7

Risk Management

Chapter Outline

Chapter Objectives

After completing this chapter, you should be able to:

1. Define project risk.
2. Recognize four key stages in project risk management and the steps necessary to manage risk.
3. Understand five primary causes of project risk and four major approaches to risk identification.
4. Recognize four primary risk mitigation strategies.
5. Explain the Project Risk Analysis and Management (PRAM) process.

PROJECT MANAGEMENT BODY OF KNOWLEDGE CORE CONCEPTS COVERED IN THIS CHAPTER

1. Plan Risk Management (PMBoK sec. 11.1)
2. Identify Risks (PMBoK sec. 11.2)
3. Perform Qualitative Risk Analysis (PMBoK sec. 11.3)
4. Perform Quantitative Risk Analysis (PMBoK sec. 11.4)
5. Plan Risk Responses (PMBoK sec. 11.5)

6. Control Risks (PMBoK sec. 11.6)

PROJECT PROFILE

The Building that Melted Cars

Driving a car in London just got a lot more dangerous. A soon-to-be-completed skyscraper in the downtown area is having an impact that no one could have imagined: It is starting fires and melting cars. The building—designed by internationally renowned architect Rafael Viñoly—is a dramatic edifice with curved exterior walls. Built at 20 Fenchurch Street in London's financial center, the 38-story skyscraper is known locally as "the Walkie-Talkie" for its unusual shape.

But that curvilinear shape is exactly what's causing the problem: The south-facing exterior wall is covered in reflective glass, and because it's concave, it focuses the sun's rays onto a small area, not unlike the way a magnifying glass directs sunbeams onto a superhot pinpoint of light.

"Fundamentally it's reflection. If a building creates enough of a curve with a series of flat windows, which act like mirrors, the reflections all converge at one point, focusing and concentrating the light," says Chris Shepherd, from the UK's Institute of Physics. "It's like starting a fire with a parabolic mirror."

The beam caused by the curved skyscraper concentrating the sun's rays was measured at more than 110 degrees Celsius (230 degrees Fahrenheit) in September. So far, the building has been responsible for partially destroying a parked Jaguar XJ luxury car, catching carpets on fire in nearby shops, and shattering slate tiles at local restaurants. This situation is likely to be a recurring problem for any structure built within range of the powerful reflected light coming from the building.

Because the effect is caused by the sun's elevation in the sky at certain times of the day and during a specific time of the year, experts expect the intense light and dangerous heating effect will last about two hours a day over a period of three weeks. To help in the short term, the building's owners have contracted with local authorities to block off a limited number of parking spaces that are right in the reflected beam's path. Longer term solutions are more problematic; the design of the building will not change and of course, the sun's path is not likely to alter in the near future!

This isn't the first time Viñoly's architecture has been the subject of similar controversy: His Vdara Hotel in Las Vegas has been criticized for directing sunbeams onto the swimming pool deck that are hot enough to melt plastic and singe people's hair. The technical term for the phenomenon is a solar convergence, but the hotspot more popularly became known as the "Vdara death ray." The Vdara resolved the "death ray" effect with larger sun umbrellas, but fixing the problem in London might take a lot more work. "There are examples in the past where an architect has had to rebuild the façade," said Philip Oldfield, an expert in tall buildings at the University of Nottingham's Department of Architecture. "If this is serious, then I dread to think how expensive it will be."

Architectural critic Jonathan Glancey says the story is not unprecedented. In 2003, the opening of the Walt Disney Concert Hall in Los Angeles, designed by architect Frank Gehry, had a similar problem. "The building was clad from head to toe, right down to the pavement, in stainless steel panels, and they would send the sun dazzling across the

FIGURE 7.1 London's Walkie-Talkie Building

Source: Lionel Derimais/Corbis

sidewalks to hotspots where people were. It was measured up to 60C (140F). Local people living there complained they were having to crank their air conditioning up to maximum to cool things down," he says. Blinding glare also affected drivers passing the building. After computer models and sensor equipment identified the panels causing the problem, they were sanded down to break up the sun's rays.

In the case of the London Walkie-Talkie building, developers could employ a number of possible solutions. "They could coat the windows to reduce reflection—which would be a cheap fix—but the downside of that is it could reduce the light entering the building. Another solution would be for them to misalign the window frames, to slightly alter them by about a millimeter, but that would be very expensive," Chris Shepherd noted.[1]

INTRODUCTION

Projects operate in an environment composed of uncertainty. There is uncertainty regarding project funding, the availability of necessary resources, changing client expectations, potential technical problems—the list is seemingly endless. This uncertainty forms the basis for project risk and the need to engage in risk management. **Risk management**, which recognizes the capacity of any project to run into trouble, is defined as the art and science of identifying, analyzing, and responding to risk factors throughout the life of a project and in the best interests of its objectives. The difference between projects that fail and those that are ultimately successful has nothing to do with the fact that one lacks problems the other has. The key lies in the plans that have been made to deal with problems once they arise. The Project Management Institute defines **project risk** as "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, or quality. A risk may have one or more causes and if it occurs, may have one or more impacts." This definition is important because, unlike the past, when project risk was automatically assumed to lead to negative consequences, it is now recognized as the source of either opportunities *or* threats. As a result, whereas in the past leading project management researchers assumed that project risk was "an estimate of the probability of loss from a large population of unwanted circumstances,"[2] risk in the modern sense argues that the uncertainty that exists in any project can result in either positive or negative outcomes. Project managers must acknowledge the possibility that the same risk event may bring several outcomes, of both a positive and detrimental effect on the project. Underlying these definitions is the recognition that many events, both within the organization and outside its control, can affect our best efforts to successfully complete projects.

Risk management consists of anticipating, at the beginning of the project, unexpected situations that may arise that are beyond the project manager's control. These situations have the capacity to severely undermine the success of a project. Broadly speaking, for the manager, the process of risk management includes asking the following questions:

- What is likely to happen (the probability and impact)?
- What can be done to minimize the probability or impact of these events?
- What cues will signal the need for such action (i.e., what clues should I actively look for)?
- What are the likely outcomes of these problems and my anticipated reactions?

This chapter will explore the concept of project risk management in detail. We will address some of the principal sources of uncertainty, and hence risk, in projects. The chapter will also provide information on identifying the key steps to consider in formulating project risk management processes, methods for assessing risk impact, and processes for mitigating negative effects.

Project risk is based on a simple equation:

$$\text{Event Risk} = (\text{Probability of Event})\ (\text{Consequences of Event})$$

In other words, all risks must be evaluated in terms of two distinct elements: the likelihood that the event is going to occur as well as the consequences, or effect, of its occurrence. The risk of a project manager in your company being struck by lightning on the way to work would clearly constitute a high level of consequence to the project, but the probability of such an occurrence is sufficiently low to minimize your need to worry about it. On the other hand, people do change jobs, so an low to minimize your need to worry about it. On the other hand, people do change jobs, so an event such as the loss of a key project team member midway through the development phase may have both a potentially serious impact and a high degree of probability in some organizations. Hence, in those project environments, it would be appropriate to develop mitigation strategies to address this risk, given its high likelihood of occurring and the negative consequences it would engender. For example, the project manager could develop a bonus or other incentive program to reward personnel who remain on the project team as a useful response (risk mitigation) for the potential loss of key personnel during the project.

