12 Risks and Issues

QUICKTEST

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Introduction

The impact of risk management is integral to a project manager's daily work and the exam will test your knowledge of risk management at a sophisticated level. For example, you may be given a situation and, based on the information provided, need to determine which risk management process is being performed or what should be done next.

Before we look at the risk management process in detail, let's start with a story. An RMC student was a project manager on a hardware and software installation project in an area where hurricanes are a relatively frequent occurrence. Then a hurricane struck. Not long after the hurricane was over, the project manager told people what a great job his team had done and how quickly they had recovered from the disaster.

> **Think About It.** Would you have been proud of yourself if you were the project manager? As you answer, consider the following information:
>
> - The activity the team was working on required three days to complete.
> - The project manager had warning that the hurricane was coming.
> - They had to recover from the disaster.

Instead of being excited about how quickly his team was able to recover from the hurricane, the project manager—and the sponsor—should have questioned the wisdom of scheduling the implementation at a time when there was a strong probability of a hurricane. Or, if the scheduling had already been completed, they should have questioned the wisdom of keeping to that schedule. This is the value of risk management. When a hurricane was forecast the team could have responded according to a plan, such as moving the implementation to another weekend to avoid the danger, damage, and rework that was likely to result.

A project manager's work should focus on preventing problems rather than on dealing with them. Think about your own projects. How would it feel if you could say, "No problem; we anticipated this, and we have a plan in place that will resolve it whenever a problem occurs"? How much time and money would you save that would have otherwise been spent addressing the problem? How much less stress would you have in your life?

Projects inherently include uncertainty, volatility, complexity, and ambiguity (discussed in the Uncertainty Domain in the *PMBOK® Guide*). Project risk management helps prevent many threats (or negative risks) and make others less likely or less impactful. And it helps to increase the probability and/or impact of opportunities (positive risks). When the project manager eliminates threats and increases opportunities, schedule and cost estimates can be decreased. With that in mind, we'll look at some of the basic risk management concepts.

Definitions Related to Risk Management

Here is some basic vocabulary that will be used in this chapter.

Project Risk

A probable event that, if it occurs, will negatively or positively affect one or more project constraints. A risk can affect the project team's ability deliver the value for which the project was chartered and meet the agreed-upon budget, schedule, and quality requirements.

Project Risk Management

This is the process of identifying, evaluating, and planning responses to uncertain events that might occur during the course of a project. The project manager identifies risks and begins to manage them in initiating and planning. While the project is underway the project manager and the team frequently look at what uncertain events have happened or may soon happen, and reassess the planned risk strategy.

Watch List

This is a list of risks that currently do not warrant planned risks responses, but it is understood that any of these risks could become more probable and need a planned response.

Risk Owner

An individual who watches out for the occurrence of an assigned risk and leads the implementation of preplanned responses.

Threats and Opportunities

A risk event can have positive or negative impacts on the project if it happens. We often focus on threats, which are things that can go wrong. But there can also be opportunities on projects—positive impacts that may allow the project manager and team to deliver even more value to the organization and customer than planned.

Opportunities can include such things as:

- If we can combine orders for the ZYX equipment, buy more than 20 items at once, we could decrease the cost by 20 percent.
- If we can train the team to improve efficiency, then work package number 3.4 (and possibly others) could be completed two days faster than expected.
- If we can obtain a more experienced resource with a higher level of productivity, then the critical path activity 4.7.2 could be done 10 percent faster.

Projects have the potential for many opportunities, and the vast majority of identified threats can be mitigated or eliminated by changing how the work is planned and performed. There are strategies that may reduce threats and even create opportunities; for example, careful resource optimization, using the most experienced people possible and providing training as needed.

Even though threats are what we often think about when we hear the word "risk," for the exam remember there is as much likelihood that you'll see questions related to opportunities. The iterative nature of project management methods also requires a continuous attention to updating the risk management plan. Risk identification and planning is ongoing throughout a project.

Think About It. The concept of risk is so closely related to value that we can think of negative project risks (threats) as "anti-value"—factors that have the potential to erode, remove, or reduce value if they occur. Think of the value you create with your project as money you bring into the household budget. You plan to accrue value in the budget with work effort (resulting in paychecks). Threats that actually occur like an unexpected expense remove money from the budget so it now has less value. An unexpected bonus, however, can potentially increase the value of the budget. To create the most value, you maximize monetary flow into the budget (opportunities) and minimize unexpected outflow (threats).

Risk Factors

When assessing risk, the project manager needs to determine the:

- Probability that a risk event will occur (how likely)
- Range of possible outcomes (impact or amount at stake)
- Expected timing for it to occur in the project life cycle (when)
- Anticipated frequency of risk events from that source (how often)

Risk Appetites and Thresholds

These terms refer to the level of risk an individual or group is willing to accept.

- **Risk appetite** Also referred to as risk tolerance, this is a general description of the level of risk acceptable to an individual or an organization.

  Example A sponsor may be willing to accept little risk to the schedule on a project. This may (and should) make the sponsor more flexible with cost since adding resources can compress the schedule (this is known as "crashing").

- **Risk threshold** This refers to the specific point at which risk becomes unacceptable.

  Example The sponsor will not accept the risk of a schedule delay of 15 days or longer.

- **Risk averse** This term describes an individual or organization with a very low appetite for the negative impact of threats.

Risk appetites and thresholds vary and can include any project constraint (scope, schedule, cost, etc.), as well as risks to reputation, customer satisfaction, and other intangibles depending on the individual or organization.

Example An organization may have more tolerance for cost-related risks than for risks that affect customer satisfaction or their reputation in the marketplace.

When answering exam questions related to risk response strategies, look for information about individual and organizational risk appetites and thresholds.

Risk Definitions Specific to Agile

Adaptive environments are well-suited for projects with a lot of uncertainty, especially where evolving scope is concerned. You will see as we discuss the Process Groups model for risk management that agile projects can make use of this predictive-based model to a large extent, since all risk management should be done repeatedly throughout any project.

Let's start with the reminder that every well-planned agile backlog is a risk-adjusted backlog. Then, because agile projects are iterative, teams go through risk identification and analysis, and threat mitigation or elimination for each iteration. Additionally, agile continuous improvement practices always include looking for opportunities to deliver as much value as possible. Risks are identified in daily standup meetings as team members report any potential impediments to their progress.

Spikes

Agile teams often explore big risks like new processes or technology using special iterations called spikes. A spike is basically a short iteration dedicated to exploring an issue or an approach. A risk-based spike is done before an associated increment's development begins to attempt risk mitigation or elimination—or, enhancement, if an opportunity is being explored.

Example As part of the new library, the staff's stored digital files are being migrated from a shared local area network drive to a cloud environment. The biggest risk here, of course, is the loss of files. So the agile team would schedule a risk spike to test that the migration will not result in a loss of files. By doing this testing up front, they will uncover issues and greatly reduce risk by eliminating discoverable issues.

Architectural spike

You may also see this term on the exam. This spike is for proof-of-concept efforts. In our previous example of migrating files, an architectural spike may be completed prior to any risk-based spikes. During the architectural spike, the team might install new technology or run through how the processes work with the new technology to ensure everything works as planned.

Fast Failure

Spikes can induce "fast failure," and this is actually desirable. The earlier failure occurs the quicker resources can be diverted to a different strategy on a project, or even to a different project. The team is basically trying to cause the failure if they think there is probability of it happening anyway. Assuming they can fix the problem, the cost of the failure may be reduced if it is fixed early in the project. Figure 12.1 illustrates how fast failure can benefit a project.

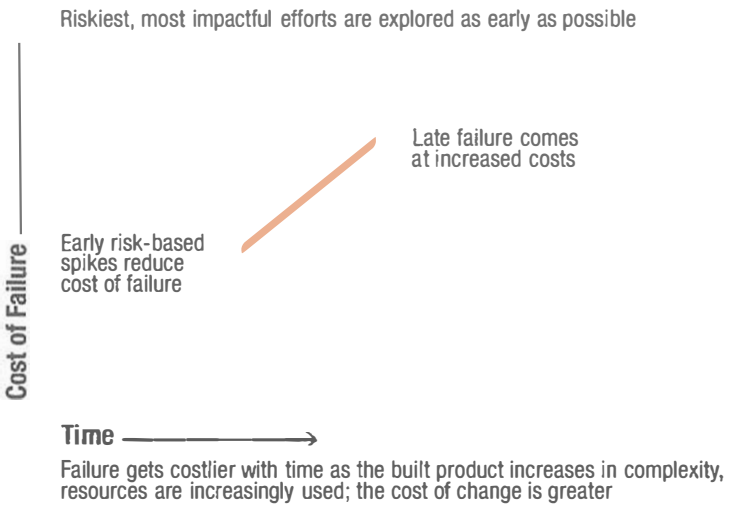


FIGURE 12.1 *Fast failure*

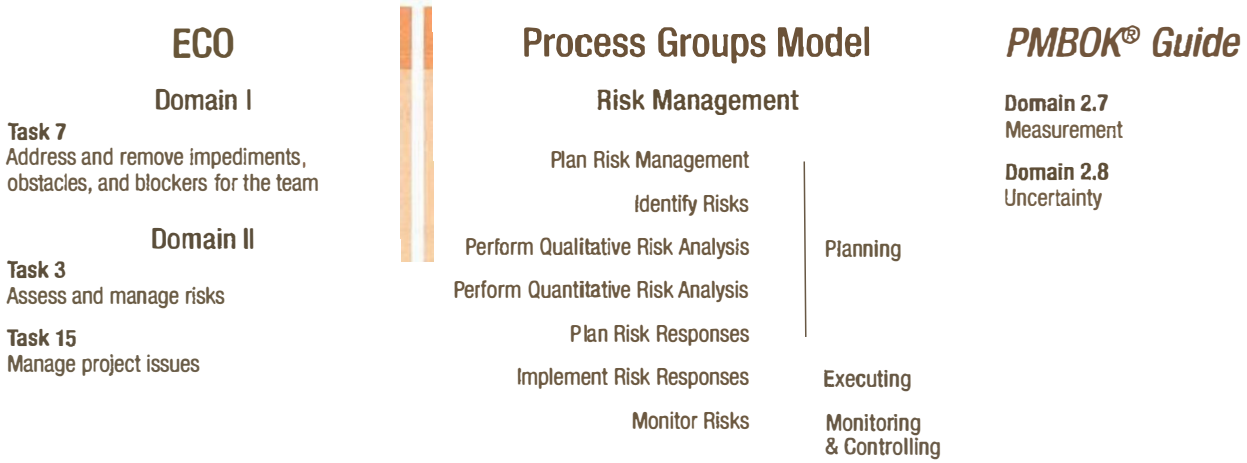
Risk Management Overview

As we have in other chapters, we will help you understand the overall Risk Management process by using the Process Groups model, as well as include information about risk management methods that are unique to adaptive environments. First let's take a look at how the Risk Management process in the *Examination Content Outline* (ECO) maps to the same process in the Process Groups model.

