, 346
project documents, 346
quality management plan, 345
risk management plan, 344
schedule management plan, 345
scope baseline, 345
stakeholder register, 346
outputs
  overview, 349
  risk register, 350
output, 343–344
tools and techniques
  checklist analysis, 348
documentation reviews, 347
  expert judgment, 349
  information-gathering techniques, 347
output, 347
SWOT analysis, 349
Identify Stakeholders process, 36, 233, 432
inputs
  enterprise environmental factors, 426
  organizational process assets, 426
output, 425
procurement documents, 426
project charter, 425
outputs
  overview, 428
  stakeholder register, 429–430
output, 425
tools and techniques
  expert judgment, 428
meetings, 428
overview, 426
stakeholder analysis, 426–428
IFB (invitation for bid), 394
impact matrix, 342
independent estimates, 400
indirect costs, 194
influence diagram, 349
influencing, 424
informal communication, 318
information-gathering techniques, 347
information management systems, 322
inputs
Acquire Project Team process, 279–280
Close Procurements process, 411
Collect requirements process, 94–95
Conduct Procurements process
  make or buy decisions, 398
  organizational process assets, 399
output, 397
procurement documents, 398
procurement management plan, 397
procurement statement of work, 398–399
project documents, 398
seller proposals, 398
source selection criteria, 398
Control Communications process, 324–325
Control Procurements process, 406
Control Quality process, 251–252
Control Risks process, 369–370
Control Schedule process, 169–170
Control Scope process, 113–114
Control Stakeholder Engagement process
  issue log, 441
output, 441
project documents, 442
project management plan, 441
work performance data, 442
Create WBS process
  enterprise environmental factors, 104
  organizational process assets, 105
output, 104
project scope statement, 104
requirements documentation, 104
scope management plan, 104
Define Activities process, 132
Define scope process
  organizational process assets, 101
output, 100
inputs

project charter, 100
requirements documentation, 100
scope management plan, 100

Develop Project Team process
human resource management plan, 284
overview, 284
project staff assignments, 285
resource calendars, 285

Develop Schedule process, 158–160

Estimate Activity Durations process
activity attributes document, 148
activity list, 148
activity resource requirements, 148
task definition, 148
enterprise environmental factors, 149
organizational process assets, 149
overview, 148
project scope statement, 148–149
resource breakdown structure, 149
resource calendars, 148
risk register, 149
schedule management plan, 148

Estimate Activity Resources process
activity attributes, 143
activity cost estimates, 144
activity list, 143
task definition, 143
enterprise environmental factors, 144
organizational process assets, 144
overview, 143
resource calendars, 143
risk register, 144
schedule management plan, 143

Identify Risks process
activity cost estimates, 345
activity duration estimates, 346
cost management plan, 344–345
task definition, 346
human resource management plan, 345
organizational process assets, 346
overview, 344
procurement documents, 346
project documents, 346
quality management plan, 345
risk management plan, 344
schedule management plan, 345
scope baseline, 345
stakeholder register, 346

Identify Stakeholders process
enterprise environmental factors, 426
organizational process assets, 426
overview, 425
procurement documents, 426
project charter, 425
Plan Schedule Management process
  enterprise environmental factors, 128
  organizational process assets, 128
  overview, 127
  project charter, 128
  project management plan, 128
Plan Scope Management process
  enterprise environmental factors, 89
  organizational process assets, 90
  overview, 89
  project charter, 89
  project management plan, 89
Plan Stakeholder Management process
  enterprise environmental factors, 432
  organizational process assets, 433
  project management plan, 432
  stakeholder register, 432
Sequence Activities process
  enterprise environmental factors, 136
  milestone list, 136
  organizational process assets, 136
  project scope statement, 136
Validate Scope process
  overview, 109
  project management plan, 109
  requirements documentation, 109
  requirements traceability matrix, 110
  verified deliverables, 110
  work performance data, 110
inspections
  Control Procurements process, 407
  Control Quality process, 252
  technique, 110
interactive communication, 317
internal dependencies, 139
Internal Rate of Return (IRR), 37
International Organization for Standardization (ISO), 2, 230
interpersonal skills
  Develop Project Team process, 285–290
  Manage Project Team process, 299
  Manage Stakeholder Engagement process, 438
interrelationship digraphs, 246
interviews, 95, 347
invitation for bid (IFB), 394
IRR (Internal Rate of Return), 37
Ishikawa diagram, 235
Ishikawa, Kaoru, 239
ISO 9000 standard, 244
ISO/IEC 15288 standard, 104
ISO (International Organization for Standardization), 2, 230
issue log
  Control Communications process, 325
  Control Stakeholder Engagement process, 441
  Manage Project Team process, 297
  Manage Stakeholder Engagement process, 439
J
JAD (joint application design/development sessions), 95
JIT (just in time), 231
joint application design/development sessions (JAD), 95
Juran, Joseph, 232, 237
just in time (JIT), 231
K
kaizen, 230
key performance indicators (KPIs), 297
kick-off meeting, 63, 433
KJ Methods diagrams, 245
KPIs (key performance indicators), 297
L
lags
  Control Schedule process, 172
  Develop Schedule process, 165
  Sequence Activities process, 139–140
late finish (LF), 161
late start (LS), 161
leads
  Control Schedule process, 172
  Develop Schedule process, 165
  Sequence Activities process, 139–140
LF (late finish), 161
linear programming, 38
litigation, 412
LS (late start), 161
lump sum contract, 402
make or buy analysis