Risk and opportunity are mirror opposites of the same coin—opportunity emerges from favorable project uncertainties and negative consequences from unfavorable events. Figure 7.2 illustrates the dynamics of risk and opportunity over the project life cycle compared to the severity of negative consequences. Early in the life of a project, both risk and opportunity are high. The concept may be thought valuable, and the opportunities are strong, as are the negative risks. This result is due to the basic uncertainty early in a project's life cycle. Until we move forward into the development phases, many unanswered questions remain, adding to overall project uncertainty. On the other hand, the severity of negative consequences (the "amount at stake") is minimal early in the project's life. Few resources have yet been committed to the project, so the company's exposure level is still quite low. As the project progresses and more budget money is committed, the overall potential for negative consequences ramps up dramatically. At the same time, however, risk continues to diminish. The project takes on a more concrete form and many previously unanswered questions ("Will the technology work?" "Is the development time line feasible?") are finding answers. The result is a circumstance in which overall opportunity and risk (defined by their uncertainty) are dropping just as the amount the company has at stake in the project is rising.

The periods of greatest worry shown in Figure 7.2 are the execute and finish stages, at which point uncertainty is still relatively high and the amount at stake is rapidly increasing. The goal of a risk management strategy is to minimize the company's exposure to this unpleasant combination of uncertainty and potential for negative consequences.

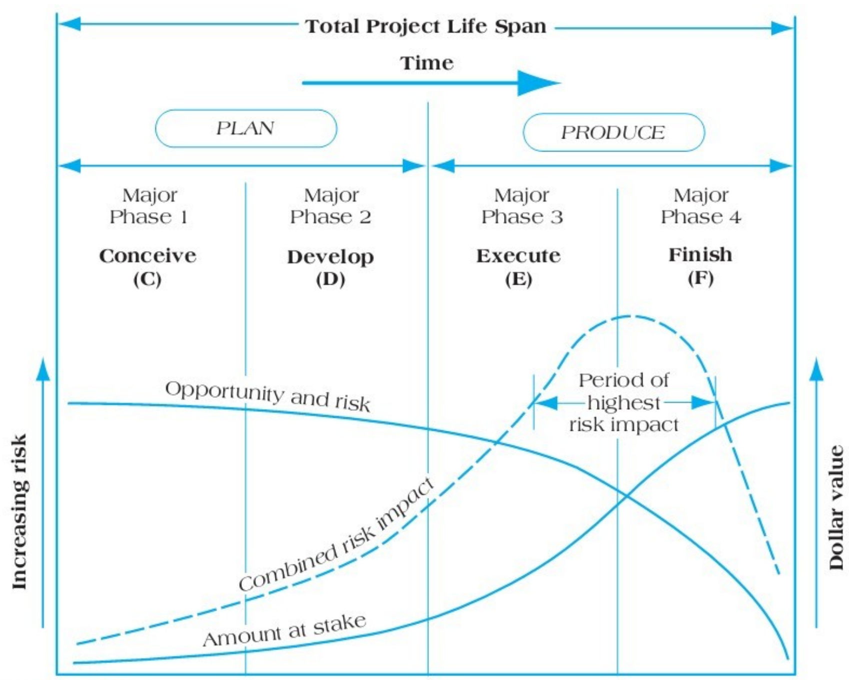

FIGURE 7.2 Risk Versus Amount at Stake: The Challenge in Risk Management

Source: R. Max Wideman. (2004). *A Management Framework for Project, Program and Portfolio Integration*. Victoria, BC, Canada, 2004. Copyright © 2004 by R. Max Wideman, AEW Services Vancouver, BC, Canada: Trafford Publishing. Figure from page 64. Reproduced with permission of R. Max Wideman.

BOX 7.1

Project Managers in Practice

Mathew Paul, General Electric Company

Mathew Paul is the Program Leader for Liquefied Natural Gas (LNG) Locomotives at GE Transportation in Erie, PA. He is currently responsible for leading the introduction of GE's natural gas locomotives for domestic markets from the Engineering function. Mathew completed his Bachelor's in Mechanical Engineering from The University of Kerala, India, in 1998. After a short stint at Cochin Port Trust and Lucent Technologies in India, he decided to pursue his Master's in Mechanical Engineering at The University of Alabama, Tuscaloosa. He also holds a Master's in Business Administration from Fogelman's College of Business at The University of Memphis, Tennessee. He is PMP certified and a Six Sigma Green Belt.

Mathew's career started as an Engineer at Cummins working on new internal combustion engine introduction projects to meet customer requirements and environmental regulations. His specific job was to identify combustion recipes and meet engine performance requirements. However, during the recession of 2008, he was given the responsibility of leading cost reductions as well as identifying profitable projects for the business. Identifying components that either need to be avoided in the engine or redesigned to gain economies of scale was not an easy task due to the wide application and customer base. Project management methodologies had to be implemented to execute the tasks and show the benefits to customers. It was in meeting these challenges that Mathew learned the art of project management and decided to switch careers to project management.

In 2010, Mathew led the introduction of a low-cost Cummins fuel injection system in China for the trucking market to capture market share and reduce dependence on other firms' products. It was the first of its kind for Cummins Fuel Systems and the team quickly realized that a different approach was required to be successful in China. His specific tasks included managing a project comprised of people from both China and the United States in designing, developing, testing, and manufacturing the fuel system. Due to the magnitude of the project, project management methodologies were introduced for the first time at Cummins Fuel Systems. In his words, "The main challenge was to use the data-based approach in communicating with customers, suppliers, and team members as the Chinese culture is mostly customer-centric and saying 'no' was never appreciated. The profit margin per unit was very low and business was based on volume. Maintaining risks—both in quality and cost—was critical for the success of the project."

After the successful implementation of the low-cost fuel system for Cummins, Mathew moved to GE Transportation to introduce PowerHaul™ locomotives in Australia and Korea. Paul recounts, "Even though the product was similar, the challenges were different—while meeting tight schedules was critical for Australia, maintaining customer relations and the highest quality were primary requirements for Korea." Mathew was also tasked to lead GE Transportation's first natural gas locomotive project for domestic markets. Due to the

FIGURE 7.3 An Example of the Next-Generation GE Locomotives that Mathew Paul Supports

Source: Sean Gallup/Getty Images

(continued)

availability of shale gas in the United States, the move to natural gas as the predominant fuel for locomotives seemed a logical next step. However, being a new technology, the safety of personnel and environment was considered as the paramount criteria. "The project was huge as part of my job involved coordinating the work of 250 people from five different countries with an initial investment of over $70 million dollars. We constructed and followed risk analysis and risk mitigation plans that had to be constantly updated—pretty much every day—due to the nature of the project. The project was capital intensive and eagerly awaited by customers, government, and competitors."

Mathew recollects that every project to date had been different and that makes it critical to follow a project management methodology for standard guidelines. He notes that planning is critical for the success of the project and executing the plan is essential; however, the key for any project manager is to have a "sixth" sense about potential risks and be able to respond to it at the earliest. Even with these challenges, the final outcome for any project manager is very fulfilling. "When the first natural gas locomotive was cranked and pulled the load at the desired speed, my eyes watered with joy. I got to experience several firsts in my life. When the first Cummins Tier 3 19L engine was rolled out of their Seymour engine plant, when the first fuel system rolled out of Cummins Wuhan plant, and when the first PowerHaul™ GE engine was unveiled at the customer property in Australia, to cite a few." As Paul has found, that is the moment when years of hard work, volumes of documentation, and hours of meeting converge and only a project manager can envision the final product and strive towards attaining the same on a daily basis.

7.1 RISK MANAGEMENT: A FOUR-STAGE PROCESS

Systematic risk management comprises four distinct steps:

- **Risk identification**—the process of determining the specific risk factors that can reasonably be expected to affect your project.
- **Analysis of probability and consequences**—the potential impact of these risk factors, determined by how likely they are to occur and the effect they would have on the project if they did occur.
- **Risk mitigation strategies**—steps taken to minimize the potential impact of those risk factors deemed sufficiently threatening to the project.
- **Control and documentation**—creating a knowledge base for future projects based on lessons learned.