The *Examination Content Outline* and Process Groups Model

Think About It. In the ECO, domain II, task 3—assess and manage risks—is closely related to the risk management process as defined in the Process Groups model. Other tasks that closely align to managing risk include but are not limited:

- Domain I (People domain), task 7: **Address and remove impediments, obstacles, and blockers for the team**
- Domain II (Process domain), task 15: **Manage project issues**



Take time to review the ECO and note any additional tasks that may be applicable.

Example

- Risk management may rely on work to **Ensure knowledge transfer for project continuity** (domain II, task 16).
- If there's conflict on your project, isn't it a risk to leave it unresolved? The following are also related to risk management:
  - ✓ **Manage conflict** (domain I, task 1)
  - ✓ **Ensure team members/stakeholders are adequately trained** (domain I, task 5)

What other tasks can you recognize as possibly impacting risk? Taking time to think about this now will help you become more familiar with the ECO and be more prepared for the exam.

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The Process Groups model for risk has many parts to it and students love to have an acronym when there are many parts to remember. You can remember the following Process Groups model for risk with the acronym "**PIP P PIM**" (Plan-Identify-Perform-Perform-Plan-Implement-Monitor). Or, if you like: "**PIQQRIM**" (Plan-Identify-Qualitative-Quantitative-Responses-Implement-Monitor).

Figure 12.2 is a visualization of risk management at a high level from the Process Groups model perspective. It can help you visualize where you are in the risk management process as you continue with this chapter, and understanding it will help you on the exam.

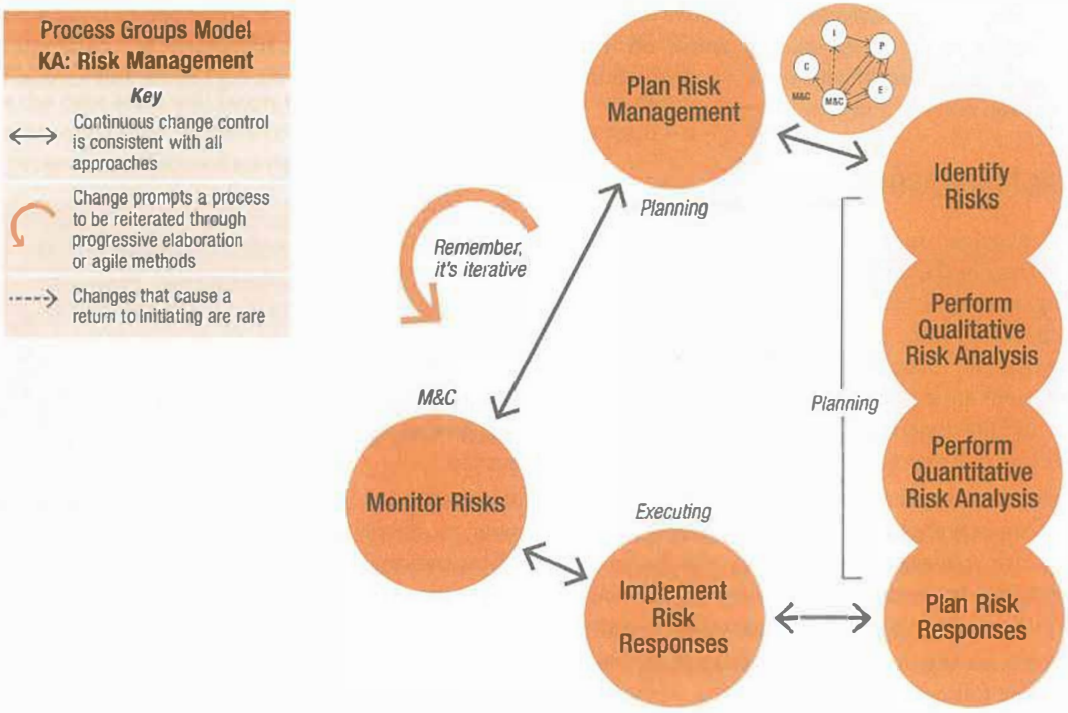


FIGURE 12.2 *Risk management process*

Desired Outcomes of Risk Management

For the exam, assume that risk management has been properly planned according to the concepts presented in this chapter unless a question indicates otherwise. This means the following are built into risk planning, and subsequent risk monitoring and risk response implementation:

- Internal and external environmental factors affecting project risks are considered.
- Risk and responses address the inherent uncertainty and complexity on projects.
- Risk related to all possible variables and constraints are accounted for along with their interdependencies.
- There are no huge "fires" to put out every day—they are eliminated with risk response plans.
- Risks are reviewed in every meeting, triggers are monitored, and risks are addressed before they happen.
- Normally, if a risk event does occur, there is a plan in place to deal with it. Hectic meetings to develop responses are a rarity and are only needed when an unknown (i.e., unpredictable) risk event occurs and requires the team to develop a workaround.
- Risk management helps to limit cost, time, and resource investments on the project.
- There are reserves set aside in the budget for risk events.

Risk Management Summary

Remember that the Process Groups model describes how and in what order risk management generally occurs but project management is iterative and dynamic. Initiating is repeated on large-scale projects when a phase-gate system is used. And, of course, on an agile or hybrid project, risk management is considered every time the backlog is prioritized for a new iteration, when estimates are created, during release and iteration planning, during iteration reviews and retrospectives.

Plan Risk Management

The project manager, sponsor, team, customer, other stakeholders, and experts may be involved in planning risk management. Part of planning involves determining, at a high level, the amount and areas of potential risk on the project. Risk checklists from previous projects can be helpful in planning and identifying risks, but risk management is tailored to every project. In practice, risk management efforts will differ depending on the size and complexity of the project and the experience and skill of the project team. Even how much time is spent on risk management is based on the needs of the project.

The project manager and team evaluate the risk appetites of management and other key stakeholders and identify how the team will go about performing risk management and who will be involved. Organizational process assets like documented procedures and templates related to risk, such as standard probability and impact matrices, are identified and adapted.

Process Groups Model

PG: Planning
Process: Plan Risk Management

Domain I
Task 7 Address & remove impediments for team

Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide

Domain 2.4 Planning
Domain 2.8 Uncertainty

When risk management planning is complete, the risk management plan may include the following:

- **Risk strategy** This is an overall approach to managing risk throughout the life of the project.
- **Methodology** This defines how risk management will be performed to meet the needs of the specific project. Low-priority or low-risk projects will likely warrant less of a risk management effort than high-priority or high-risk projects.
- **Roles and responsibilities** This section of the risk management plan explains who will do what risk management work. Did you realize that the project manager does not do it all and that stakeholders outside the project team may have roles and responsibilities regarding risk management?
- **Funding** There is a cost of doing risk management, but overall risk management saves the project time and money by avoiding or reducing threats and by taking advantage of opportunities. This section includes a plan for utilizing reserves in response to risks on the project.

- **Timing** This section specifies when to do risk management depending on estimated timing for the occurrence of identified risks. Also note that time needs to be allocated in the schedule for risk management activities.
- **Risk categories** These are discussed next in the Identify Risks section.
- **Stakeholder risk appetite/thresholds** The risk appetites and thresholds of key stakeholders are documented and considered in the risk management plan. This information is also considered when ranking risks based on probability and impacts, and when prioritizing which risks will be addressed in risk response planning.
- **Definitions of probability and impact** Would everyone who rates the probability of a particular risk a 7 on a 1-to-10 scale in qualitative risk analysis mean the same thing? A person who is risk averse might think of 7 as very high, while someone who is risk prone might think of 7 as a low figure. The definitions and the probability and impact matrix (discussed later in this chapter) help standardize these interpretations and also help compare risks between projects.
- **Reporting** This section of the plan describes what risk-related reports will be created, what they will include, and to whom they will be sent. In addition, the composition of the risk register for the project is defined here.
- **Tracking** The tracking section describes how the risk management process will be audited and how the results of risk management efforts will be documented.

Identify Risks

In this process, risks to the project and their characteristics are identified. This effort should involve all stakeholders and might include literature reviews, research, and communicating with non-stakeholder subject matter experts. Sometimes the core team will begin the process and then other team members will become involved, or there could be a special, dedicated risk team—a part of the project team focused on risk management efforts.

Process Groups Model
PG: Planning
Process: Identify Risks

ECO
Domain I
Task 7 Address & remove impediments for team
Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide
Domain 2.4 Planning
Domain 2.8 Uncertainty

TRICKS OF THE TRADE

When you get a question about who should be involved in risk identification, the best answer is "everyone"! Each type of stakeholder has a different perspective of the project and can provide thoughts on opportunities and threats.

Project managers should begin looking for risks as soon as they start on the project. In fact, an assessment of overall project risk is included in the project charter. The project manager will need good facilitation skills for the identification of as many risks as possible.

It is worth repeating that while risk identification primarily occurs during planning, risks are identified throughout the project. For the exam, understand that in a predictive environment risk identification is also done during integrated change control, when working with contracts, when working with resources, and when dealing with project issues (which are small concerns that may become problems or risks if not resolved). In an adaptive environment, risk identification takes place in release planning, iteration planning, and throughout each iteration of building the product.

Agile Focus

Risk Categories

A standard list of risk categories can help ensure areas of risk are not forgotten. Risk categories are broad, common areas or sources of risk that similar projects or other people in the organization have encountered. They can include things like technology changes, resource shortages, regulatory hurdles, changes within the internal or external environments, or cultural issues.

Organizations and PMOs should maintain standard lists of risk categories that project managers can use as prompt lists to help identify and categorize project risks. When leading risk identification efforts, the project manager should make sure each category is considered.

A risk breakdown structure (RBS) is a hierarchical chart that looks like an organizational chart and can help the project manager identify and document risk categories. The following breakdown of risk categories is by no means comprehensive but will give you a good understanding of how risk categories work.

Methods for Identifying Risks

The primary methods for this process relate to data gathering and data analysis. They include:

- Brainstorming
- Checklist analysis
- Documentation reviews
- Root cause analysis
- Interviewing
- SWOT (strengths, weaknesses, opportunities and threats)

Checklist analysis is most often used with risk category prompt lists discussed earlier. Root cause analysis is often carried out using a cause-and-effect diagram (like a Fishbone diagram, also known as a "Why-why" or Ishikawa diagram). Root cause analysis leads to reorganizing identified risks by their root causes to help find more risks.