Identify Stakeholders process, 428
make or buy analysis, 398
management of, 43
Monitor and Control Project Work process, 63
Perform Integrated Change Control process, 68–69
Plan Communications Management process, 318
Plan Cost Management process, 191
Plan Human Resource Management process, 277
Plan Procurement Management process, 393
Plan Quality Management process, 240
Plan Risk Management process, 340
Plan Schedule Management process, 129
Plan Scope Management process, 90
Plan Stakeholder Management process, 433
memorandum of understanding (MOU), 40
methodologies, of project management, 16
milestone list
  Define Activities process, 134–135
  Sequence Activities process, 136
minus sign (−), 140
modeling techniques
  Control Schedule process, 171–172
  Develop Schedule process, 165
Monitor and Control Project Work process, 253
  analytical techniques, 61–63, 73
  change requests, 63
  cost forecasts, 60
  enterprise environmental factors, 61
  expert judgment, 61
  meetings in, 63
  organizational process assets, 61
  overview, 58–59
  project document updates, 64–65
  project management information system, 63
  project management plan, 59
  project management plan updates, 64
  schedule forecasts, 60
  validated changes, 60
  work performance information, 60–61, 215
Monte Carlo analysis, 165, 172, 362
MOU (memorandum of understanding), 40
multicriteria decision analysis, 281

negotiated settlements, 412
negotiation, 281, 412
Net Present Value (NPV), 38, 360
networking, 273
n(n-1)/2 formula, 314–315
non-linear programming, 38
nonverbal communication, 317
normal distributions, 359
NPV (Net Present Value), 38, 360

O

observations
 Collect requirements process, 96
 Manage Project Team process, 298
OBS (organizational breakdown structure), 105
operations management, 11–12
Opportunity Cost, 38
organizational breakdown structure (OBS), 105
organizational charts, 268–273
organizational influences, 13–15
organizational process assets, 14
 Acquire Project Team process, 280
 Close Project or Phase process, 73
 Conduct Procurements process, 399
 Control Communications process, 325
 Control Costs process, 208
 Control Quality process, 252
 Control Schedule process, 170
 Control Scope process, 114
 Create WBS process, 105
 Define Activities process, 132
 Define scope process, 101
 Determine Budget process, 203
 Develop Project Charter process, 41–42
 Develop Project Management Plan process, 48
 Develop Schedule process, 160
 Direct and Manage Project Work process, 54
 Estimate Activity Durations process, 149
 Estimate Activity Resources process, 144
 Estimate Costs process, 196
 Identify Risks process, 346
 Identify Stakeholders process, 426
 Manage Communications process, 321
 Manage Project Team process, 297
 Manage Stakeholder Engagement process, 437
 Monitor and Control Project Work process, 61
 Perform Integrated Change Control process, 68
 Perform Quantitative Risk Analysis process, 359
Plan Communications Management process, 314
Plan Cost Management process, 190
Plan Human Resource Management process, 268
Plan Procurement Management process, 391–392
Plan Quality Management process, 234
Plan Risk Management process, 339
Plan Schedule Management process, 128
Plan Scope Management process, 90
Plan Stakeholder Management process, 433
Sequence Activities process, 136
updates to
 Close Procurements process, 413–414
 Close Project or Phase process, 74–75
 Control Communications process, 327
 Control Costs process, 216–217
 Control Procurements process, 410
 Control Quality process, 255
 Control Risks process, 372–373
 Control Schedule process, 175
 Control Scope process, 115
 Control Stakeholder Engagement process, 443–444
 Manage Communications process, 323
 Manage Project Team process, 300
 Manage Stakeholder Engagement process, 440
 Perform Quality Assurance process, 249–250
organizational project management maturity, 7
organizational strategy, 11–12
organizational theory, 274–277
Ouchi’s theory Z, 288
outputs
 Acquire Project Team process, 282–283
 Close Procurements process
 closed procurements, 413
 organizational process assets updates, 413–414
 overview, 413
 Collect requirements process
 overview, 97
 requirements documentation, 97–98
 requirements traceability matrix, 98–99
 Conduct Procurements process
 agreements, 401–403
 change requests, 403
 overview, 400–401
 project documents updates, 403–404
 project management plan updates, 403
 resource calendars, 403
 selected sellers, 400–401
Identify Stakeholders process
  overview, 428
  stakeholder register, 429–430
Manage Communications process, 322–323
Manage Project Team process, 299–300
Manage Stakeholder Engagement process
  change requests, 439
  issue log, 439
  organizational process assets updates, 440
  overview, 439
  project documents updates, 440
  project management plan updates, 439
Perform Qualitative Risk Analysis process
  overview, 355
  project documents updates, 355–356
Perform Quality Assurance process, 249–250
Perform Quantitative Risk Analysis process, 363
Plan Communications Management process, 318–319
Plan Human Resource Management process, 278
Plan Procurement Management process
  change requests, 396
  make or buy decisions, 395
  overview, 394
  procurement documents, 394–395
  procurement management plan, 394
  procurement statement of work, 394
  project documents updates, 396
  source selection criteria, 395
Plan Quality Management process, 240–242
Plan Risk Management process
  overview, 340
  risk management plan, 341–343
Plan Risk Responses process, 367
Plan Schedule Management process
  overview, 129
  schedule management plan, 129–130
Plan Scope Management process
  overview, 90
  requirements management plan, 91–92
  scope management plan, 91
Plan Stakeholder Management process
  overview, 434
  project documents updates, 434–435
  stakeholder management plan, 434
Sequence Activities process
  overview, 140
  project documents updates, 141–142
  project schedule network diagrams, 140–141
Plan Communications Management process

Validate Scope process
accepted deliverables, 111
change requests, 111
overview, 111
project documents updates, 111–112
work performance information, 111