Risk Identification

A useful method for developing a risk identification strategy begins by creating a classification scheme for likely risks. Remember that risk implies the potential for both positive and negative effects on the project. Risks commonly fall into one or more of the following classification clusters:[3]

- **Financial risk**—Financial risk refers to the financial exposure a firm opens itself to when developing a project. If there is a large up-front capital investment required, as in the case of Boeing or Airbus Industries' development of a new airframe, the company is voluntarily assuming a serious financial risk in the project. Construction companies building structures "on spec" provide another example. Without a contracted buyer prior to the construction, these companies agree to accept significant financial risk in the hopes of selling office space or the building itself after it is completed.
- **Technical risk**—When new projects contain unique technical elements or unproven technology, they are being developed under significant technical risk. Naturally, there are degrees of such risk; in some cases, the technical risk is minimal (modifications to an already-developed product), whereas in other situations the technical risk may be substantial. For example, Goodrich Corporation developed a modification to its electronic hoist system, used for cable hoists in rescue helicopters. Because the company had already developed the technology and was increasing the power of the lift hoist only marginally, the technical risk was considered minimal. On the other hand, the Spanish ship-builder Navantia is currently wrestling with serious performance problems in its newest generation of submarine, the S-80 class, because of the decision to include too many ground-breaking technical upgrades in one ship. The problems with the S-80 are so severe that the submarine itself is considered unsafe and not ready for sea trials (see Case Study 7.2 at the end of the chapter). The greater the level of technical risk, the

greater the possibility of project underperformance in meeting specification requirements.

- **Commercial risk**—For projects that have been developed for a definite commercial intent (profitability), a constant unknown is their degree of commercial success once they have been introduced into the marketplace. Commercial risk is an uncertainty that companies may willingly accept, given that it is virtually impossible to accurately predict customer acceptance of a new product or service venture.
- **Execution risk**—What are the specific unknowns related to the execution of the project plan? For example, you may question whether geographical or physical conditions could play a role. For example, developing a power plant on the slopes of Mount Pinatubo (an active volcano) in the Philippines would involve serious execution risks! Likewise, poorly trained or insufficient project team personnel might constrain project execution. Execution risk is a broad category that seeks to assess any *unique* circumstances or uncertainties that could have a negative impact on execution of the plan.
- **Contractual or legal risk**—This form of risk is often consistent with projects in which strict terms and conditions are drawn up in advance. Many forms of contracted terms (e.g., cost-plus terms, fixed cost, liquidated damages) result in a significant degree of project risk. Companies naturally seek to limit their legal exposure through legal protection, but it is sometimes impossible to pass along contractual risk to other parties. For example, most U.S. railroads will not accept penalty clauses for late deliveries of components because they have an almost monopolistic control of the market. Therefore, organizations utilizing rail transportation must accept all delivery risk themselves.

After understanding the broad categories of risk, you want to anticipate some of the more common forms of risk in projects. The following list, though not inclusive, offers a short set of some of the more common types of risk to which most projects may be exposed:

- Absenteeism
- Resignation
- Staff being pulled away by management
- Additional staff/skills not available
- Training not as effective as desired
- Initial specifications poor or incomplete
- Work or change orders multiplying due to various problems
- Enhancements taking longer than expected

Although the broad categories and common types of risk in the preceding lists are both good starting points, you also need to consider common industry-specific risks that run across different types of projects in the specific field in which you are working. A number of methods, both qualitative and quantitative, are available for conducting risk factor identification for industry-specific risks, including:

- ***Brainstorming meetings***—Bringing the members of the project team, top management, and even clients together for a brainstorming meeting can generate a good list of potential risk factors. Brainstorming is a qualitative idea-creation technique, not one focused on decision making. In order to be effective, brainstorming meetings must be free of judgments, criticism of others' viewpoints, and pressure to conform. A mini-scenario of risk management is at work. Think about it: Would you be willing to place your most creative ideas on the table in front of 10 other people if you were at risk of being immediately critiqued? Or might you be tempted to hold an idea for later if your boss required that you present it in a fully developed way? In short, the brainstorming environment needs to be made safe for the risk-averse.
- ***Expert opinion***—This technique can be used in two alternative ways in assessing project risks. The more quantifiable method, commonly referred to as the Delphi approach, collects and consolidates the judgments of isolated anonymous respondents. For Delphi to be used effectively, some preliminary screening of potential contributors is usually necessary. The collective "wisdom" of the set of experts is then used as the basis for decision making. The simpler, more intuitive method for using expert judgments is based on the principle that "experience counts." You simply identify and consult people within the organization who have had similar experiences in running projects in the past or who have been with the firm long enough to have a clear grasp of the mechanics of project risk analysis. As obvious as this may seem, this opportunity may not be clear to everyone, particularly if management shifts recently have

taken place in a firm or if new employees are not aware of the firm's project history.

- ***History***—In many cases the best source of information on future risks is history. Has a firm encountered a consistent pattern of problems while pursuing projects over time? What "storm signals," or events that have preceded past problems, have been detected? Experience can be used to identify not only risk factors but their leading indicators as well. The problem with experience is that it is no guarantee of future events. The issues or conditions that contributed to project risk in the past decade, year, or even month may not be relevant to current market conditions or the state of project work as it is now being conducted. Hence, history can be useful for identifying key project risk factors provided all parties employ a reasonable degree of caution when evaluating current projects through the portal of past events. Rauma Corporation of Finland, for example, developed state-of-the-art logging equipment that worked well in locations with good infrastructure to allow for frequent servicing. When it attempted to use the equipment in remote rain forest regions of Indonesia, however, the company found it had not anticipated the problems involved in routine servicing, including having to fly the machinery hundreds of miles out of the forests to servicing centers. Experience had not prepared the company for new risks.
- ***Multiple (or team-based) assessments***—Using single-case sources to identify project risks is itself a risky proposition because of the potential bias in any one person's viewpoint.[4] It makes sense that no one individual, regardless of her perceived degree of expertise, can possibly discern all sources of threat and project risk. Although an engineer is likely to be more attuned to technical risks, a cost accountant to budgetary risks, and so forth, not even the most seasoned manager with experience in many fields is all-knowing. A team-based approach to risk factor identification encourages identification of a more comprehensive set of potential project risks. At the same time, a collaborative approach can help persuade the half-convinced or uncommitted members of the team to support project goals.[5]

PROJECT PROFILE

Bank of America Completely Misjudges Its Customers

When Bank of America (BofA) decided it would begin to charge customers $5 per month in 2012 just to gain access to their funds via their debit cards, it was unprepared for a response that was far more hostile than it could have imagined. After announcing the new fee in late September 2011, the giant bank anticipated some negative reaction from its customers but thought that after an initial angry response, most would fall in line and grudgingly accept the fee. Perhaps BofA felt secure due to the initial decision by some of its largest competitors, including Wells Fargo, SunTrust, and JPMorgan Chase, to mirror the fees. If BofA thought "might made right," it was in for a giant surprise.

The announcement of a pending new charge just to allow customers to use their debit cards led to massive consumer anger directed at the bank and a pledge that the new fees would not be accepted. These informal protests were galvanized and given a degree of organization by the creation of several viral Internet and Facebook sites to support two major dates in November 2011: "Bank Transfer Day" (November 5) and "Dump your Bank Day" (November 8). Wells Fargo, SunTrust, and JPMorgan Chase banks all dropped their fee-charging plan in the face of these gathering protests, leaving BofA standing alone and continuing to assert its intention of charging the debit card fee. By October 2011, a poll by *TheStreet* showed a whopping 83% of BofA customers said they would indeed take the time out of their busy schedules and dump BofA. Contributing to the poor timing of the BofA announcement was the continuation of the "Occupy Wall Street" protests against financial institutions. Seen in this light, the timing of BofA's decision could not have been worse.