Agile Project Pre-Mortems

A project pre-mortem is a risk identification method commonly used by agile teams. Here, the project manager asks the team to imagine that the project (or iteration) has failed. The team identifies where and why the project might have failed and generates a list of potential failure points. They then troubleshoot the plan to attempt avoidance or mitigation of identified causes for failure. A pre-mortem typically involves these steps:

1. Imagine the failure
2. Generate reasons for the failure
3. Consolidate the list
4. Revisit the plan

Example Remember our example of files being transferred to the cloud? If the project manager holds a pre-mortem, the team can identify potential issues that would cause files to be damaged or lost in the transfer process. Once those issues are identified, they can generate reasons for the failure and try to solve the reasons or mitigate the impact should the ones they can't solve occur.

Artifacts of Identify Risks: Risk Register

The risk register is the main artifact resulting from the Identify Risks process. Think of the risk register as the central document for the entire risk management process that will be continually updated as the risk management processes are completed and the project continues.

TRICKS OF THE TRADE

Notice that the risk register is a project document update for several risk management processes. Read exam questions carefully and remember that the risk register contains different information at different points in the project management process.

Example If the project has just started and you are in the Identify Risks process, the risk register will contain the identified risks and potential responses, not selected response plans, which come later.

The risk register at this point in the risk management process includes the list of risks and also may contain potential risk responses and their potential risk owners responsible to manage assigned risk responses, root causes of risks when they have already been identified, and updated risk categories. Other information that can be documented in the risk register includes risk triggers (defined later in this chapter), potential impacts, when each risk could occur, and when each risk will no longer present a threat or opportunity.

TRICKS OF THE TRADE

A tricky question on the exam might ask, "When in the risk management process are risk responses documented?" The answer is both during Identify Risks (as potential responses) and during Plan Risk Responses (as selected responses).

Perform Qualitative Risk Analysis

As the project manager begins this process, they should have a long list of risks documented in the risk register from the Identify Risks process. It would be neither efficient nor effective to plan responses to all of them, so they need to prioritize those that need planned responses in case they should occur. Qualitative risk analysis is the first of two steps in deciding which risks need planned responses. It involves subjectively analyzing all identified risks for their probabilities and impacts on the project.

Along with the risk register, the project management plan (including the risk management plan), project documents, and organizational influencing factors are important contributions to the Perform Qualitative Risk Analysis process. Once we have completed assessing risks qualitatively, we can decide which of these risks will move on to the second ranking step: quantitative risk analysis.

Process Groups Model
PG: Planning
Process: Perform Qualitative Risk Analysis

ECO
Domain I
Task 7 Address & remove impediments for team
Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide
Domain 2.4 Planning
Domain 2.8 Uncertainty

Qualitative versus Quantitative Analysis

Many people confuse these two types of analysis. Remember for the exam that qualitative risk analysis is a subjective evaluation. In predictive environments the numbers used to rate each risk are usually based on a scale of 1-5 or 1-10. For example, if a risk has a high probability of happening it will be a 3 or 4 as opposed to the lower probability of 1 or 2. This is just an example, however. The meaning of the scale is created and agreed upon by the team, making it subjective.

In contrast, quantitative risk analysis is based on a measurable rating like cost and time. The rating of each risk is based on an estimate of the actual probability and the actual monetary value at stake (impact). For example, the rating for a risk in qualitative analysis might be established as a probability of 3, multiplied by an impact of 4, equaling 12 (or 3 x 4 =12). The same risk would be quantified as a probability of 65% times a cost of $40,000 equaling $26,000 (or .65 x $40,000 = $26,000).

Many people forget which risk analysis is done first: qualitative or quantitative. An easy way to remember this is by thinking of the order in the alphabet in which the first unique letter of each word occurs. The letter "L" comes in the alphabet before the letter "N": Qualitative comes before quantitative.

Methods for Qualitative Risk Analysis

Data collection and analysis methods specific to this process include a risk data quality assessment, further use of the risk categorization discussed earlier, a probability and impact matrix, and analyses of other risk parameters.

Risk Data Quality Assessment

With this we assess the information available on a given risk for accuracy and reliability to determine if the risk is valid and whether more research is needed to understand it.

Example Imagine you receive a short risk description anonymously that doesn't include a lot of data. You may allow anonymous contributions during risk identification, but all identified risks must be defined well enough to perform a qualitative assessment.

Risk Categorization

Assigning risks to categories may be helpful when planning risk responses. It's also important to know that a risk breakdown structure allows a project manager to represent risk sources into a chart-like structure, which can help answer questions like "What will we find if we regroup the risks by category? By source? By work package?"

Using risk categories may also allow a project manager to eliminate several risks at once. Think about how useful it would be to have not only a subjective assessment of the total amount of risk on a project, but also a breakdown of the risks that shows which work packages, processes, people, or other potential causes have the most risk associated with them.

Probability and Impact Matrix

This is a data representation method to plot risks visually to help determine which risks to move forward to quantitative risk analysis. Common subjective analysis scales include Low, Medium, High, and 1 to 5 or 1 to 10 ratings.

Example Risks and their rankings are shown in figure 12.3. The product of probability and impact equals the rank. As shown in figure 12.4, the probability and impact values can also be plotted on a matrix showing values from higher to lower along the vertical and horizontal axes.

A diagonal line is then drawn through the center. Risks to the right of the diagonal line call for more attention. Many or all will be moved forward to Quantitative Risk Analysis.

Note: The numbers in the Rank column of figure 12.3 can be deceiving without further analysis. Risks A and D are very close in rank and their ranks are relatively low. However, risk A's impact is not tolerable. You can see that using a matrix helps with this type of analysis.

#	Risk	P	I	Rank
A	Hurricane during installation	1	5	5
B	XYZ system will arrive late causing a two-week delay in deliverable Q.	2	2	8
C	Module K won't work with PC operating system	2	5	10
D	Project will interfere with Morgan's daily work	2	2	4

FIGURE 12.3 *Risks and their Rankings*

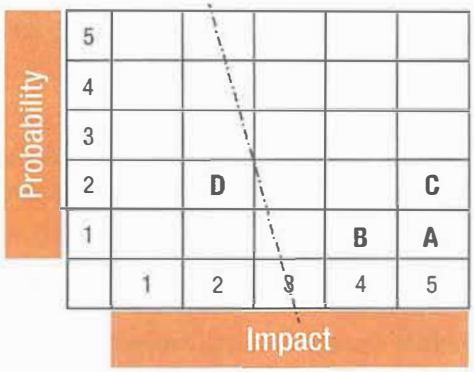


FIGURE 12.4 *Probability and impact matrix*

Because qualitative risk analysis is a subjective evaluation, organizations frequently define a standard rating system to foster a common understanding of what each risk ranking means, as shown in figure 12.5.

Probability Scale		Impact Scale	
Rating	Interpretation	Rating	Definition
1	Low	1	No real impact
2	Medium	2	Small to medium reduction of time or cost reserves
3	Medium-High	3	Medium to large reduction of time or cost reserves
4	High	4	Over budget or behind schedule or both (0-15%)
5	Fact	5	Unacceptably over budget or behind schedule or both (over 15%); possible physical danger or project failure

FIGURE 12.5 *Ranking definitions for probability and impact*

Risk Parameters Assessments

In addition to creating a short list of risks, qualitative risk analysis includes identifying risks that should move more quickly than others through the process due to factors that are referred to as risk parameters. Some examples of risk parameters include the following:

- **Urgency** This parameter indicates if the risk is likely to occur soon (requiring the response to be implemented quickly) or if the risk requires a particularly long time to plan a response. Urgent risks may be moved directly or more quickly into risk response planning.
- **Dormancy** This is the anticipated time between when a risk occurs and when its impact is felt.
- **Manageability and controllability** This parameter indicates the level of difficulty involved in dealing with an identified risk, should it occur.
- **Strategic impact** This is the degree to which the occurrence of a risk would affect the strategic goals of the performing organization.

TRICKS OF THE TRADE

Qualitative risk analysis can be used for project management tailoring to do the following:

- Compare the risk of the project to the overall risk of other projects.
- Determine whether the project should be continued or terminated.
- Determine whether to proceed to the Perform Quantitative Risk Analysis or Plan Risk Responses processes (depending on the needs of the project and the performing organization).

Artifacts of Qualitative Risk Analysis

When this process is complete, there will be updates to the following artifacts:

- Project management plan (including the risk management plan)
- Project documents
- Assumptions log
- Risk report
- Risk register (updated with qualitative analysis data)
- Issue log
- Watch list

The risk report will include the results of risk prioritization thus far, including a list of the highest-ranking lists to be moved forward to the Quantitative Risk Analysis process. Those risks that do not move forward to Quantitative Risk Analysis will moved to a watch list.

Perform Quantitative Risk Analysis

The Perform Quantitative Risk Analysis process involves analyzing the probability and impact (the amount at stake or the consequences) of risks that ranked highest in qualitative risk analysis. The numbers used in this case are based on monetary estimates of the time and costs, should a risk happen. Quantitative risk analysis also looks at how risks could affect the objectives of the project. The purpose of quantitative risk analysis is to determine:

- Which risk events warrant a response plan and which require the most attention.
- Overall project risk (risk exposure).
- The quantified probability of meeting project objectives.

  Examples "We have an 80 percent chance of completing the project within the six months required by the customer," or "We have a 75 percent chance of completing the project within the $800,000 budget."
- Cost and schedule reserves.
- Realistic and achievable cost, schedule, or scope targets.

Process Groups Model

PG: Planning
Process: Perform Quantitative Risk Analysis

ECO

Domain I
Task 7 Address & remove impediments for team

Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide

Domain 2.4 Planning
Domain 2.8 Uncertainty

For some projects, there may be a subset of risks identified that require quantitative analysis. While the project manager should always do qualitative risk analysis, they should proceed with quantitative risk analysis only if it is worth the time and money; otherwise they should move directly to risk response planning.

The Perform Quantitative Risk Analysis process can include a lot of calculation and analysis. Luckily, the details of these efforts are not a focus of the exam. You need to know that the following actions are part of quantitative risk analysis but not how to do them beyond what is explained in this chapter:

- Further analyze the highest-ranked risks on the project and other results of qualitative analysis.
- Perform data analysis to determine which risks have the most impact on the project.
- Determine how much quantified risk the project has through data analysis.