P
padding estimates, 154
paralingual communication, 317
parametric estimating
   Estimate Activity Durations process, 150
   Estimate Costs process, 197
Pareto principle, 237
Payback Period, 38
payment systems, 408
PDCA (Plan-Do-Check-Act) cycle, 16
PDM (precedence diagramming method), 135
PDPC (process decision program chart), 246
performance reporting
   Control Procurements process, 407
   Manage Communications process, 322
performance reviews
   Control Costs process, 215
   Control Schedule process, 170–171
Perform Integrated Change Control process, 114, 254, 372, 437
   approved change requests, 54, 69
   change control tools, 69
   change log, 69
   change requests, 67–68
   enterprise environmental factors, 68
   expert judgment, 68
   meetings in, 68–69
   organizational process assets, 68
   overview, 65–67
   project document updates, 70
   project management plan, 67
   project management plan updates, 69
   work performance reports, 67
Perform Qualitative Risk Analysis process
inputs
   enterprise environmental factors, 353
   organizational process assets, 353
   overview, 352
   risk management plan, 352
risk register, 352
scope baseline, 352
outputs
   overview, 355
   project documents updates, 355–356
   overview, 351–352
tools and techniques
   expert judgment, 355
   overview, 353
   probability and impact matrix, 354
   risk categorization, 354
   risk data quality assessment, 354
   risk probability and impact assessment, 353
   risk urgency assessment, 355
Perform Quality Assurance process, 240
inputs, 244
outputs, 249–250
overview, 243–244
tools and techniques
   overview, 245
   process analysis, 249
   quality audits, 248–249
   quality management and control tools, 245–248
Perform Quantitative Risk Analysis process
inputs
   cost management plan, 358
   enterprise environmental factors, 358
   organizational process assets, 359
   overview, 358
   risk management plan, 358
   risk register, 358
   schedule management plan, 358
outputs, 363
overview, 357
tools and techniques
   data gathering and representation
      techniques, 359
   expert judgment, 363
   overview, 359
   quantitative risk analysis and modeling tech-
      niques, 360–362
personnel assessment tools, 293
PERT (Program Evaluation and Review Technique), 150, 153, 197
phases, within projects, 15
Plan Communications Management process, 437
inputs, 313–314
outputs, 318–319
Plan Cost Management process

overview, 313
tools and techniques
communications methods, 317–318
communications models, 316–317
communications requirements analysis, 314–315
communications technology, 315
meetings, 318
overview, 314

Plan Cost Management process
analytical techniques, 191
cost management plan, 192
enterprise environmental factors, 190
expert judgment, 191
meetings in, 191
organizational process assets, 190
project management plan, 189

Plan-Do-Check-Act (PDCA) cycle, 16, 232

Plan Human Resource Management process, 278
inputs, 267–268
outputs, 278
overview, 267
tools and techniques
expert judgment, 277
meetings, 277
networking, 273
organizational charts and position descriptions, 268–273
organizational theory, 274–277
planned value (PV), 209

Plan Procurement Management process, 98
inputs
activity cost estimates, 390
enterprise environmental factors, 391
organizational process assets, 391–392
overview, 389
project management plan, 389
project schedule, 390
requirements documentation, 390
risk register, 390
Stakeholder register, 390–391

outputs
change requests, 396
make or buy decisions, 395
overview, 394
procurement documents, 394–395
procurement management plan, 394
procurement statement of work, 394
project documents updates, 396
source selection criteria, 396
overview, 389
tools and techniques
expert judgment, 393
make or buy analysis, 392
market research, 393
meetings, 393
overview, 392

Plan Quality Management process, 98
inputs, 233–234
outputs, 240–242
overview, 232–233
tools and techniques
additional quality planning tools, 240
benchmarking, 235–239
cost-benefit analysis, 234
cost of quality, 234–235
design of experiments, 240
design of experiments tool, 240
meetings, 240
overview, 234
seven basic quality tools, 235–239
statistical sampling, 240

Plan Risk Management process
inputs
enterprise environmental factors, 338–339
organizational process assets, 339
overview, 338
project charter, 338
project management plan, 338
stakeholder register, 338

outputs
overview, 340
risk management plan, 341–343
overview, 338
tools and techniques
analytical techniques, 339
expert judgment, 339
meetings, 340
overview, 339

Plan Risk Responses process
inputs
overview, 364
risk management plan, 364
risk register, 365

outputs, 367
overview, 364
tools and techniques
contingent response strategies, 366
expert judgment, 366
Plan Schedule Management process
inputs
enterprise environmental factors, 128
organizational process assets, 128
overview, 127
project charter, 128
project management plan, 128
outputs
overview, 129
schedule management plan, 129–130
overview, 127
tools and techniques
analytical techniques, 129
expert judgment, 129
meetings, 129
overview, 128

Plan Scope Management process
inputs
enterprise environmental factors, 89
organizational process assets, 90
overview, 89
project charter, 89
project management plan, 89
outputs
overview, 90
requirements management plan, 91–92
scope management plan, 91
overview, 88
tools and techniques, 90

Plan Stakeholder Management process, stakeholder management
inputs
enterprise environmental factors, 432
organizational process assets, 433
overview, 432
project management plan, 432
stakeholder register, 432
outputs
overview, 434
project documents updates, 434–435
stakeholder management plan, 434
overview, 431
tools and techniques
analytical techniques, 433–434
expert judgment, 433
meetings, 433
overview, 433
plus sign (+), 140
PMBOK® Guide, 2–4
PMI Code of Ethics and Professional Conduct, 453–454
PMI (Project Management Institute), 7, 48, 453
PMO (Project Management Office), 7, 42
PMP (Project Management Professional) certification, 4
point of total assumption (PTA), 402–403
portfolio manager, 270
portfolios, 5–8
preassignment, 280
precedence diagramming method (PDM), 135, 137–138
precision, 230
predecessor relationship, 137
Present Value, 37
preventive action, 57, 63
prioritization matrices, 247
proactive, 436
probability and impact matrix, 342, 354
probability distributions, 359
process analysis, 249
process decision program chart (PDPC), 246
process improvement plan
Perform Quality Assurance process, 244
Plan Quality Management process, 241
procurement agreement, 401
procurement audits, 412
procurement documents
Close Procurements process, 411
Conduct Procurements process, 398
Control Procurements process, 406
Identify Risks process, 346
Identify Stakeholders process, 426
Plan Procurement Management process, 394–395
procurement management plan