Belatedly realizing its mistake, BofA announced on November 1, 2011, that it was cancelling the $5 debit card fee. Although it is uncertain how many customers BofA lost as a result of this misguided decision, there is no doubt that it sacrificed a huge amount of customer goodwill. In a recession, when Americans were carefully watching their spending, BofA's decisions made no sense. Charging $5 to be allowed to use your own money angered too many and the announcement to drop the charge came too late, causing people to bail on BofA.[6]

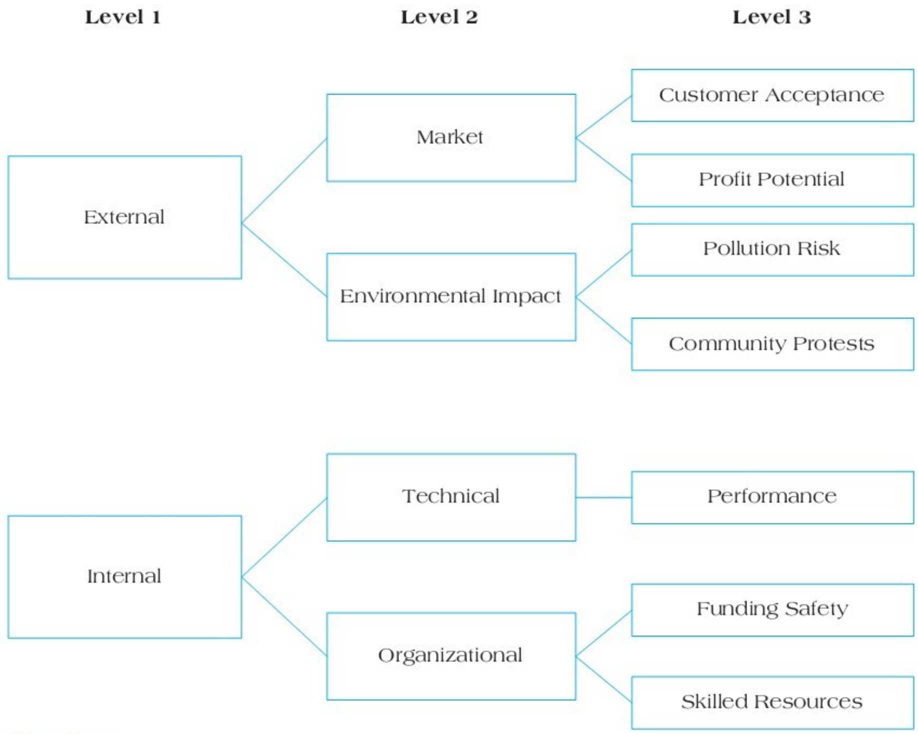

FIGURE 7.4 **Risk Breakdown Structure (RBS)**

Once the process of risk factor analysis is complete and the variety of circumstances or sources of risk have been uncovered, an assessment of potential risk impact can be undertaken.

Risk Breakdown Structures

In identifying and categorizing various project risks, one useful tool is the **Risk Breakdown Structure** (RBS). An RBS is defined as "a source-oriented grouping of project risks that organizes and defines the total risk exposure of the project."[7] Remember in Chapter 5 that we developed the Work Breakdown Structure (WBS) as a means to hierarchically organize and define the various elements of the project scope by breaking up the deliverables into increasingly distinct elements, known as work packages. An RBS employs a similar approach; however, in this case, our goal is to create a hierarchical representation of the project's risks, starting at the higher, general level and breaking the risks down to more specific risks at lower levels. For example, at the highest level, you have both external and internal risks. Specifying more closely, you may identify "Market risks," "Technical risks," "Environmental Impact risks," and "Quality risks" as second level categories. From this first level, your project team breaks out the specific types of risk associated with each of these broader concepts. Figure 7.4 gives an example of an RBS for this hypothetical project. Moving down to more specific risks, we can further classify "Market Risks" as consisting of customer acceptance and profit potential. Likewise, for "Environmental Impact," we have identified two specific risks: pollution risks and community protest potential. A similar de-classification can be conducted across each broader category of project risk. You can see that the advantage of the RBS is that it provides the project team with a visual representation of the critical risks for their project, as well as highlighting the specific components of these risks. This identification method helps with the next step in project risk management: the analysis of probability and consequences associated with each risk.[8]

Analysis of Probability and Consequences

The next step in the process consists of trying to attach a reasonable estimate of the likelihood of each of these risk events occurring. We can construct a risk impact matrix similar to the one shown in Figure 7.5.[9] The matrix reflects all identified project risks, each prioritized according to the probability of its occurrence, along with the potential consequences for the project, the project the probability of its occurrence, along with the potential consequences for the project, the project

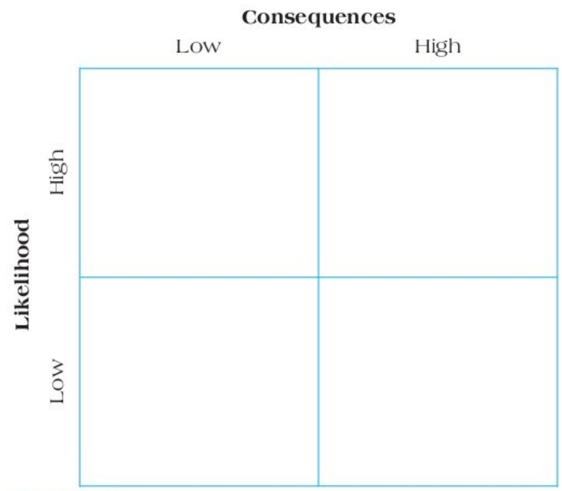

FIGURE 7.5 **Risk Impact Matrix**

team, or the sponsoring organization should the worst come to pass. Probability combined with consequences provides a sense of overall risk impact. With such a prioritization scheme, the project team is better able to focus their attention where their energy can do the most good.

Figure 7.6 shows a risk impact matrix in use by several *Fortune* 500 companies. Note that instead of a high-low classification, this alternative one features three levels: high, medium, and low. This matrix is further refined by classifying risk impact as either serious, moderate, or minor. The fundamental reason for employing this more complete matrix is to develop a sense of priority in addressing the various risks.

After a project team has worked through and completed a detailed matrix, it is better equipped to recognize the sorts of risks to which the project is subject and the "criticality" of each of those risks in terms of their potential impact on project performance. Clearly, the types of risks that are most relevant to project planning are those that the team classifies as having both high likelihood of occurring (probability) and high potential for harming the project (impact). Risks that fall into this category require detailed contingency planning in order to adequately protect the project's development cycle. Figure 7.6 shows how projects might be classified on the basis of their potential risk impact. The team first identifies the risk factors and then evaluates their impact using the matrix. You can see how the high-low-moderate classification scheme plays out in this example.