Methods for Quantitative Risk Analysis

Quantitative probability and impact can be determined in a variety of ways that make use of some or all the following tools:

- Expert judgment from the team and risk specialists
- Data-gathering techniques, such as interviewing
- Data analysis techniques, such as sensitivity analysis and decision tree analysis
- Interpersonal and team skills
- Cost and schedule estimating
- Use of historical records from previous projects

Simulations

These techniques can be extremely valuable. Monte Carlo analysis is a simulation in which schedule and cost estimates are used to "perform" the project many times to simulate results. Traditionally, there has been only one or two questions about Monte Carlo analysis on the exam.

TRICKS OF THE TRADE®

You do not need to have direct experience performing Monte Carlo analysis for the exam. You should just understand that Monte Carlo analysis:

- Evaluates the overall risk in the project
- Is done with a specialized computer application
- Determines the probability of completing the project on any specific day or for any specific cost
- Determines the probability of any activity actually being on the critical path
- Considers path convergence (points in the network diagram where many paths converge into one activity)
- Translates uncertainties into impacts to the project
- Can be used to assess cost and schedule impacts
- Results in a probability distribution (in the form of a chart)

Sensitivity Analysis

This technique analyzes and compares the potential impacts of identified risks. A tornado diagram may be used to graphically depict the results of this analysis. Risks are represented by horizontal bars. The longest and uppermost bar represents the greatest risk, and progressively shorter horizontal bars beneath represent lower-ranked risks. The resulting graphic resembles a funnel cloud, or tornado, as shown in figure 12.6.

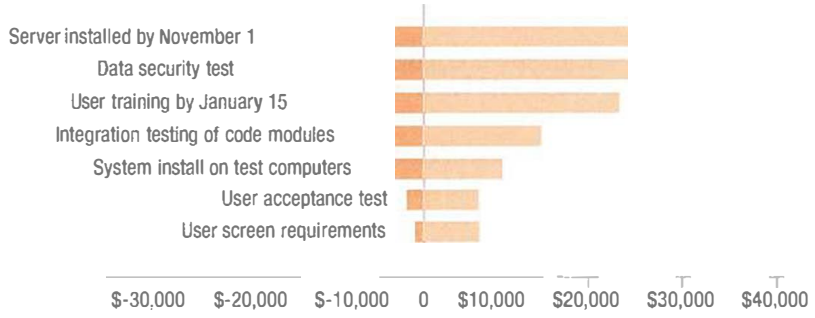


FIGURE 12.6 *Tornado diagram*

Expected Monetary Value (EMV)

This is an important method for quantitative risk analysis. EMV can be used in several ways but is often used to estimate the impact of a risk by calculating the product of its estimated probability (as a percentage) times its estimated cost (as a dollar amount, should it occur). The equation for EMV is:

EMV = P x I

Example 65% x $40,000 = $26,000. In other words, a 65% probability of risk that would cost $40,000 if it happened has an EMV of $26,000.

, EMV estimates for risks in a quantitative risk analysis are summed to calculate contingency reserves. Questions on the exam may ask "What is the expected monetary value of the following?" Do the following exercise to give this a try. The exam could also ask you to calculate the expected monetary value for cost, the expected value (or just "value") for the schedule of a path, or the value of your decision.

Note that for opportunities, expected monetary value is presented as a positive amount (e.g., $3,000), while threats are presented as negative numbers (e.g., –$3,000).

12.1 Exercise

In your Exercise Notebook, calculate the expected monetary value for each of these work packages. The math is not difficult but completing this exercise will help you remember this calculation for the exam.

Work Package	Probability	Impact	Expected Monetary Value
A	10%	$20,000	
B	30%	$45,000	
C	68%	$18,000	

Answer

Work Package	Probability	Impact	Expected Monetary Value
A	10%	$20,000	$2,000
B	30%	$45,000	$13,500
C	68%	$18,000	$12,240

Decision Tree Analysis

There have historically been only one or two questions about decision trees on the exam, but since they are unfamiliar to many people we will talk about them here. You should know what a decision tree is and be able to calculate a simple one from data within an exam question.

A decision tree is analyzed by calculating the value of each branch (another way of using EMV). The outcome of this calculation will show the best option to select. You should also know the following about decision trees:

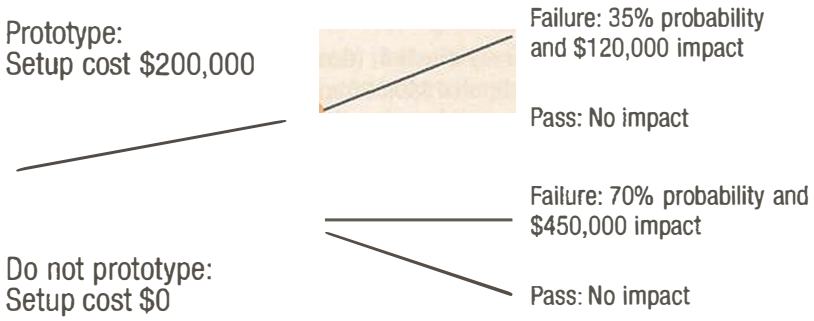
- They consider future events.
- They calculate the expected value (probability multiplied by impact) in more complex situations. For example, a project manager could evaluate the costs or schedule implications and benefits of several risk responses at once to determine the best option.
- They involve mutual exclusivity.

Some examples of decision trees have the costs occurring only at the end of the project, while others have costs occurring early or in the middle of the project. Because a decision tree models all the possible choices to resolve an issue, costs can appear anywhere in the diagram, not just at the end. When you are taking the exam, don't get confused when you look at examples of decision trees. Pay attention to the data provided in the question so you can correctly interpret the answer.

The following exercise includes a decision tree analysis. The box represents a decision to be made, and the circles represent what can happen as a result of the decision.

12.2 Exercise

A company is trying to determine if prototyping is worthwhile on a project. They have come up with the following impacts (see the diagram) of whether the equipment works or fails. Based on the information provided in the diagram, what is the expected monetary value of each option? Which is the cheaper option—to prototype or not to prototype? Do the calculations and write the answer in your Exercise Notebook.



Answer

If you just look at the setup cost of prototyping, it would seem like an unwise decision to spend money on prototyping. However, the analysis proves differently. Taking into account only the one future event of whether the equipment works or fails, the decision tree reveals that it would be cheaper to do the prototyping. The expected monetary value of prototyping is $242,000; the expected monetary value of not prototyping is $315,000.

Prototype	35% × $120,000 = $42,000 $42,000 + $200,000 = $242,000
Do Not Prototype	70% × $450,000 = $315,000

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Project management saves time and money on projects. Getting your organization's executives to understand that fact can be difficult at times. How beneficial would it be if you could prove the value of project management?

Example Imagine that you have just calculated the EMV of all high-ranking and high-priority risks in qualitative risk analysis, or that you have completed a Monte Carlo analysis for a project. In either case, you calculate that you need a $98,000 contingency reserve on the project to adapt for risks. Then, when the team moves on to the Plan Risk Responses process (discussed next) they eliminate some risks and reduce the probability or impact of others. The EMV calculation or Monte Carlo analysis is redone, showing a revised need for a $12,000 reserve. You have potentially saved $86,000 before project work even starts!

Artifacts of Perform Quantitative Risk Analysis

The Perform Quantitative Risk Analysis process results in updates to the risk register and other project documents, including:

- **Prioritized list of quantified project risks** What risks are most likely to have a negative effect on the critical path? What risks need the most contingency reserve?
- **The quantified probability of meeting project objectives**
  Examples "We have an 80 percent chance of completing the project within the six months required by the customer," or, "We have a 75 percent chance of completing the project within the $800,000 budget."
- **Quantitative risk analysis trends** As the project manager repeats quantitative risk analysis in project planning and when changes are proposed, they can track changes to the overall project risk and see trends.
- **Initial contingency time and cost reserves needed** (finalized in Plan Risk Responses)
  Example "The project requires an additional $50,000 and two months of time to accommodate the project risks."
- **Assessment of overall project risk exposure** Use overall project success probability (how likely it is that the project will achieve all key objectives) and any variables that may still affect the project to fully understand the overall risk exposure of the project.
- **Possible realistic and achievable completion dates and project costs**, with confidence levels, versus the time and cost objectives for the project.
  Example "We are 90 percent sure that we can complete this project on May 25th for $989,000."
- **Recommended risk responses** After quantitative risk analysis is performed, the risk register may include suggested responses to overall project risks and individual project risks.

Plan Risk Responses

The Plan Risk Responses process involves figuring out, "What are we going to do about each top-ranked risk?" We have and will use the risk register, which has been updated throughout the risk management process and now includes the analyzed and prioritized risks. The "Top Risks" are the risks for which responses will be planned. The project manager will use methods like alternatives analysis and cost benefit analysis to evaluate the values of various response strategies and specific risk response plans relative to their costs. The cost baseline will describe a contingency reserve that will be used in addressing these specific risks. See the discussion on reserves later in this chapter.

Process Groups Model
PG: Planning
Process: Plan Risk Responses

ECO
Domain I
Task 7 Address & remove impediments for team

Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide
Domain 2.4 Planning
Domain 2.8 Uncertainty

Responses for Top Risks

The project's risk responses may include doing one or a combination of the following for each top risk:

- Do something to eliminate the threats before they happen.
- Do something to make sure the opportunities happen.
- Decrease the probability and/or impact of threats.
- Increase the probability and/or impact of opportunities.

This is what risk management is all about. There are always options to respond to risks. If a change to a team member's availability is a top risk, the project manager can investigate the possibility of replacing that team member with another resource with similar skills. If a work package is causing a large amount of risk, the project manager might look at:

- Changing the deliverable
- Modifying the work to produce it
- Changing the quality requirements
- Removing scope from the project

Responses for Residual Risks

Residual risks are those left in the project that cannot be anticipated or planned for. Every project has them. For the remaining (residual) threats that cannot be eliminated or exploited:

- Do something if the risk happens (contingency plans). Contingency plans should be measurable so the project manager can evaluate their effectiveness.
- Do something if contingency plans are not effective or are only partially effective (fallback plans).

The project manager and the team determine what to do about each of the residual risks—those that cannot be eliminated or exploited. This might mean accepting these residual risks, or planning additional risk responses. The work involved in all risk responses is then assigned to risk owners.

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When taking the exam, assume that all major potential problems and opportunities that could have been anticipated as risks were identified and analyzed before they occurred and that there was a plan for each risk. With this in mind, the best answer to a question describing a major problem on the project will be the choice that talks about implementing a contingency plan, rather than one that involves discussing possible solutions to a problem after it has occurred. Many people have said that these types of questions were the reason they failed the exam. They simply made the wrong choices in situational questions. Be sure to make the transition to this way of thinking if it is unfamiliar to you.

However, no matter how much risk analysis and response planning is done, there is usually residual risk on a project. This is why there is a management reserve as well as a contingency reserve.