overview, 405
tools and techniques, 407–409
defined, 388
overview, 387
Plan Procurement Management process
inputs, 389–392
outputs, 394–396
overview, 389
tools and techniques, 392–393
procurement management plan
  Conduct Procurements process, 397
  Plan Procurement Management process, 394
procurement negotiations, 400–401
procurement performance reviews, 407
procurement statement of work
  Conduct Procurements process, 398–399
  Plan Procurement Management process, 394
product analysis, 101
Program Evaluation and Review Technique (PERT), 150, 153, 197
program manager, 270
program of projects, 5–8
progressive elaboration, 9
project calendars
  Control Schedule process, 170
  Develop Schedule process, 167
project charter
  Collect requirements process, 94
  Define scope process, 100
  Develop Project Charter process, 43–44
  Develop Project Management Plan process, 46
  Identify Stakeholders process, 425
  Plan Cost Management process, 190
  Plan Risk Management process, 338
  Plan Schedule Management process, 128
  Plan Scope Management process, 89
project communications
  Control Communications process, 325
  Manage Communications process, 322
Project Communications management group, 18
project coordinator, 269
project cost management
  Control Costs process
    change requests, 216
costs forecasts, 216
earned value management, 209–211
forecasting, 212–214
organizational process assets, 208
organizational process assets updates, 216–217
overview, 207
performance reviews, 215
project document updates updates, 216
project funding requirements, 208
project management plan, 208
project management software, 215
reserve analysis, 215
TCPI, 214
work performance data, 208
work performance information, 215
Determine Budget process
  activity cost estimates, 202
  agreements, 203
  basis of estimates, 202
cost aggregation, 204
cost baseline, 205–206
cost management plan, 202
  expert judgment, 204
funding limit reconciliation, 205
historical relationships, 204
organizational process assets, 203
overview, 201–202
project document updates, 206–207
project funding requirements, 206
project schedule, 203
reserve analysis, 204
resource calendars, 203
risk register, 203
scope baseline, 202
Estimate Costs process, 200–201
  activity cost estimates, 200
  analogous estimating, 197
  basis of estimates, 200
cost aggregation, 197
bottom-up estimating, 197
cost management plan, 195
cost of quality, 199
expert judgment, 196
group decision-making techniques, 200
human resource management plan, 195
organizational process assets, 196
overview, 193–195
parametric estimating, 197
project management software, 199
project schedule, 195
reserve analysis, 198–199
risk register, 196
scope baseline, 195
three-point estimating, 197–198
vendor bid analysis, 199
overview, 187–188, 189
Plan Cost Management process
analytical techniques, 191
cost management plan, 192
enterprise environmental factors, 190
expert judgment, 191
meetings in, 191
organizational process assets, 190
overview, 189
project charter, 190
project management plan, 189
Project Cost management group, 18
project documents
Conduct Procurements process, 398
Control Quality process, 252
Control Stakeholder Engagement process, 442
Identify Risks process, 346
Perform Quality Assurance process, 244
project document updates
Control Costs process, 216
Determine Budget process, 206–207
Direct and Manage Project Work process, 57–58
Estimate Costs process, 200–201
Monitor and Control Project Work process, 64–65
Perform Integrated Change Control process, 70
project expeditor, 269
project funding requirements
Control Costs process, 208
Determine Budget process, 206
Project Human Resource management group, 18
project integration management
Close Project or Phase process
accepted deliverables, 73
analytical techniques, 73
expert judgment, 73
final product, service, or result transition, 74
meetings in, 73
organizational process assets, 73
organizational process assets updates, 74–75
overview, 70–72
project management plan, 72
Develop Project Charter process
agreements, 40–41
business case, 39–40
enterprise environmental factors, 41
expert judgment, 42
facilitation techniques, 42–43
organizational process assets, 41–42
overview, 35–38
project charter output, 43–44
SOW, 39
Develop Project Management Plan process
enterprise environmental factors, 47
expert judgment, 48–49
facilitation techniques, 49
organizational process assets, 48
outputs from other processes as inputs, 46–47
overview, 45
project charter input, 46
project management plan output, 50–52
Direct and Manage Project Work process
approved change requests, 54
change requests, 57
deliverables, 56
enterprise environmental factors, 54
expert judgment, 55
meetings in, 55
organizational process assets, 54
overview, 52–53
project document updates, 57–58
project management information system, 55
project management plan, 53–54
project management plan updates, 57
work performance data, 56–57
Monitor and Control Project Work process
analytical techniques, 61–63
change requests, 63
cost forecasts, 60
enterprise environmental factors, 61
expert judgment, 61
meetings in, 63
organizational process assets, 61
overview, 58–59
project document updates, 64–65
project management information system, 63
project management plan, 59
project management plan updates, 64
schedule forecasts, 60
validated changes, 60
work performance information, 60–61
overview, 31–33
Perform Integrated Change Control process
approved change requests, 69
change control tools, 69
Project Integration management group