It is also useful to revisit our earlier point about the potential opportunities that may emerge from the uncertainty of project risk. That is, when analyzing the probability and consequences of risk events, we should include, as part of our calculation, the ways in which these uncertainties can

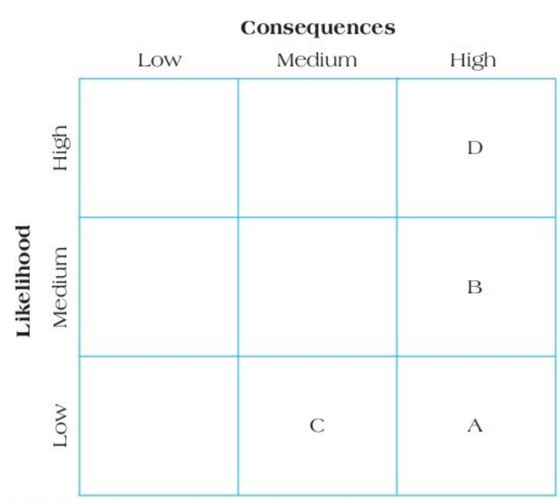

FIGURE 7.6 **Classifying Project Risks**

open up opportunities for the organization. For example, if our project team identifies several project risks (market, technical, political, etc.), brainstorming sessions can help us determine if these risks are distinctly negative or if they open up the possibility of finding innovative, win-win solutions by transforming them into opportunities. For example, a firm may have concern about the risk from possible governmental regulations regarding reducing greenhouse gases to slow man-made climate change. These concerns can lead a firm to adopt one of two actions: (1) defensive—employing lobbyists to try and derail the legislation to maintain business as usual, or (2) opportunistic—getting out ahead of the regulations by challenging business units to start employing nontraditional, sustainable solutions to technical challenges, leading to new products or processes that they can market to other firms facing similar challenges. As a result, part of our analysis of risk probability consequences should always take into consideration both negative and positive consequences.

Table 7.1 illustrates this quantitative method using the example of a firm developing a new software product for the retail market. The scenario considers both probability of failure and consequences of failure. In *probability of failure,* we are interested in identifying any factors that can significantly affect the probability that the new prject can be successfully completed. Think of this category as requiring us to focus on the potential *causes* of failure. For the example in this section, let us assume that the issues identified as potential contributors are (1) maturity of the software design—is it a new product or based on an existing software platform? (2) complexity of the

TABLE 7.1 Determining Likely Risks and Consequences

Probability of Failure (P_f)

Score	Maturity	Complexity	Dependency
Low (0.1)	Existing software	Simple design	Not limited to existing system or clients. No external or uncontrollable events are likely to have an impact on the project.
Minor (0.3)	Minor redesign	Minor increase in complexity	Schedule or performance depends on an existing system. Effect on cost or schedule is minor.
Moderate (0.5)	Major change	Moderate increase	Moderate risk to schedule or performance due to dependence on existing system, facility, or processes. Effect on cost is moderate.
Significant (0.7)	Technology is available, but complex design	Significant increase	Schedule or performance depends on new system or process. Significant cost or schedule risk.
Major (0.9)	State of art, some research complete	Extremely complex	Schedule and performance depend on new system and process. Very high cost or schedule risk.

Consequence of Failure (C_f)

Score	Cost	Schedule	Reliability	Performance
Low (0.1)	Budget estimate not exceeded	Negligible impact on program, no impact on critical path	Minimal or no reliability consequence	Minimal or no performance consequence.
Minor (0.3)	Cost estimate exceeds budget by < 5%	Minor slip in schedule (less than 5%)	Small reduction in reliability	Small reduction in system performance.
Moderate (0.5)	Cost estimate exceeds budget by < 15%	Small slip in schedule starting to impact critical path	Some reduction in reliability	Some reduction in system performance. May require moderate debugging.
Significant (0.7)	Cost estimate exceeds budget by < 30%	Development time slips in excess of 1 month, requires readjustment of critical path	Significant degradation in reliability	Significant degradation in system performance. Guarantees are at risk. Serious debugging required.
Major (0.9)	Cost estimate exceeds budget by > 50%	Large schedule slips ensure the system will miss client time frame	Reliability goals cannot be achieved under current plan	Performance goals cannot be achieved. Results may not be usable.

TABLE 7.2 Calculating a Project Risk Factor

1. Use the project team's consensus to determine the scores for each Probability of Failure category: Maturity (P_m), Complexity (P_c), Dependency (P_d).
2. Calculate P_f by adding the three categories and dividing by 3:

$$P_f = (P_m + P_c + P_d)/3$$

3. Use the project team's consensus to determine the scores for each Consequence of Failure category: Cost (C_c), Schedule (C_s), Reliability (C_r), Performance (C_p).
4. Calculate C_f by adding the four categories and dividing by 4:

$$C_f = (C_c + C_s + C_r + C_p)/4$$

5. Calculate Overall Risk Factor for the project by using the formula:

$$RF = P_f + C_f - (P_f)(C_f)$$

Rule of Thumb:

Low risk	$RF < .30$
Medium risk	$RF = .30$ to $.70$
High risk	$RF > .70$

product—is the design relatively simple or is it highly complex in structure? and (3) dependency—can the product be developed independently of any system currently in place in the company or is it tied to current operating systems or practices? A number of factors can have an impact on the probability of a new project's successful completion. Although our example identifies three (maturity, complexity, and dependency), depending upon the project, a team may identify many unique issues or factors that will increase the probability of failure.

Under the dimension of *consequences of failure,* we are concerned with the issues that will highlight the *effects* of project failure. The consequences of failure require us to critically evaluate the results of a project's success or failure along a number of key dimensions. For this example, the organization has identified four elements that must be considered as critical effects of project failure: (1) cost—budget adherence versus overruns, (2) schedule—on time versus severe delays, (3) reliability—the usefulness and quality of the finished product, and (4) performance—how well the new software performs its designed functions. As with items shown under probability of failure, the set of issues related to the consequences of failure that should be clearly identified will be unique to each project.

Table 7.2 demonstrates the process of creating a project risk score. The scores for each individual dimension of probability and consequence are added and the sum is divided by the number of factors used to assess them. For example, under *probability of failure,* the scores of the three assessed elements (maturity, complexity, and dependency) are totaled to derive an overall score, and that number is divided by 3 to arrive at the probability score. This table shows the overall risk factor formula for the sample project, based on the quantitative assessment. A common rule of thumb assigns any project scoring below .30 as "low risk," projects scoring between .30 and .70 as "medium risk," and projects scoring over .70 as "high risk."

Risk Mitigation Strategies

The next stage in risk management is the development of effective risk mitigation strategies. In a general sense, there are four possible alternatives a project organization can adopt in deciding how to address risks: (1) accept risk, (2) minimize risk, (3) share risk, or (4) transfer risk.

ACCEPT RISK One option that a project team must always consider is whether the risk is sufficiently strong that any action is warranted. Any number of risks of a relatively minor nature may be present in a project as a matter of course. However, because the likelihood of their occurrence is so small or the consequences of their impact are so minor, they may be judged acceptable and ignored. In this case, the decision to "do nothing" is a reasoned calculation, not the result of inattention or incompetence. Likewise, for many types of projects, certain risks are simply part of the equation and must be factored in. For example, it has been estimated that the U.S. recording the equation and must be factored in. For example, it has been estimated that the U.S. recording industry spends millions every year in developing, producing, and promoting new recording artists, knowing full well that of the thousands of albums produced every year, less than 5% are profitable.[10] Likewise, Chapter 3 detailed the extraordinary lengths that pharmaceutical manufacturers must go to and the high percentage of failures they accept in order to get a small percentage of commercially successful drugs to the marketplace. Hence, a high degree of commercial risk is embedded in the systems themselves and must be accepted in order to operate in certain industries.

MINIMIZE RISK Strategies to minimize risk are the next option. Consider the challenges that Boeing Corporation faces in developing new airframes, such as the newly introduced 787 model. Each aircraft contains millions of individual parts, most of which must be acquired from vendors. Further, Boeing has been experimenting with the use of composite materials, instead of aluminum, throughout the airframe. The risks to Boeing in the event of faulty parts leading to a catastrophic failure are huge. For example, several early flights were plagued by meltdowns in the aircraft's lithium ion batteries, manufactured in Japan by GS Yuasa. Consequently, the process of selecting and ensuring quality performance from vendors is a challenge that Boeing takes extremely seriously. One method Boeing employs for minimizing risk in vendor quality is to insist that all significant vendors maintain continuous direct contact with Boeing quality assessment teams. Also, in considering a new potential vendor, Boeing insists upon the right to intervene in the vendor's production process in order to ensure that the resulting quality of all supplier parts meets its exacting standards. Because Boeing cannot produce all the myriad parts needed to fabricate an aircraft, it seeks to minimize the resultant risk by adopting strategies that allow it to directly affect the production processes of its suppliers.