Here are a couple more points that can be tricky on the exam:

- Can all threats be eliminated on a project? Remember that threats can be eliminated and opportunities exploited, but the time and trouble involved in eliminating all the threats and exploiting all the opportunities on a project would probably not be worthwhile.
- Did you know that qualitative risk analysis, quantitative risk analysis, and risk response planning occur throughout the life of a project? As noted in other parts of this book, planning is iterative. The project manager needs to review risks throughout the project, including while the project work is being done or when checking results. Newly identified risks need to go through the risk planning process.

Risk Response Strategies

When completing risk response planning, a thorough analysis must be done of the potential responses for each risk. Some of these risk response strategies, also known as risk mitigation strategies or strategies for threats and opportunities, involve changing the planned approach to completing the project, including changes to the WBS, the quality management plan, resources, schedule, budget, or communications strategies.

Response Strategies for Threats

The risk response plans the project manager has for specific risks are called contingency plans. The types of response strategies for threats include:

- **Avoid** This means eliminating the threat by eliminating the cause. Examples include removing a work package or changing the person assigned to do work. Avoiding a threat might even involve expanding the scope of the project.

  Example Imagine there's an estimated 75 percent likelihood of a threat occurring, but an additional level of testing or an additional activity would likely prevent this threat. Expanding the scope of the project in this way could help avoid the threat.

On an overall project level, if the threat is beyond the organization's risk threshold, the project manager will need to take action to make the project acceptable. This could include removing pieces of the project that are too risky to avoid or cancelling the entire project.

- **Mitigate** This is reducing the probability and/or the impact of threat, thereby making it a smaller risk and possibly removing it from the list of top risks on the project. Options for reducing the probability are considered separately from options for reducing the impact. Any reduction will make a difference, but the option with the most probability and/or impact reduction is often the option selected.

- **Transfer (deflect, allocate)** Think "insurance." This is done by purchasing insurance, performance bonds, warranties, or guarantees, or by outsourcing the work, making an outside party responsible for managing the risk. There is a strong connection here between risk and procurement (contracts). When proper project management is done, risk analysis is completed before a contract is signed, and transference of risk is included in the terms and conditions of the contract.

Avoidance and mitigation are generally used for high-priority, high-impact risks. Transference, along with escalation and acceptance (discussed next) may be appropriate for low-priority, low-impact risks as well as those with higher impact.

- **Pure risk** A response to pure risks—such as fire, property damage, or personal injury—is transference, or purchasing insurance. Insurance exchanges an unknown cost impact of a known risk for a known cost impact.

  Example With a risk of fire, the cost impact of the risk is unknown. But when insurance is purchased, the cost impact of the risk of fire becomes known; it is the cost of the insurance and the deductible. Transferring the risk by purchasing insurance does not eliminate all impacts. There may still be residual risks. A project could experience schedule delays due to a fire even if fire insurance was purchased, or the cost of the fire damage could exceed the amount of insurance purchased.
- **Secondary risk** In another example, there is a risk that the risk response plan itself could cause a problem. If the third party (insurance company or seller) has trouble delivering on their end, they could cause a schedule delay. The project manager still needs to decide what to do about any possible secondary risks.

Response Strategies for Opportunities

The choices of response strategies for opportunities include:

- **Exploit (the reverse of avoid)** Either add work or change the project to make sure the opportunity occurs. This could be on the individual project risk level or on the overall project risk level.
- **Enhance (the reverse of mitigate)** Increase the likelihood (probability) and/or positive impacts of the opportunity occurring. This could be related to the overall approach to scope and schedule, resources used, or project replanning, as well as to individual project risks.
- **Share** Allocate ownership or partial ownership of the individual or overall project opportunity to a third party (forming a partnership, team, or joint venture) that is best able to achieve the opportunity.

  Example It is common in a procurement contract to offer a bonus or incentive to complete the seller's part of the project early if it creates an equal or better savings opportunity for the buyer.

Response strategies for both threats and opportunities include:

- **Escalate** If it is outside the scope of the project or beyond the project manager's authority, a risk should be escalated within the organization. These risks are typically managed at the program or portfolio level. An escalated risk needs to be accepted by the program or portfolio manager; the escalation is then documented and the risk is no longer monitored at the project level.
- **Accept** Passive acceptance means to do nothing and to essentially say, "If it happens, it happens." This leaves actions to be determined as needed (workarounds) if the risk occurs. Active acceptance involves creating contingency plans to be implemented if the risk occurs and allocating time and cost reserves to the project.

Common Response Strategies for Threats or Opportunities

The following rules and strategies can be used for threats and opportunities:

- Strategies must be timely.
- The effort selected must be appropriate to the severity of the risk. Avoid spending more money to prevent the risk than the cost of the impact of the risk had it occurred.
- One response can be used to address more than one risk.
- More than one response can be used to address the same risk.
- A response can address the root cause of risk and thereby address more than one risk.
- The team, other stakeholders, and experts should be involved in selecting a strategy.

Watch out for questions on the exam about communicating risk-related information! Risk response strategies must be communicated to the sponsor, management, and stakeholders. These parties will need to know that you are in control of the project even if there is a problem, and they may need to approve the resources to make the risk response strategies happen. Communicating about risk is essential for gaining buy-in to the strategy.

12.3 Exercise

Now let's see if you can apply what you have learned. Identify the type of risk response strategy (avoid, mitigate the probability, mitigate the impact, transfer, exploit, enhance the probability, enhance the impact, share, escalate, or accept) being described. Write the answer in your Exercise Notebook for each description.

Description	Risk Response Strategy
1. Remove a work package or activity from the project.	
2. Assign a team member to frequently visit the seller's manufacturing facilities to learn about problems with deliveries as early as possible.	
3. Move a work package to a date when a more experienced resource is available to be assigned to the project.	
4. Begin negotiation for the equipment earlier than planned so as to secure a lower price.	
5. Outsource a work package so as to gain an opportunity.	
6. Notify management that there could be a cost increase if a risk occurs because no action is being taken to prevent the risk.	
7. Remove a troublesome resource from the project.	
8. Provide a team member who has limited experience with additional training.	
9. Train the team on conflict resolution strategies.	
10. Outsource difficult work to a more experienced company.	
11. Ask the client to handle some of the work.	
12. Prototype a risky piece of equipment.	
13. Notify the PMO that the testing software needed for the project could be used by three other IT groups if the enterprise solution is purchased.	
14. The team adds a risk spike to see if a new, less expensive, cloud provider could support the product.	

Answer

Risk Response Strategy		
1 Avoid	6 Accept	11 Transfer
2 Mitigate the impact	7 Avoid	12 Mitigate the probability
3 Exploit	8 Mitigate the probability	13 Escalate
4 Enhance the impact	9 Mitigate the impact	14 Exploit
5 Share	10 Transfer	

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Potential risk response strategies and contingency plans must be analyzed to determine which strategy or strategies are most cost-effective and most likely to address the risk. Cost-benefit analysis and multicriteria analysis are techniques to evaluate and rank potential risk responses. You may see a question on the exam asking you to compare the cost effectiveness of various risk response options.

Artifacts of Plan Risk Responses

Planned risk responses may require changes to management plans that have been drafted in planning—at the overall project risk level as well as at the individual project risk level. Other artifact updates as a result of planning risk responses may include:

- Risk register (see below)
- Cost forecasts
- Project schedule
- Change requests
- Quality metrics
- Communications management plan
- Assumptions log
- Lessons learned register
- Project team assignments (roles and responsibilities)
- Stakeholder engagement strategy
- Risk report

Risk Report

This is updated to communicate the risks of greatest threat or opportunity, overall project risk exposure, anticipated changes, and anticipated outcomes of planned risk responses. The concepts defined next relate to the risk register updates resulting from Plan Risk Responses.

Risk Register Updates

The risk register is updated to add the results of risk response planning, including:

- **Residual risks** After risks have been avoided, exploited, mitigated, enhanced, transferred, shared, escalated, and accepted (and related contingency and fallback plans have been created), there will still be risks that remain. The known residual risks that are passively accepted should be documented and reviewed throughout the project because their rankings may need to change.
- **Contingency plans** These plans describe the specific actions that will be taken if the opportunity or threat occurs.
- **Fallback plans** These plans are specific actions that will be taken if the contingency plans are not effective. Think how prepared you will feel if you have plans for what to do if a risk occurs and what to do if the original plan does not work.
- **Risk owners** Each risk must be assigned to someone who will help lead the development of the risk response and who will be assigned to lead the risk response or "own" the risk. The risk owner can be a stakeholder other than a team member. Think about how the application of risk management could change real-world projects. The risk occurs; the risk owner takes the pre-approved action determined in project planning and informs the project manager. No meeting is needed—just action! This can be very powerful.
- **Secondary risks** Any new risks created by the implementation of selected risk responses should also be analyzed as part of risk response planning. Frequently, a response to one risk will create the possibility of new risks. For example, if a portion of the project work is outsourced to a seller because the project team does not have the expertise to complete the work efficiently, there may be a secondary risk of the seller going out of business. The discovery of secondary risks may require additional risk response planning, including ensuring that the secondary risks are of a lower severity than the primary risk.
- **Risk triggers** These are events that trigger the contingency response. The early warning signs for each risk on a project should be identified so risk owners know when to take action.
- **Contracts** Before a contract is finalized, the project manager should have completed a risk analysis and included contract terms and conditions required to mitigate threats and enhance opportunities. Any contracts issued to deal with risks should be noted in the risk register.
- **Reserves (contingency and management)** Having reserves for time and cost is a required part of project management. We explain these further next.

Contingency and Management Reserves

Reserves are covered in the "Budget and Resources" chapter, but let's look at them again here. Time and cost each have two types of reserves: contingency reserves and management reserves. Contingency reserves account for "known unknowns" (or simply "knowns"); these are items identified during risk management. Management reserves account for "unknown unknowns" (or simply "unknowns"); these are items the project manager did not or could not identify during risk management.

Projects can have both kinds of reserves. As shown in the diagram in figure 12.7 (also shown in the "Budget and Resources" chapter), contingency reserves are calculated and become part of the cost baseline. Management reserves are estimated (for example, 5 percent of the project cost), and these reserves are then added to the cost baseline to get the project budget. The project manager has control of the cost baseline and can approve use of the contingency reserves, but management approval is needed to use management reserves. The same applies to reserves in the schedule.