change log, 69
change requests, 67–68
enterprise environmental factors, 68
expert judgment, 68
meetings in, 68–69
organizational process assets, 68
overview, 65–67
project document updates, 70
project management plan, 67
project management plan updates, 69
work performance reports, 67
Project Integration management group, 17
projectized organizations, 275
project life cycle, 15–19
project management
  organizational influences on, 13–15
  overview, 8–10
  versus operations management, 11
project management information system
  Direct and Manage Project Work process, 55
  Monitor and Control Project Work process, 63
Project Management Institute (PMI), 7, 48, 97, 453
project management methodologies, 16
Project Management Office (PMO), 7, 42
project management plan
  Close Procurements process, 411
  Close Project or Phase process, 72
  Control Communications process, 324
  Control Costs process, 208
  Control Procurements process, 406
  Control Risks process, 369
  Control Schedule process, 169
  Control Scope process, 113
  Control Stakeholder Engagement process, 441
  Develop Project Management Plan process, 50–52
  Direct and Manage Project Work process, 53–54
  Monitor and Control Project Work process, 59
  Perform Integrated Change Control process, 67
  Plan Communications Management process, 314
  Plan Human Resource Management process, 267
  Plan Procurement Management process, 389
  Plan Quality Management process, 233
  Plan Risk Management process, 338
  Plan Schedule Management process, 128
  Plan Scope Management process, 89
  Plan Stakeholder Management process, 432
  updates to
    Acquire Project Team process, 282–283
    Conduct Procurements process, 403
  Control Costs process, 216
  Control Procurements process, 409
  Control Quality process, 254
  Control Risks process, 372
  Control Schedule process, 174
  Control Scope process, 115
  Develop Schedule process, 168
  Direct and Manage Project Work process, 57
  Manage Communications process, 323
  Manage Project Team process, 300
  Manage Stakeholder Engagement process, 439
  Monitor and Control Project Work process, 64
  Perform Quality Assurance process, 249
  Plan Risk Responses process, 367
  Validate Scope process, 109
Project Management Professional (PMP) certification, 4
project management software
  Control Costs process, 215
  Control Schedule process, 171
  Estimate Activity Resources process, 145
  Estimate Costs process, 199
project manager, 268
project mandate, 43
project performance appraisals, 298
project phases, 15
project procurement management. See procurement management
Project Procurement management group, 19
Project Quality management group, 18
Project Risk management group, 18
projects, 5–8
project schedule
  Control Schedule process, 170
  Determine Budget process, 203
  Develop Schedule process, 166–167
  Estimate Costs process, 195
  Plan Procurement Management process, 390
project schedule network diagrams
  Develop Schedule process, 158
  Sequence Activities process, 140–141
Project Scope management. See Scope management
Project Scope management group, 17
project scope statement
  Create WBS process, 104
  Define scope process, 102
  Develop Schedule process, 159
  Estimate Activity Durations process, 148–149
  Sequence Activities process, 136
project selection process, 36
requirements traceability matrix

project sponsor, 271
project staff assignments
  Acquire Project Team process, 282
  Develop Project Team process, 285
  Develop Schedule process, 159
  Manage Project Team process, 297
Project Stakeholder Identification Management, 36
project stakeholder management. See stakeholder management
Project Stakeholder management group, 19
project steering committee, 271
Project Time management group, 18
proposal evaluation techniques, 400
prototypes, 96
PTA (point of total assumption), 402–403
published estimating data, 144–145
pull communication, 317, 438
push communication, 317, 438
PV (planned value), 209

Q
QFD (quality function deployment), 95
qualitative risk analysis, 352
quality, 231
quality audits, 248–249
quality checklists
  Control Quality process, 251
  Plan Quality Management process, 242
quality control measurements
  Control Quality process, 253
  Perform Quality Assurance process, 244
quality function deployment (QFD), 95
quality management, 232
  Control Quality process, 250–255
  defined, 230–232
  overview, 229
  Perform Quality Assurance process
    inputs, 244
    outputs, 249–250
    overview, 243–244
    tools and techniques, 245–249
Plan Quality Management process
  inputs, 233–234
  outputs, 240–242
  overview, 232–233
  tools and techniques, 234–240
quality management plan, 232
  Control Quality process, 251
  Identify Risks process, 345
  Perform Quality Assurance process, 244
  Plan Quality Management process, 241
quality metrics
  Control Quality process, 251
  Perform Quality Assurance process, 244
  Plan Quality Management process, 242
quality planning tools, 240
quantitative risk analysis and modeling techniques, 360–362
questionnaires and surveys, 96

R
RACI chart, 273
RAM (responsibility assignment matrix), 273
RBS (resource breakdown structure), 105
RBS (risk breakdown structure), 105, 341, 354
recognition, 293
records management system
  Close Procurements process, 413
  Control Procurements process, 408–409
regression analysis, 62
reporting systems
  Control Communications process, 326
  Control Stakeholder Engagement process, 442
request for information (RFI), 394
request for proposal (RFP), 394
request for quotation (RFQ), 394
requirements, defined, 93
requirements documentation
  Collect requirements process, 97–98
  Control Scope process, 113
  Create WBS process, 104
  Define scope process, 100
  Plan Procurement Management process, 390
  Plan Quality Management process, 233
  Validate Scope process, 109
requirements management plan
  Collect requirements process, 94
  Plan Scope Management process, 91–92
requirements traceability matrix
  Collect requirements process, 98–99
  Control Scope process, 113
  Validate Scope process, 110
reserve analysis