SHARE RISK Risk may be allocated proportionately among multiple members of the project. Two examples of risk sharing include the research and development done through the European Space Agency (ESA) and the Airbus consortium. Due to tremendous barriers to entry, no one country in the European Union has the capital resources and technical skills to undertake the development of the Ariane rocket for satellite delivery or the creation of a new airframe to compete with Boeing in the commercial aircraft industry. ESA and Airbus partners from a number of countries have jointly pooled their resources and, at the same time, agreed to jointly share the risk inherent in these ventures.

In addition to partnerships that pool project risk, ameliorating risk through sharing can be achieved contractually. Many project organizations create relationships with suppliers and customers that include legal requirements for risk to be shared among those involved in the project. Host countries of large industrial construction projects, such as petrochemical or power generation facilities, have begun insisting on contracts that enforce a "Build-Own-Operate-Transfer" provision for all project firms. The lead project organization is expected to build the plant and take initial ownership of it until its operating capacity has been proven and all debugging occurs before finally transferring ownership to the client. In this way, the project firm and the host country agree to jointly accept financial (risk) ownership of the project until such time as the project has been completed and its capabilities proven.

TRANSFER RISK In some circumstances, when it is impossible to change the nature of the risk, either through elimination or minimization, it may be possible to shift the risks bound up in a project to another party. This option, transferring risk to other parties when feasible, acknowledges that even in the cases where a risk cannot be reduced, it may not have to be accepted by the project organization, provided that there is a reasonable means for passing the risk along. Companies use several methods to transfer risks, depending upon their power relative to the client organizations and the types of risks they face. For example, if our goal is to prevent excessive budget overruns, a good method for directly transferring risk lies in developing fixed-price contracts. **Fixed-price contracts** establish a firm, fixed price for the project upfront; should the project's budget begin to slip, the project organization must bear the full cost of these overruns. Alternatively, if our goal is to ensure project functionality (quality and performance), the concept of liquidated damages offers a way to transfer risk through contracts. **Liquidated damages** represent project penalty clauses that kick in at mutually agreed-on points in the project's development and implementation. A project organization installing a new information system in a large utility may, for example, agree to a organization installing a new information system in a large utility may, for example, agree to a liquidated damages clause should the system be inoperable after a certain date. Finally, insurance is a common option for some organizations, particularly in the construction industry. Used as a risk mitigation tool, insurance transfers the financial obligation to an insuring agency.

Use of Contingency Reserves

Contingency reserves in several forms, including financial and managerial, are among the most common methods to mitigate project risks. They are defined as the specific provision for unforeseen elements of cost within the defined project scope. Contingency reserves are viewed differently, however, depending upon the type of project undertaken and the organization that initiates it. In construction projects, it is common to set aside anywhere between 10% and 15% of the construction price in a contingency fund. A contract to construct a $5 million building will actually be built to the cost of approximately $4.5 million, with the balance retained for contingency. In other fields, however, project teams are much more reluctant to admit to the up-front need for establishing contingency reserves, fearing that customers or other project stakeholders will view this as a sign of poor planning or inadequate scope definition (see Chapter 5).

The best way to offset concerns about the use of contingency reserves is to offer documentation of past risk events—unforeseen or uncontrollable circumstances that required the need for such contingency planning. Some of the concerns that might be generated may also be offset if the project team has done its homework and demonstrated in a detailed plan how contingency funds will be released as they are needed. Since the goal of creating contingency funds is to ensure against unforeseen risks, the key to their effective use lies in proactive planning to establish reasonable triggers for their release.[11]

TASK CONTINGENCY Perhaps the most common form of contingency reserve is **task contingency**, which is used to offset budget cutbacks, schedule overruns, or other unforeseen circumstances accruing to individual tasks or project work packages. These budget reserves can be a valuable form of risk management because they provide the project team with a buttress in the face of task completion difficulties. It may be found, for example, that some components or work packages of the project are highly unique or innovative, suggesting that development estimates and their related costs cannot be estimated with anything less than a bound of $\pm 20\%$ or even greater. Hence, task contingency becomes extremely important as a method for offsetting the project team's inability to make an accurate budget estimate.

EXAMPLE 7.1 Calculating Contingency Expected Cost

Suppose a project task is estimated to cost $10,000 to complete, but it is viewed as a high-risk operation. A task contingency multiplier would require our budget to reflect the following:

$$\text{(Task estimated cost)(Task contingency multiplier)} = \text{Expected cost}$$
$$(\$10{,}000)(1.2) = \$12{,}000$$

Naturally, as the project moves forward, it may be possible to reduce budget reserve requirements for task contingency because the project's scope will have been made clearer and its development will have progressed; that is, many of the tasks for which the contingency fund was established will have been completed. As a result, it is quite common for project organizations to assign a budget reserve to a project that is diminished across the project's development cycle.

MANAGERIAL CONTINGENCY While task contingency may involve the risk associated with the development of individual work packages or even tasks, managerial contingency is an additional safety buffer applied at the project level. **Managerial contingency** is budget safety measures that address higher-level risks. For example, suppose a project team has begun development of a new wireless communication device set to operate within guidelines established for technical performance. At some point in the midst of the development process, the primary client requests major scope changes that will dramatically alter the nature of the technology to be employed. Managerial contingency typically is used as a reserve against just such a problem. Another way managerial contingency may be used is to offset potentially disastrous "acts of God," which are natural disasters that, by definition, are unforeseeable and highly disruptive.

One final point about budget reserves at either the task or managerial level: It is extremely important that open channels of communication be maintained between top management and the project manager regarding the availability and use of contingency reserve funds. Project managers must be fully aware of the guidelines for requesting additional funding and how extra project budget is to be disbursed. If either the project manager or top management group uses contingency reserves as a political tool or method for maintaining control, the other party will quickly develop an attitude of gamesmanship toward acquiring those reserves. In this case, the atmosphere and communications between these key stakeholders will become characterized by distrust and secrecy—two factors guaranteed to ensure that a project is likely to fail.

INSURANCE **Insurance** can be a useful means for risk mitigation, particularly in certain types of projects, such as construction. Risks in construction go beyond technical risks or monetary/commercial risks to include health and safety concerns. Not all organizations or countries enforce the same rules regarding occupational health and safety standards. For example, there are countries in the developing world that do not require (or enforce) the use of safety harnesses for workers on skyscrapers, even though a fall would be fatal. Contractors acquire insurance as a means to offset the risks from the project that are often covered under contractual terms. For example, a construction contractor will routinely acquire insurance against loss or theft of building materials, workers' compensation, and professional or general liability. One of the duties of project managers in these settings is to ensure that all certificates of compliance are up to date; that is, all necessary insurance has been acquired and is valid for the life of the project to mitigate against potential risks.

Other Mitigation Strategies

In addition to the set of mitigation strategies already discussed, many organizations adopt practical approaches to minimizing risk through creating systems for effectively training all members of their project teams. One successful method for dealing with project risks involves **mentoring** new project managers and team members. In a mentoring program, junior or inexperienced project personnel are paired with senior managers in order to help them learn best practices. The goal of mentoring is to help ease new project personnel into their duties by giving them a formal contact who can help clarify problems, suggest solutions, and monitor them as they develop project skills. Another method for mitigating risks involves **cross-training** project team personnel so that they are capable of filling in for each other in the case of unforeseen circumstances. Cross-training requires that members of the project team learn not only their own duties but also the roles that other team members are expected to perform. Thus, in the case where a team member may be pulled from the project team for an extended period, other team members can take up the slack, thereby minimizing the time lost to the project's schedule.