Make sure you understand that reserves are not an additional cost to a project. The risk management process should result in a decrease to the project's estimated time and cost. As threats are eliminated or their probability or impact reduced, there should be a reduction to the project's schedule and budget. Contingency reserves are allocated for the contingency plans and fallback plans to deal with the associated, accepted opportunities and threats that remain after the risk

management planning processes have been completed. No matter what the project manager does, risks will remain in the project, and there should be a time or cost allotment for them, just as time or cost is allotted to work activities on the project.

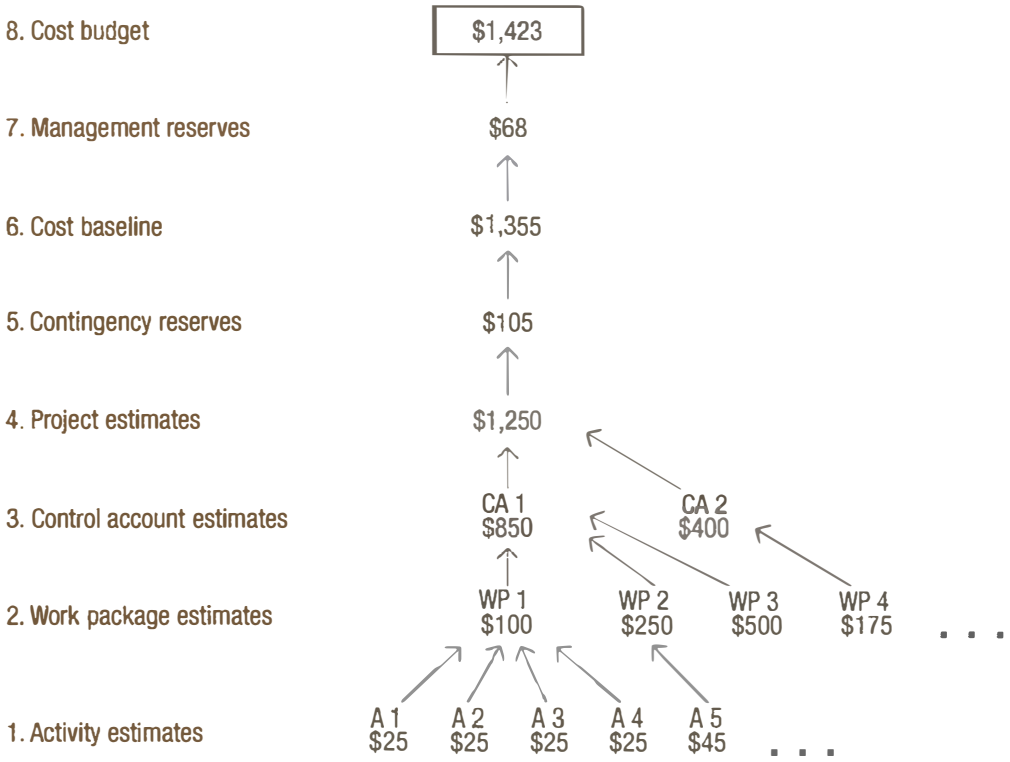


FIGURE 12.7 *Contingency and management reserves create a cost budget*

There may be questions on the exam that ask you to calculate the contingency reserve for several risk events, which may be a combination of opportunities and threats. To do this, you must calculate the value of each risk using the equation for expected value (P × I). On the exam, you may have to calculate contingency reserves for either schedule (expected value) or cost (expected monetary value). But think about this a minute. Let's use the example for cost impacts to projects. Can you just add all the expected monetary value amounts of the opportunities and threats together and come up with one grand total for the budget? No! You'll need to subtract the total expected monetary value of the opportunities from the total expected monetary value of the threats. Why?

Opportunities will save money and time on the project if they occur. This can reduce the cost or schedule baselines. Conversely, the threats will add cost and time to the project.

You're being told to subtract opportunities here, but weren't you told earlier that expected value is often presented as a positive amount for opportunities and a negative amount for threats? That's often true when the values are depicted on something like a decision tree, so you can easily identify positive and negative outcomes and their overall effect on project costs or schedule. But this example is specifically looking to determine how much money or time to set aside for the contingency reserves. Threats will require increasing the amount of contingency reserves, whereas opportunities will decrease the required reserves.

The next exercise will give you practice on calculating a contingency reserve.

12.4 Exercise

Imagine you are planning the manufacture of modifications to an existing product. Your analysis has come up with the following information. In your Exercise Notebook, calculate the cost contingency reserve for each of the following scenarios, and then calculate the total cost contingency reserve for the project.

Project Data

1. There is a 30 percent probability of a delay in the receipt of parts, with a cost to the project of $9,000.
2. There is a 20 percent probability that the parts will cost $10,000 less than expected.
3. There is a 25 percent probability that two parts will not fit together when installed, costing an extra $3,500.
4. There is a 30 percent probability that the manufacture may be simpler than expected, saving $2,500.
5. There is a 5 percent probability of a design defect, causing $5,000 of rework.

Total Cost Contingency Reserve

Answer

You use the expected monetary value calculation (EMV = P × I) to determine the contingency reserve. The answer is $1,075 for the total cost contingency reserve. See the following table for the detailed calculations.

Cost Contingency Reserve Calculations

1. 30% × $9,000 = $2,700
   Add $2,700
2. 20% × $10,000 = $2,000
   Subtract $2,000
3. 25% × $3,500 = $875
   Add $875
4. 30% × $2,500 = $750
   Subtract $750
5. 5% × $5,000 = $250
   Add $250

Total Cost Contingency Reserve = $1,075

> **Think About It.** Let's assume this exercise had examples of threats and opportunities to the schedule. If you had a 30 percent probability of a 15-day activity delay, the expected value would be 4.5 days, which would be added to the schedule. And if the probability of an activity taking 10 days less than planned was 20 percent, the expected value would be -2 days. The resulting contingency for these two risks would be 2.5 days.

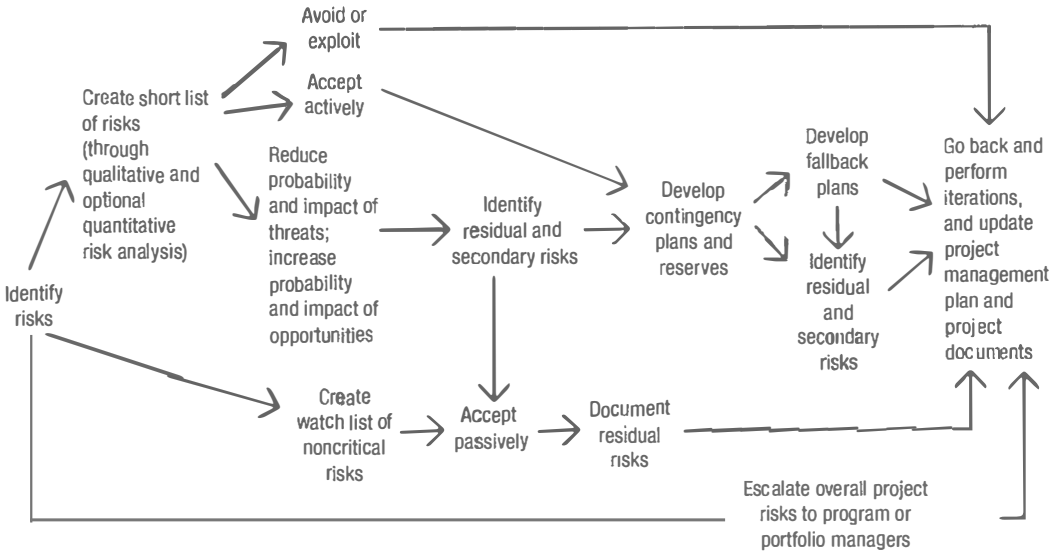
If the risk management process is new to you, the following exercise should help you put it all together by looking at it in a chart form.

12.5 Exercise

In your Exercise Notebook, create a flowchart of the risk process from Identify Risks through Plan Risk Responses.

Answer

Creating this chart will help you check whether you have understood what you have read in this chapter. Your flowchart could be different than the following depiction.



Agile Risk Responses

As we have said before, any of the already discussed concepts and methods can be used in any environment. In agile and hybrid environments the result of all this this work takes the form of reprioritizing the backlog, creating risk response stories, updates to iteration and release plans, and updates to iteration roadmaps.

Agile Focus

Risk-adjusted Backlog

In an agile environment, a project's backlog is prioritized not just for features but for the risk responses that have been developed for identified risks. In planning each iteration, agile teams seek to balance delivering the highest-value features and mitigating the biggest threats that remain on the project. The backlog can now be referred to as a "risk-adjusted backlog," as illustrated in figure 12.8.

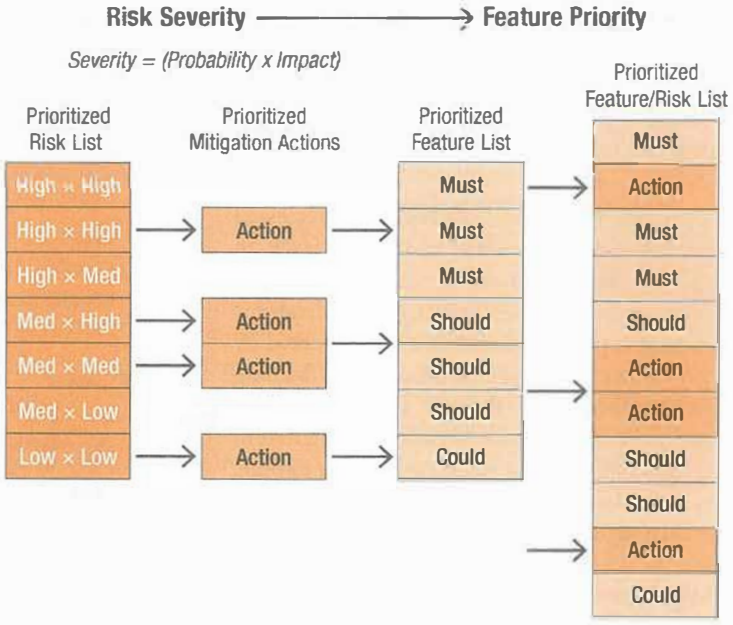


FIGURE 12.8 *Risk-adjusted backlog (prioritized feature list)*

Set-based Design

Another concept in adaptive environments is set-based design. This is just like doing an extensive what-if analysis. Note that a tool like decision tree analysis can be used here. Set-based design involves exploring multiple options, or designs, early in the project and eliminating the ones that won't work. It creates flexibility and allows teams to develop knowledge as they work through the different options.

Spend a moment now thinking about how risk response planning might also lead to adjustments to the schedule, cost, quality, procurement, communications, and resource management plans, as well as to the scope, schedule, and cost baselines for the project. This concept is critical for understanding the impact risk management has on projects, especially if you don't currently do risk management on your projects.