Control Costs process, 215
Control Risks process, 371
defined, 62
Determine Budget process, 204
Estimate Activity Durations process, 154–155
Estimate Costs process, 198–199
resource breakdown structure (RBS), 105
Develop Schedule process, 159
Estimate Activity Durations process, 149
Estimate Activity Resources process, 145–146
resource calendars
Acquire Project Team process, 282
Conduct Procurements process, 403
Determine Budget process, 203
Develop Project Team process, 285
Develop Schedule process, 158
Estimate Activity Durations process, 148
Estimate Activity Resources process, 143
resource leveling, 164
resource optimization techniques
Control Schedule process, 171
Develop Schedule process, 164
resource smoothing, 164
respect, 457–458
responsibility, 454–456
responsibility assignment matrix (RAM), 273
Return on Invested Capital (ROIC), 38
Return on Investment (ROI), 38
rewards, 293
RFI (request for information), 394
RFP (request for proposal), 394
RFQ (request for quotation), 394
risk audits, 370
risk breakdown structure (RBS), 105, 341, 354
risk categorization, 354
risk data quality assessment, 354
risk management
Control Risks process
inputs, 369–370
outputs, 372–373
overview, 368
tools and techniques, 370–371
defined, 336–337
Identify Risks process
inputs, 344–346
outputs, 350
overview, 343–344
tools and techniques, 347–349
overview, 335
Perform Qualitative Risk Analysis process
inputs, 352–353
outputs, 355–356
overview, 351–352
tools and techniques, 353–355
Perform Quantitative Risk Analysis process
inputs, 358–359
outputs, 363
overview, 357
tools and techniques, 359–363
Plan Risk Management process
inputs, 338–339
outputs, 341–343
overview, 338
tools and techniques, 339–341
Plan Risk Responses process
inputs, 364–365
outputs, 367
overview, 364
tools and techniques, 366
Risk Management knowledge area, 233
risk management plan
Identify Risks process, 344
Perform Qualitative Risk Analysis process, 352
Perform Quantitative Risk Analysis process, 358
Plan Risk Management process, 341–343
Plan Risk Responses process, 364
risk probability and impact assessment, 353
risk reassessment, 370
risk register
Control Risks process, 369
Determine Budget process, 203
Develop Schedule process, 159
Estimate Activity Durations process, 149
Estimate Activity Resources process, 143
Estimate Costs process, 196
Identify Risks process, 350
Perform Qualitative Risk Analysis process, 352
Perform Quantitative Risk Analysis process, 358
Plan Procurement Management process, 390
Plan Quality Management process, 233
Plan Risk Responses process, 365
risk tolerance, 336
risk urgency assessment, 353
ROIC (Return on Invested Capital), 38
ROI (Return on Investment), 38
rolling wave planning, 9, 133
rule of seven, 238
salience model, 427–428
scatter diagrams, 239
schedule baseline, 166
schedule compression, 165–166, 172
schedule data
  Control Schedule process, 170
  Develop Schedule process, 167
schedule forecasts
  Control Schedule process, 173–174
  Monitor and Control Project Work process, 60
schedule management plan
  Define Activities process, 132
  Develop Schedule process, 158
  Estimate Activity Durations process, 148
  Estimate Activity Resources process, 143
  Identify Risks process, 345
  Perform Quantitative Risk Analysis process, 358
  Plan Schedule Management process, 129–130
  Sequence Activities process, 136
schedule network analysis, 160
schedule performance index (SPI), 173, 211
schedule variance (SV), 173, 211
scheduling tool
  Control Schedule process, 172
  Develop Schedule process, 166
scope baseline
  Create WBS process, 106–107
  Define Activities process, 132
  Determine Budget process, 202
  Estimate Costs process, 195
  Identify Risks process, 345
  Perform Qualitative Risk Analysis process, 352
scope creep, 66, 102
scope management
  Collect requirements process
    inputs, 94–95
    outputs, 97–99
    overview, 93–94
    tools and techniques, 95–97
  Control Scope process
    inputs, 113–114
    outputs, 114
    overview, 112–113
    tools and techniques, 114
  Create WBS process
    inputs, 104–105
    outputs, 106–108
    overview, 103–104
    tools and techniques, 105–106
defined, 86–88
Define scope process
  inputs, 100–101
  outputs, 102–103
  overview, 99–100
  tools and techniques, 101
  overview, 85
Plan Scope Management process
  inputs, 89–90
  outputs, 90–92
  overview, 88
  tools and techniques, 90
Validate Scope process
  inputs, 109–110
  outputs, 111–112
  overview, 108–109
  tools and techniques, 110
Scope Management knowledge area, 233
scope management plan
  Collect requirements process, 94
  Create WBS process, 104
  Define scope process, 100
  Plan Scope Management process, 91
S-curve, 205
SD (standard deviations), 151–152
selected sellers, 400–401
seller proposals, 398
sellers, 388
sensitivity analysis, 360
Sequence Activities process
  inputs, 136–137
  outputs
    overview, 140
    project documents updates, 141–142
    project schedule network diagrams, 140–141
    overview, 135–136
    tools and techniques
      applying leads and lags, 139–140
      dependency determination, 139
      overview, 137
      precedence diagramming method, 137–138
SF (start-to-finish) relationship, 138
simple average, 197
SIPOC (Suppliers, Inputs, Process, Outputs, and Customers), 236
Six Sigma, 152, 231
slack, 160–161
source selection criteria