Control and Documentation

Once project risk analysis has been completed, it is important to begin developing a reporting and documentation system for cataloging and future reference. Control and documentation methods help managers classify and codify the various risks the firm faces, its responses to these risks, and the outcome of its response strategies. Table 7.3 gives an example of a simplified version of the risk management report form that is used in several organizations. Managers may keep a hard-copy file of all these analyses or convert the analyses to databases for better accessibility.

Having a repository of past risk analysis transactions is invaluable, particularly to novice project managers who may recognize the need to perform risk management duties but are not sure of the best way to do them or where to begin. The U.S. Army, for example, has invested significant budget and time in creating a comprehensive database of project risk factors and their mitigation strategies as part of project management training for their officers. Newly appointed

TABLE 7.3 Sample Risk Management Report Form

Customer: ______________________ Project Name: ______________________
Budget Number: ______________________ Project Team: ______________________
Date of Most Recent Evaluation: ______________________
Risk Description: ______________________
____
____
____
Risk Assessment: ______________________ Risk Factor: ______________________
Discussion: ______________________
____
____
Risk Reduction Plan: ______________________ Owner: ______________________
____
Time Frame to Next Assessment: ______________________
Expected Outcome: ______________________
____
____

officers to Army procurement and project management offices are required to access this information in order to begin establishing preliminary risk management strategies prior to initiating new programs. Figure 7.7 illustrates a contingency document for adjustments to the project plan.

Establishing **change management** as part of risk mitigation strategies also requires a useful documentation system that all partners in the project can access. Any strategy aimed at minimizing

Probable Event	**Adjustment to Plans**
Absenteeism	
Resignation	
Pull-aways	
Unavailable staff/skills	
Spec change	
Added work	
Need more training	
Vendors late	

FIGURE 7.7 Contingency Document for Adjustments to Project Plan a project risk factor, along with the member of the project team responsible for any action, must be clearly identified. The sample risk management report form shown in Table 7.3 includes the important elements in such change management. In order to be effective, the report must offer a comprehensive analysis of the problem, the plan for its minimization, a target date, and the expected outcome once the mitigation strategy has been implemented. In short, as a useful control document, a report form has to coherently identify the key information: what, who, when, why, and how.

- ***What***—Identify clearly the source of risk that has been uncovered.
- ***Who***—Assign a project team member direct responsibility for following this issue and maintaining ownership regarding its resolution.
- ***When***—Establish a clear time frame, including milestones if necessary, that will determine when the expected mitigation is to occur. If it is impossible to identify a completion date in advance, then identify reasonable process goals en route to the final risk reduction point.
- ***Why***—Pinpoint the most likely reasons for the risk; that is, identify its cause to ensure that efforts toward its minimization will correspond appropriately with the reason the risk emerged.
- ***How***—Create a detailed plan for how the risk is to be abated. What steps has the project team member charted as a method for closing this particular project "risk window"? Do they seem reasonable or far-fetched? Too expensive in terms of money or time? The particular strategy for risk abatement should, preferably, be developed as a collaborative effort among team members, including those with technical and administrative expertise to ensure that the steps taken to solve the problem are technically logical and managerially possible.

Documentation of risk analysis such as is shown in Table 7.3 and Figure 7.7 represents a key final component in the overall risk management process.

PROJECT PROFILE

Collapse of Shanghai Apartment Building

The science and engineering principles surrounding the construction of simple apartment blocks are well known and have been practiced for centuries. And yet, even in the most basic of construction projects, events can sometimes transpire to produce shocking results. Just such a story occurred in late June of 2009 in China, when a Shanghai high-rise, 13-story apartment building literally toppled onto its side. The nearly completed structure was part of an 11-building apartment complex in a new development known as "Lotus Riverside." Because the 629-unit apartment building was not yet completed, it was virtually empty. Although one worker was killed in the accident, the tragedy could have been far worse had the building been fully occupied.

FIGURE 7.8 **Shanghai Apartment Building Collapse**

Source: Imago stock&people/Newscom

(continued)

The demand for affordable housing in Chinese cities has never been greater. With the economy humming along and a high demand for workers in economic regions such as Shanghai, there is a critical shortage of available housing. Private and governmental organizations are working to rapidly install new apartment blocks to keep up with this huge demand. Unfortunately, one of the risks with rapid building is the temptation to cut corners or use slipshod methods. When speed is paramount, the obvious concern is whether acceptable standards of building are being maintained.

In the Lotus Riverside building project, unfortunately, the construction firm opted for a procedure that is generally frowned upon (indeed, the method is outlawed in Hong Kong due to its inherent riskiness). Under this system, rather than pour a deep concrete base on which to rest the structure, a series of prestressed, precast concrete pilings were used as a set of anchors to "pin" the building into the ground. Although this system can work effectively with shorter buildings, it has long been considered unsafe for larger, higher structures.

The problem was made critical when the construction crews began digging an underground garage on the south side of the building to a depth of nearly 5 meters. The excavated dirt was piled on the north side of the building to a height of 10 meters. The underground pilings began receiving severe lateral pressure from the excavation, which was further compromised by heavy rainstorms. The storms undermined the apartment building on the south side, causing more soil erosion and putting even greater lateral pressure (estimated at 3,000 tons) on the anchor piling system (see Figure 7.9). Suddenly, the pilings began snapping and the building toppled over on its side. Local officials noted that the only lucky result of the collapse was that the building fell into an empty space. Considering that all the buildings in the complex had been constructed in a similar manner, there was a very real possibility of creating a chain reaction of toppling buildings, much like a set of dominos falling over.

The Chinese government immediately began to aggressively trace the cause of the collapse, questioning the private contractor's use of unskilled workers, questionable construction practices, and overall quality control. China's official news agency, Xinhua, said officials were taking "appropriate control measures" against nine people, including the developer, construction contractor, and supervisor of the project, after it was reported that the company's construction license had expired in 2004. Although it is certain that penalties will be imposed for the building failure, a less certain future awaits the tenants of the other buildings in the complex. After all, what more visible evidence could there be of the unsoundness of the construction in the complex than seeing a "sister building" lying on its side not far from the other structures? Hundreds of prospective tenants have besieged government offices, demanding refunds for apartments in the same complex that they purchased for upward of $60,000 but are now too frightened to live in.

Meanwhile, *China Daily*, the state-run newspaper, published an angry editorial blaming the collapse on the often corrupt relationship between Chinese property developers and local government officials who depend on property taxes and land sales for a significant proportion of their income. The paper raised fears—expressed by some construction industry insiders in China—that many buildings designed to have a 70-year life span "would not stand firm beyond 30 to 40 years" because of corner-cutting during China's rampant construction boom. "It is ironic that such an accident happened in Shanghai—one of the most advanced and international Chinese cities," the paper concluded. "The sheer fact that such a collapse occurred in the country's biggest metropolis should serve as warning to all developers and the authorities to ensure that construction projects do not cut corners and endanger people's lives."[12]