Think about it. You are nearing the end of the Plan Risk Responses section. Let's examine some important concepts for the exam in this group of questions and answers. Take a few moments to test yourself.

Question What do you do with noncritical risks?
Answer Document them in a watch list, and revisit them periodically.

Question Would you choose only one risk response strategy for each particular risk? For the project as a whole?
Answer No, you can select a combination of choices.

Question What risk management activities are done during the execution of the project?
Answer Watching out for watch-listed (noncritical) risks that increase in importance and looking for new risks; implement contingency plans if triggers indicate the risk is about to occur or is occurring.

Question What is the most important item to address in project team meetings?
Answer Risk.

Question How would risks be addressed in project meetings?
Answer By asking, "What is the status of risks? Are there any new risks? Is there any change to the order of importance?"

Implement Risk Responses

Implementing risk responses is where the value of proper risk management becomes most apparent. When the preliminary work has been done well, the Implement Risk Responses process can be handled smoothly, since the previously documented plans allow for timely and effective responses to risk events.

Throughout the project, the risk register and risk report are reviewed regularly, ensuring everyone is aware of potential risks and ready to implement the planned responses as needed. Information on triggers enables the project manager, risk owner, and team to recognize indications that a risk event is imminent. At that point, the risk owner, supported by the project manager, leads previously assigned resources in performing response activities. The consequences of threats are averted, or opportunities are taken advantage of. Risk thresholds are documented in the plan along with expected outcomes of risk responses—for example, how much should be saved by each planned risk response so the success of the implementation can be evaluated.

Process Groups Model
PG: Executing
Process: Implement Risk Responses

ECO
Domain I
Task 7 Address & remove impediments for team
Domain II
Task 3 Assess & manage risks
Task 15 Manage project issues

PMBOK® Guide
Domain 2.5 Project work
Domain 2.6 Delivery
Domain 2.8 Uncertainty

Think about it. At the beginning of this chapter we included the story of a project manager who was managing a hardware/software installation during a hurricane. Let's revisit that example. If the project manager had performed proper risk management, he would have had a plan in place to avoid the risk of a hurricane having an impact on his project.

Example Schedule the project to happen before or after the forecasted hurricane. If the project manager and the risk owners had actively monitored known risk triggers (such as the results of weather reports including wind speeds and the projected path of the hurricane) and then implemented a risk response plan before the hurricane reached the area, they could have avoided the danger, rework, delays, and the costs resulting from the hurricane.

Sometimes carefully developed plans don't have the expected result.

Example Let's assume the risk owner or the project manager in the previous story implemented a risk response plan to reschedule the implementation, causing the schedule to be extended. Although the plan was executed as intended, the hurricane caused more damage than anticipated, and the schedule had to be extended beyond the planned number of days. Such unforeseen results are managed through change requests to the cost and schedule management plans.

Artifacts of Implement Risk Responses

Project documents are updated as a result of the Implement Risk Responses process. The risk register and risk report are updated with information on responses taken, details on how well the responses addressed the risks, and suggested changes to future risk response plans. The lessons learned register is updated with what worked and what didn't work when risk responses were implemented. The risk report is updated with changes to the project's risk exposure and changes to planned risk responses. Ongoing issues, such as confusion or disagreement regarding the response as it was implemented, are added to the issue log.

Monitor Risks

Risk-related questions on the exam assume that the project manager has done proper project management, including assigning risk owners, putting contingency plans and reserves in place, and taking actions as outlined in the plan—unless data in the question indicates otherwise. The exam also assumes the project is substantially less risky with this planning done. If you do not have experience using risk management in the real world, spend more time in this chapter and practicing with these concepts so you are prepared for these exam questions.

It is during the Monitor Risks process that the project manager will evaluate the effectiveness of the risk management plan. In predictive and adaptive environments alike, the project manager will make sure that proper risk management procedures are being followed and will watch for unexpected effects or consequences of risk events. Corrective actions may be needed and change requests will be sent to integrated change control, or on an agile project additional risk adjustments will be made to the backlog.

Process Groups Model
PG: Monitoring and Controlling
Process: Monitor Risks

ECO
Domain I
Task 7 Address &remove impediments for team
Domain II
Task 3 Assess & manage risks
Task 10 Manage project changes
Task 15 Manage project issues

PMBOK® Guide
Domain 2.7 Measurement
Domain 2.8 Uncertainty

You will find on the RMC Resources page a checklist of actions a project manager needs to take in a predictive environment during the Monitor Risks process. Review that checklist to make sure you understand each of the actions. You can find it by scanning the code to the right or going to rmcls.com/rmc-resources.

RMC RESOURCES

Agile Risk Monitoring

In an agile or hybrid environment, you may update risk burndown charts, review risks in a retrospective, and ask the project team how plans are going to reduce threats and maximize opportunities. Do you need to create any new stories to address new or escalating risks? Do you need to engage the product owner in discussions about reprioritizing the backlog based on new risk information?

Agile Focus

Methods for Monitoring Risk

Other work that is part of the Monitor Risks process is outlined in the following sections.

Workarounds

If the project has deviated from the baselines, the team may take corrective action to bring it back in line. Recommendations for such corrective actions may include workarounds. Whereas contingency responses are developed in advance, workarounds are unplanned responses developed to deal with the occurrence of unanticipated events or problems on a project (or to deal with risks that had been accepted because of the unlikelihood of an occurrence and/or minimal impact). Project managers who do not perform risk management spend a lot of their time creating workarounds.

Risk Reassessments

Questions always seem to come up on the exam that require you to know that the team needs to periodically review the risk management plan and risk register and adjust the documentation as required. It is important to determine whether any changes or adjustments need to be made to what was planned based on information that becomes apparent once work begins. Reassessing risk is a good topic for a team meeting, a retrospective, or even a separate meeting, as part of risk reviews.

Risk Reviews and Audits

For the exam, think of status meetings as team meetings in which the project manager can perform risk reviews and risk audits.

- Risk reviews are held regularly to discuss the effectiveness of planned risk responses that have been implemented on the project, and may result in the identification of new risks, secondary risks created by risk response plans, and risks that are no longer applicable. Closing of risks allows the team to focus on managing the risks that are still open. The closing of a risk should result in the associated risk reserve being returned to the company.
- Audits can be performed during meetings to assess how well risk processes are working for the project. The auditing process is documented in the risk management plan.

Reserve Analysis

Reserve analysis is a matter of checking to see how much reserve remains and how much might be needed. It is like checking the balance in your bank account to ensure your monthly budget is on track. Reserves must be protected throughout the project life cycle.

Now let's talk about a concept that can be tricky on the exam, especially for those who are not experienced in systematically managing risk. People wanting to change the project in response to problems that have occurred may suggest using the reserves instead of adding cost or time to the project. It is important to know that a contingency reserve may only be used to handle the impact of the specific risk it was set aside for. So, if the change is part of the risk response plan that was previously accounted for in the budget, the reserve designated for that response may be used. If it is not, the project manager must take preventive or corrective action, fast track, crash, or otherwise adjust the project to accommodate or make up for the impact of the problem and its resulting changes, or request new reserve line items.

Under certain circumstances, usually determined by the project sponsor, management reserves may be used for situations that are within the scope of the project but were not previously identified.

Example Assume that a change to the product order functionality on a website has exposed an unidentified data-sharing incompatibility with the real-time data on the legacy inventory management system. A workaround needs to be created to keep the project on track. Management reserves will be used to hire experts to fix the problem and keep the project close to the current schedule.

If identified risks do not occur, the associated time or cost reserves are returned to the company, rather than used to address other issues on the project. If you are inexperienced with risk management, make sure you understand how reserves are used and protected.

Technical Performance Analysis

Technical performance analysis uses project data to compare planned versus actual completion of technical requirements to determine if there is any variance from what was planned. Any variance could indicate possible risks to the project, either opportunities or threats.

Agile Retrospectives and Risk Burndown Charts

Retrospectives and risk burndown charts are agile tools that allow for ongoing monitoring and controlling for risks.

- Retrospectives occur throughout an agile project at the end of iterations. Retrospectives offer a number of benefits for controlling risk including improved:
  - ✓ Productivity by identifying and applying lessons learned immediately.
  - ✓ Capability by providing a venue for spreading scarce knowledge (or tacit knowledge).
  - ✓ Quality by finding circumstances that have led to defects and removing the causes.
  - ✓ Capacity by finding process improvements, which in turn improve a team's work capacity.
- Risk burndown charts may be used for planning, managing, and controlling risk. These charts allow stakeholders to easily see a risk profile on a project. Risk burndown charts quickly inform stakeholders whether the threats are moving in the right direction (downward), or if they are escalating. See the example in figure 12.9 in which the project team is developing library software for patrons who are looking for jobs. Four risks have been identified.

The biggest risk is that the "Resume builder" software is not able to make a nice-looking, professional resume because it can't decide where a logical page break should be inserted. The team performs a risk spike in January to try an artificial intelligence module to find the best place for the page break. When they succeed, the associated risk is eliminated and in turn the overall project risk was reduced by early February.

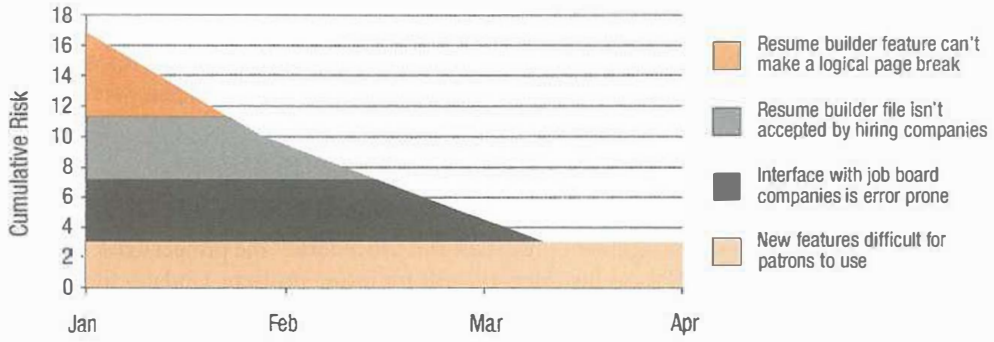


FIGURE 12.9 *Risk burndown chart*

Artifacts of Monitor Risks

As with other risk management processes, change requests, updates to any project management plan component, the risk register, risk report, and other project documents are a result of Monitor Risks, along with additional outputs listed here.