- Conduct Procurements process, 398
- Plan Procurement Management process, 395
- SOW (statement of work), 39
- specification limit, 238
- SPI (schedule performance index), 173, 211
- SS (start-to-start) relationship, 138
- staffing management plan, 278
- stakeholder analysis, 426–428
- stakeholder engagement assessment matrix, 433–434
- stakeholder management
  - Control Stakeholder Engagement process
    - inputs, 441–442
    - outputs, 443–444
    - overview, 441
    - tools and techniques, 442–443
  - defined, 424–425
  - Identify Stakeholders process
    - inputs, 426
    - outputs, 428–430
    - overview, 425
    - tools and techniques, 426–428
  - Manage Stakeholder Engagement process
    - inputs, 439–440
    - overview, 436
    - tools and techniques, 437–439
    - overview, 423
  - Plan Stakeholder Management process
    - inputs, 432–433
    - outputs, 434–435
    - tools and techniques, 433–434
- Stakeholder Management knowledge area, 233
- stakeholder management plan
  - Collect requirements process, 94
  - Manage Stakeholder Engagement process, 437
  - Plan Stakeholder Management process, 434
- stakeholder register
  - Collect requirements process, 95
  - Identify Risks process, 346
  - Identify Stakeholders process, 429–430
  - Plan Procurement Management process, 390–391
  - Plan Quality Management process, 233
  - Plan Risk Management process, 338
  - Plan Stakeholder Management process, 432
- stakeholder risk profile analysis, 339
- stakeholders, 424
- standard deviations (SD), 151–152
- start-to-finish (SF) relationship, 138
- start-to-start (SS) relationship, 138
- statement of work (SOW), 39
- statistical sampling, 240
- status meetings, 371
- strategies for negative risks or threats, 365
- strategies for positive risks or opportunities, 366
- strong matrix organization, 275
- successor relationship, 137
- sunk costs, 194
- Suppliers, Inputs, Process, Outputs, and Customers (SIPOC), 236
- SV (schedule variance), 173, 211
- SWOT analysis, 349
- T
- tailoring, 3
- TCPI (to-complete performance index), 214
- team-building activities, 291–293
- team performance assessments
  - Develop Project Team process, 294
  - Manage Project Team process, 297
- technical performance measurement, 371
- techniques. See tools and techniques
- three-point estimating
  - Estimate Activity Durations process, 150–153
  - Estimate Costs process, 197–198
- time and material contract (T&M), 402
- time management
  - Control Schedule process
    - inputs, 169–170
    - outputs, 173–175
    - overview, 169
  - Define Activities process
    - inputs, 132
    - outputs, 133–135
    - overview, 131
    - tools and techniques, 132–133
  - defined, 126–127
  - Develop Schedule process
    - inputs, 158–160
    - outputs, 166–168
    - overview, 157
    - tools and techniques, 160–166
  - Estimate Activity Durations process
    - inputs, 148–149
    - outputs, 155–156
    - overview, 147
Estimate Activity Resources process
inputs, 143–144
outputs, 145–146
overview, 142–143
tools and techniques, 144–145
overview, 125
Plan Schedule Management process
inputs, 127–128
outputs, 129–131
overview, 127
tools and techniques, 128–129
Sequence Activities process
outputs, 140–142
overview, 135–136
tools and techniques, 137–140
T&M (time and material) contract, 402
tools and techniques
Acquire Project Team process, 280–281
Close Procurements process
negotiated settlements, 412
overview, 412
procurement audits, 412
records management system, 413
Collect requirements process
benchmarking, 97
collection diagrams, 97
document analysis, 97
facilitated workshops, 95
focus groups, 95
group creativity techniques, 95
group decision-making techniques, 96
interviews, 95
observations, 96
overview, 95
prototypes, 96
questionnaires and surveys, 96
Conduct Procurements process
advertising, 400
analytical techniques, 400
bidder conference, 399–400
expert judgment, 400
independent estimates, 400
overview, 399
procurement negotiations, 400–401
proposal evaluation techniques, 400
Control Communications process, 325–326
Control Procurements process
claims administration, 408
contract change control system, 407
inspections and audits, 407
overview, 407
payment systems, 408
performance reporting, 407
procurement performance reviews, 407
records management system, 408–409
Control Quality process, 252–253
Control Risks process
overview, 370
reserve analysis, 371
risk audits, 370
risk reassessment, 370
status meetings, 371
technical performance measurement, 371
variance and trend analysis, 370
Control Schedule process, 170–172
Control Scope process, 114
Control Stakeholder Engagement process
expert judgment, 443
meetings, 443
overview, 442
reporting systems, 442
Create WBS process
decomposition, 105
expert judgment, 106
overview, 105
Define Activities process
decomposition, 133
expert judgment, 133
overview, 132
rolling wave planning, 133
Define scope process, 101
Develop Project Team process
interpersonal skills, 285–290
overview, 285
personnel assessment tools, 293
recognition and rewards, 293
team-building activities, 291–293
Develop Schedule process
critical path method, 160–163
leads and lags, 165
modeling techniques, 165
resource optimization techniques, 164
schedule compression, 165–166
schedule network analysis, 160
scheduling tool, 166
Estimate Activity Durations process
analogous estimating, 150
expert judgment, 149
group decision-making techniques, 153–154
overview, 149
parametric estimating, 150
reserve analysis, 154–155
three-point estimating, 150–153
tools and techniques, 149–155
Estimate Activity Resources process
alternative analysis, 144
bottom-up estimating, 145
expert judgment, 144
overview, 144
project management software, 145
published estimating data, 144–145
Identify Risks process
documentation reviews, 347
expert judgment, 349
information-gathering techniques, 347
overview, 347
SWOT analysis, 349
Identify Stakeholders process
expert judgment, 428
meetings, 428
overview, 426
stakeholder analysis, 426–428
Manage Communications process, 321–322
Manage Project Team process, 297–299
Manage Stakeholder Engagement process
communications methods, 438
interpersonal skills, 438
management skills updates, 439
overview, 437
Perform Qualitative Risk Analysis process
expert judgment, 355
overview, 353
probability and impact matrix, 354
risk categorization, 354
risk data quality assessment, 354
risk probability and impact assessment, 353
risk urgency assessment, 355
Perform Quality Assurance process
control tools, 245–248
overview, 245
process analysis, 249
quality audits, 248–249
Perform Quantitative Risk Analysis process
data gathering and representation
techniques, 359
expert judgment, 363
overview, 359
quantitative risk analysis and modeling
techniques, 360–362
Plan Communications Management process
communications methods, 316–318
communications models, 316–317
communications requirements analysis, 314–315
communications technology, 315
meetings, 318
overview, 314
Plan Human Resource Management process
meetings, 277
networking, 273
organizational charts and position descriptions, 268–273
organizational theory, 274–277
overview, 268
Plan Procurement Management process
expert judgment, 393
make or buy analysis, 392
market research, 393
meetings, 393
overview, 392
Plan Quality Management process
basic tools, 235–239
benchmarking, 235–239
cost-benefit analysis, 234
cost of quality, 234–235
meetings, 240
overview, 234
quality planning tools, 240
statistical sampling, 240
Plan Risk Management process
analytical techniques, 339
expert judgment, 339
meetings, 340
overview, 339
Plan Risk Responses process
contingent response strategies, 366
expert judgment, 366
overview, 365
strategies for negative risks or threats, 365
strategies for positive risks or opportunities, 366
Plan Schedule Management process
analytical techniques, 129
expert judgment, 129
meetings, 129
overview, 128
Plan Scope Management process, 90
Plan Stakeholder Management process
   analytical techniques, 433–434
   expert judgment, 433
   meetings, 433
   overview, 433
Sequence Activities process
   applying leads and lags, 139–140
   dependency determination, 139
   overview, 137
   precedence diagramming method (PDM), 137–138
Validate Scope process, 110
   tornado diagrams, 360
   total float, 160
   TQM (total quality management), 231
tree diagram, 247
trend analysis, 62, 171
triangular distributions, 359
   Tuckman five-stage model, 291

U
   uniform distributions, 359
updates
   change request type, 57
enterprise environmental factors
   Develop Project Team process, 294–295
   Manage Project Team process, 300
organizational process assets, 74–75
   Close Procurements process, 413–414
   Control Communications process, 327
   Control Costs process, 216–217
   Control Procurements process, 410
   Control Quality process, 255
   Control Risks process, 372–373
   Control Schedule process, 175
   Control Scope process, 115
   Control Stakeholder Engagement process, 443–444
   Manage Communications process, 323
   Manage Project Team process, 300
   Manage Stakeholder Engagement process, 440
   Perform Quality Assurance process, 249–250
project document
   Control Scope process, 115
   Create WBS process, 108
   Define scope process, 102–103
   Validate Scope process, 111–112
project documents
   Conduct Procurements process, 403–404
   Control Communications process, 327
   Control Procurements process, 410
   Control Quality process, 255
   Control Schedule process, 174
   Control Stakeholder Engagement process, 443
   Develop Schedule process, 168
   Estimate Activity Durations process, 155–156
   Estimate Activity Resources process, 146
   Manage Communications process, 323
   Manage Project Team process, 300
   Manage Stakeholder Engagement process, 440
   Perform Qualitative Risk Analysis process, 355–356
   Perform Quality Assurance process, 249
   Perform Quantitative Risk Analysis process, 363
   Plan Communications Management process, 319
   Plan Procurement Management process, 396
   Plan Quality Management process, 242
   Plan Risk Responses process, 367
   Plan Stakeholder Management process, 434–435
   Sequence Activities process, 141–142
   updates, Control Risks process, 372
project management plan
   Acquire Project Team process, 282–283
   Conduct Procurements process, 403
   Control Costs process, 216
   Control Procurements process, 409
   Control Quality process, 254
   Control Risks process, 372
   Control Schedule process, 174
   Control Scope process, 115
   Develop Schedule process, 168
   Manage Communications process, 323
   Manage Project Team process, 300
   Manage Stakeholder Engagement process, 439
   Monitor and Control Project Work process, 64
   Perform Quality Assurance process, 249
   Plan Risk Responses process, 367
VAC (variance at completion), 213
validated changes
  Control Quality process, 253–254
  Monitor and Control Project Work process, 60
validated deliverables, 254
Validate Scope process, 91, 98, 254
inputs
  overview, 109
  project management plan, 109
  requirements documentation, 109
  requirements traceability matrix, 110
  verified deliverables, 110
  work performance data, 110
outputs
  accepted deliverables, 111
  change requests, 111
  overview, 111
  project documents updates, 111–112
  work performance information, 111
overview, 108–109
tools and techniques, 110
validation vs. verification, 60
values
  fairness, 458–459
  honesty, 460–461
  respect, 457–458
  responsibility, 454–456
variable costs, 193
variance
  analysis, 114, 370
  calculating, 153
variance at completion (VAC), 213
vendor bid analysis, 199
verification vs. validation, 60
verified deliverables, 110
virtual teams, 281
Vroom's Expectancy Theory, 287

W
war room, 293
WBS (work breakdown structure), 104–107, 193, 195, 202, 272, 346
weak matrix organization, 275
weighted average, 197
what-if scenario analysis, 165, 172
whistleblower, 455
workaround, 366
work breakdown structure (WBS), 104–107, 193, 195, 202, 272, 346
work order, 43
work packages, 105
work performance data
  Control Communications process, 325
  Control Costs process, 208
  Control Procurements process, 406
  Control Quality process, 251
  Control Risks process, 369
  Control Schedule process, 170
  Control Scope process, 113
  Control Stakeholder Engagement process, 442
  Direct and Manage Project Work process, 56
  Validate Scope process, 110
work performance information
  Control Communications process, 326
  Control Costs process, 215
  Control Procurements process, 409
  Control Quality process, 254
  Control Risks process, 371
  Control Schedule process, 173
  Control Scope process, 114
  Control Stakeholder Engagement process, 443
  Monitor and Control Project Work process, 60–61
  Validate Scope process, 111
work performance reports
  Control Procurements process, 406
  Manage Communications process, 320
  Manage Project Team process, 297
  Perform Integrated Change Control process, 67
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.
Now that you’ve read the book...

Tell us what you think!

Was it useful?
Did it teach you what you wanted to learn?
Was there room for improvement?

Let us know at http://aka.ms/tellpress

Your feedback goes directly to the staff at Microsoft Press, and we read every one of your responses. Thanks in advance!
Get more practice with MeasureUp® & ace the exam!

You’ve practiced — but have you practiced enough? The disk included with this book has dozens of quality questions from the publisher to get you started. MeasureUp offers additional practice tests with more than 100 new and different questions at MeasureUp.com. And when you use our practice test you’ll pass — guaranteed.

- Performance-based simulation questions – similar to the ones found on Microsoft exams – are available online and via download.
- Study Mode helps you review the material with detailed answers and references to help identify areas where you need more study.
- Certification Mode simulates the timed test environment.


Save 20% on MeasureUp Practice Tests!

Prepare for your IT Pro, Developer or Office certification exams with MeasureUp Practice Tests and you’ll be ready to pass, we guarantee it. Save 20% on MeasureUp Practice Tests when you use this coupon code at checkout:

Coupon Code: MSP020112

www.measureup.com

*excludes VMware