Work Performance Information

This is the analysis of the work performance data gathered as part of project control. Examples include:

- Results of risk reviews and audits
- Performance measurements on schedule progress
- Determinations of which risks can be closed or are likely to close in the near future
- Variance analyses comparing the planned versus actual risk data
- Time and cost of implemented risk responses

In agile and hybrid environments risk response plans are recorded and carried out as stories in the backlog. Information is exchanged in daily standup meetings about new accomplishments as well as impediments, and is documented through an updated backlog and burnup and burndown charts.

Risk Register Updates

The Monitor Risks process will add the following to the risk and lessons learned registers:

- Outcomes of risk reassessments and risk audits
- Results of implemented risk responses
- Updates to previous parts of risk management, including the identification of new risks
- Closing of risks that are no longer applicable
- Details of what happened when risks occurred
- Lessons learned

TRICKS OF THE TRADE® Carefully read situational questions that describe suggested changes resulting from risk processes to determine whether the actual work of the project has begun. You will have to determine what efforts are generating the change requests to help you evaluate answer choices. If the work of monitoring risks is being performed, new risks may be identified, or planned risk responses may need to be adjusted based on project knowledge or an evaluation of risk processes.

As a result of approved changes, risk planning must again be performed appropriately, and new risks must be evaluated and ranked, which may result in more risk response planning. This will generate change requests to integrated change control. The trick here is to remember that the approved project management plan and baselines are not static but changes to them must go through integrated change control.

Organizational Process Asset Updates

The Monitor Risks process may include the creation or enhancement of risk templates, such as the risk register, checklists, and risk report, as well as updates to risk management processes and procedures. The project's risk breakdown structure, backlog, and other data may be added to OPAs as historical records for future projects. Updates to agile project artifacts, like new backlog and burndown chart versions, as well as records of planned vs. actual iteration velocities are also organizational process assets.

TRICKS OF THE TRADE® The exam may describe situations where the wrong thing is being done as a way of testing whether you realize it is wrong. Some of the following common risk management mistakes can help you consolidate your knowledge of risk management:

- Risk identification is completed without knowing enough about the project and then not iterated.
- Padding of estimates is used instead of the risk management process.
- The processes of Identify Risks through Perform Quantitative Risk Analysis are blended, resulting in risks that are evaluated or judged as they come to light. This decreases the number of total risks identified and causes people to end risk identification too soon.
- The risks identified are general rather than specific (for example, "communications" rather than "poor communication of customer's needs regarding installation of system XYZ could cause two weeks of rework").
- Some things considered to be risks are not uncertain; they are facts and are therefore not risks.
- Whole categories of risks (such as technological, cultural, marketplace, etc.) are missed.
- Only one method is used to identify risks (for example, only using a checklist) rather than a combination of methods. A combination helps ensure that more risks are identified.
- The first risk response strategy identified is selected without looking at other options and finding the best option or combination of options.
- Risk management is not given enough attention.
- Project managers do not explain the risk management process to their team during project planning.
- Contracts are signed long before risks to the project are discussed.

12.6 Exercise

The Risk Management Process

There may be many questions about the process of risk management on the exam. The following exercise tests if you understand what you have read. In your Exercise Notebook draw seven columns with headings of the seven processes. Your table can be organized like the following table. Then recreate the risk management process, including the outputs. Check your answers against our answers when you are done. You may need to repeat this after you have iterated your risk study process. Three attempts usually ensures you know the process well enough for the exam.

Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis	Plan Risk Responses	Implement Risk Responses	Monitor Risks
Actions						
Outputs						

Answer

Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis	Plan Risk Responses	Implement Risk Responses	Monitor Risks
Actions						
• Answers the following questions: - How will you perform risk management on the project? - What risk management policies or procedures exist, and what new ones are needed? - When will the processes and procedures of risk management be performed? - How will risks be identified, and what tools will be used? - What are stakeholders' roles and responsibilities for risk management? - Howwill you budget for risk management? - What are the appetites and thresholds for risk?	• Identify all the risks on the project. • Use tools such as brainstorming, root cause analysis, documentation review, checklists, interviews, SWOT analysis, assumptions and constraints analysis, and prompt lists to facilitate risk identification. • Involve and engage stakeholders in the risk management process.	• Qualitatively determine which risk events warrant a response. • Assess the quality of the risk data. • Complete a risk urgency assessment. • Subjectively determine the probability and impact of all risks. • Determine if you will perform quantitative risk analysis or proceed directly to risk response planning. • Find ways to represent the analyzed data from qualitative risk analysis. • Document the watch list (noncritical risks). • Determine the overall risk ranking for the project.	• Numerically evaluate the top risks. • Quantitatively determine which risks warrant a response. • Determine initial reserves. • Create realistic time and cost objectives. • Determine the probability of meeting project objectives.	• Use risk response strategies to decrease project threats and increase opportunities. • Create contingency and fallback plans. • Determine secondary and residual risks. • Calculate final reserves. • Determine risk owners (if not already done). • Identify risk triggers. • Accept or escalate risks, where appropriate.	• Implement contingency and fallback plans (risk owner and resources). • Answer questions and facilitate clarification of plan details. • Communicate with stakeholders according to the plan.	• Respond to risk triggers. • Monitor residual risks • Create workarounds. • Evaluate effectiveness of plans. • Look for additional risks; then qualify, quantify, and plan responses for them as necessary. • Revisit the watch list. • Analyze work performance data and look for trends. • Update plans. • Communicate risk status. • Close risks. • Recommend changes, including corrective and preventive actions. • Perform risk audits and risk reviews. • Perform reserve analysis.

Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis	Plan Risk Responses	Implement Risk Responses	Monitor Risks
			Outputs			
• Risk management plan	• Risk register updates, including: - List of risks - Potential risk owners - List of potential risk responses • Risk report with summary information on risk details and the sources of overall project risk • Project documents updates, such as lessons learned in the identification of risks for the project, any issues, and new or existing assumption and constraint information	• Risk register updates, including: - Risk ranking of the project as compared to other projects - List of prioritized risks - Risks by category - Risks needing additional analysis and response - Watch list - Data on probability and impact analysis - Data on risk urgency - Assumptions and constraints analysis updates in assumptions log	• Project document updates, including the following updates to the risk report: - Assessment of overall project risk exposure - Probability of meeting objectives - Interpreted quantitative analysis results, such as key sources of overall project risk Prioritized list of individual project risks - Trends in quantitative risk analysis results - Recommended risk responses - Initial reserves • Updates to the risk register on the specific analysis for individual project risks	• Change requests • Updates to the project management plan and project documents, including: - Assumptions log - Cost forecasts - Lessons learned register - Project schedule - Project team assignments - Risk report • Updates to the risk register, including: - Residual and secondary risks - Contingency and fallback plans - Risk owners - Triggers - Final reserves - Contracts - Accepted risks	• Change requests to project management plan, including schedule and cost baselines • Updates to project lessons learned register, including the effectiveness of risk responses and recommendations for managing future risks • Updates to the issue log regarding areas of confusion or disagreement • Updates to the risk report regarding: - Overall project risk exposure after implementing planned responses - Changes to planned risk responses • Updates to the risk register, including data on risk response implementations	• Work performance information • Updates to the risk register and other project documents, including: - Outcomes of risk reviews and audits - New risks - Closed risks - Details of risk occurrences - Lessons learned - Workarounds • Change requests, including recommended corrective and preventive actions • Updates to the project management plan and organizational process assets • Updates to the risk report

Putting It All Together

The responsibilities of risk management are basically the same for both predictive and adaptive environments. But, instead of doing all the risk management planning up front, agile teams go through risk identification and analysis and threat mitigation or elimination during release planning and for each iteration. For the exam, make sure you have a clear understanding of the risk management process and what happens in each process group.

Don't forget to review the Quicktest at the beginning of the chapter to identify any gaps in your knowledge.

The following exercise tests your understanding of threats and opportunities and the type of response, using the library case study as an example.

12.7 Exercise

For each risk and response below, indicate if it is a threat or opportunity and note the type of response being proposed.

Risk	Threat or Opportunity	Response	Type of response (mitigate, avoid, enhance, etc.)	Probability
1. New mayor or city council members decide to cut spending		Build strong community support to decrease likelihood.		Medium
2. A wealthy benefactor donates to have their name on the library and the city council agrees.		Meet with potential benefactors.		Low
3. Construction is delayed by weather and material shortages.		Plan inside work for rainy days; set aside reserves for expediating materials if necessary.		Medium
4. A coffee shop could bring in more revenue than expected (possibly from people who are not even using the library).		Partner with a coffee shop franchise to run the shop.		High
5. A community member forms a group to protest the library building costs.		Build strong community support.		Low
6. A construction worker is injured on the job site and requires medical care.		Make sure all contractor workers are covered by an accident insurance policy with medical coverage.		Low

Answer

Risk	Threat or Opportunity	Response	Type of response (mitigate, avoid, enhance, etc.)	Probability
1. New mayor or city council members decide to cut spending	Threat	Build strong community support to decrease likelihood.	Mitigate	Medium
2. A wealthy benefactor donates to have their name on the library and the city council agrees.	Opportunity	Meet with potential benefactors.	Enhance	Low
3. Construction is delayed by weather and material shortages.	Threat	Plan inside work for rainy days; set aside reserves for expediating materials if necessary.	Mitigate	Medium
4. A coffee shop could bring in more revenue than expected (possibly from people who are not even using the library).	Opportunity	Partner with a coffee shop franchise to run the shop.	Share	High
5. A community member forms a group to protest the library building costs.	Threat	Build strong community support.	Mitigate	Low
6. A construction worker is injured on the job site and requires medical care.	Threat	Make sure all contractor workers are covered by an accident insurance policy with medical coverage.	Avoid	Low

12.8 Exercise

Now let's look at the library case study using an adaptive approach. The library software system upgrade also has some risks. Using the adaptive approach, risks will be planned into iterations as risk spikes or tests.

Indicate the order in which the following risks should be addressed.

Risk	Response or spike plan	Sequence
The number of users is more than expected and slows the performance of the software.	A risk spike testing 10,000 concurrent users will be conducted.	
Software is not built with adequate cybersecurity protections and is hacked.	The first iteration of the software will include a virus scanner which will run daily to detect potential problems.	
The search capabilities in the software are not adequate for most patrons of the library	The software will collect all terms entered into the Search box and analyze them monthly.	

Answer

Risk	Response or spike plan	Sequence
The number of users is more than expected and slows the performance of the software.	A risk spike testing 10,000 concurrent users will be conducted.	2
Software is not built with adequate cybersecurity protections and is hacked.	The first iteration of the software will include a virus scanner which will run daily to detect potential problems.	1
The search capabilities in the software are not adequate for most patrons of the library	The software will collect all terms entered into the Search box and analyze them monthly.	3