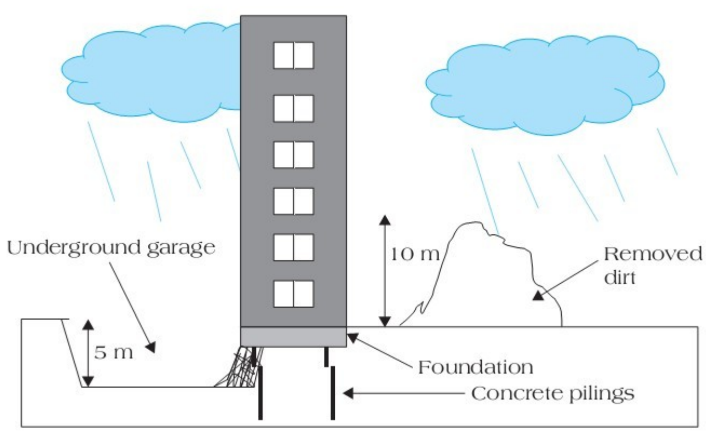

FIGURE 7.9 Schematic of Causes of Collapse

7.2 PROJECT RISK MANAGEMENT: AN INTEGRATED APPROACH

The European Association for Project Management has developed an integrated program of risk management, based on efforts to extend risk management to cover a project's entire life cycle. This program, known as **Project Risk Analysis and Management (PRAM)**, presents a generic methodology that can be applied to multiple project environments and encompasses the key components of project risk management.[13] The ultimate benefit of models such as PRAM is that they present a systematic alternative to ad hoc approaches to risk assessment, and hence can help organizations that may not have a clearly developed, comprehensive process for risk management and are instead locked into one or two aspects (e.g., risk identification or analysis of probability and consequences). The PRAM model offers a step-by-step approach to creating a comprehensive and logically sequenced method for analyzing and addressing project risk.

Among the key features of the PRAM methodology are the following:

- ***The recognition that risk management follows its own life cycle, much as a project follows a life cycle.*** Risk management is integrated throughout the project's entire life cycle.
- ***The application of different risk management strategies at various points in the project life cycle.*** The PRAM approach tailors different strategies for different project life cycle stages.
- ***The integration of multiple approaches to risk management into a coherent, synthesized approach.*** PRAM recommends that all relevant risk management tools be applied as they are needed, rather than in a "pick-and-choose" approach.

Each of the nine phases in the PRAM approach is based on a specific purpose and requires the completion of a comprehensive set of targets (deliverables). Completing PRAM gives the project team a template for getting the most out of risk management and helps them sharpen their efforts in the most productive manner. It also creates a document for merging risk management with overall project planning, linking them in a collaborative sense.

The nine phases of a comprehensive project risk assessment include the following steps:

1. *Define*—Make sure the project is well defined, including all deliverables, statement of work, and project scope.
2. *Focus*—Begin to plan the risk management process as a project in its own right, as well as determining the best methods for addressing project risk, given the unique nature of the project being undertaken.
3. *Identify*—Assess the specific sources of risk at the outset of the project, including the need to fashion appropriate responses. This step requires that we first search for all sources of risk and their responses and then classify these risks in some manner to prioritize or organize them.
4. *Structure*—Review and refine the manner in which we have classified risks for the project, determine if there are commonalities across the various risks we have uncovered (suggesting common causes of the risks that can be addressed at a higher level), and create a prioritization scheme for addressing these risks.
5. *Clarify ownership of risks*—Distinguish between risks that the project organization is willing to handle and those that the clients are expected to accept as well as allocate responsibility for managing risks and responses.
6. *Estimate*—Develop a reasonable estimate of the impacts on the project of both the identified risks and the proposed solutions. What are the likely scenarios and their relative potential costs?
7. *Evaluate*—Critically evaluate the results of the estimate phase to determine the most likely plan for mitigating potential risks. Begin to prioritize risks and the project team's responses.
8. *Plan*—Produce a project risk management plan that proactively offers risk mitigation strategies for the project as needed.
9. *Manage*—Monitor actual progress with the project and associated risk management plans, responding to any variances in these plans, with an eye toward developing these plans for the future.

TABLE 7.4 A Generic Risk Management Process (RMP) Following the PRAM Methodology

Phases	Purposes	Deliverables
Define	Consolidate relevant existing information about the project.	A clear, unambiguous, shared understanding of all key aspects of the project documented, verified, and reported.
Focus	1. Identify scope and provide a strategic plan for the RMP. 2. Plan the RMP at an operational level.	A clear, unambiguous, shared understanding of all relevant key aspects of the RMP, documented, verified, and reported.
Identify	1. Identify where risk might arise. 2. Identify what we might do about this risk in proactive and reactive response terms. 3. Identify what might go wrong with our responses.	All key risks and responses identified; both threats and opportunities classified, characterized, documented, verified, and reported.
Structure	1. Test simplifying assumptions. 2. Provide more complex structure when appropriate.	A clear understanding of the implications of any important simplifying assumptions about relationships among risks, responses, and base plan activities.
Ownership	1. Client contractor allocation of ownership and management of risks and responses. 2. Allocation of client risks to named individuals. 3. Approval of contractor allocations.	Clear ownership and management allocations effectively and efficiently defined, legally enforceable in practice where appropriate.
Estimate	1. Identify areas of clear significant uncertainty. 2. Identify areas of possible significant uncertainty.	1. A basis for understanding which risks and responses are important. 2. Estimates of likelihood and impact on scenario or in numeric terms.
Evaluate	Synthesis and evaluation of the results of the estimate phase.	Diagnosis of all important difficulties and comparative analysis of the implications of responses to these difficulties, with specific deliverables like a prioritized list of risks.
Plan	Project plan ready for implementation and associated risk management plan.	1. Base plans in activity terms at the detailed level of implementation. 2. Risk assessment in terms of threats and opportunities prioritized, assessed in terms of impact. 3. Recommended proactive and reactive contingency plans in activity terms.
Manage	1. Monitoring. 2. Controlling. 3. Developing plans for immediate implementation.	1. Diagnosis of a need to revisit earlier plans and initiation of replanning as appropriate. 2. Exception reporting after significant events and associated replanning.

Table 7.4 shows a generic risk management process following the PRAM methodology. At each of the risk management phases, specific project deliverables can be identified, allowing the project team to create comprehensive project risk management documentation while addressing specific steps along the way. These deliverables are important because they indicate to project managers exactly the types of information they should be collecting at different phases of the project and the materials they should make available to relevant stakeholders.

The PRAM model for risk management is extremely helpful because it offers project managers a systematic process for best employing risk assessment and mitigation strategies. Composed of nine interconnected steps that form a logical sequence, PRAM creates a unifying structure under which effective risk management can be conducted. Because it follows the logic of the project life cycle, PRAM should be conducted not as a "one-shot" activity but as an ongoing, progressive scheme that links project development directly to accurate risk assessment and management.

Finally, in identifying the key deliverables at each step in the process, the PRAM model ensures a similarity of form that allows top management to make reasonable comparisons across all projects in an organization's portfolio.

Project risk management demonstrates the value of proactive planning for projects as a way to anticipate and, hopefully, mitigate serious problems that could adversely affect the project at some point in the future.[14] The value of this troubleshooting process is that it requires us to think critically, to be devil's advocates when examining how we are planning to develop a project. Research and common sense suggest, in the words of the adage, "An ounce of prevention is worth a pound of cure." The more sophisticated and systematic we are about conducting project risk management, the more confident we can be, as the project moves through planning and into its execution phase, that we have done everything possible to prepare the way for project success.

Summary

1. **Define project risk.** Project risk is defined as any possible event that can negatively affect the viability of a project. We frequently use the equation: Risk event = (Probability of event)(Consequences of event). Effective risk management goes a long way toward influencing project development. To be effective, however, project risk management needs to be done early in the project's life. To quote Shakespeare's *Macbeth:* "If it were done, when 'tis done; then 'twere well it were done quickly."[15] As an important element in overall project planning, risk management identifies specific risks that can have a detrimental effect on project performance and quantifies the impact each risk may have. The impact of any one risk factor is defined as the product of the likelihood of the event's occurrence and the adverse consequences that would result. The tremendous number of unknowns in the early phases of a project makes this the time when risk is highest. As the project moves forward, the team continues to address risk with technical, administrative, and budgetary strategies.
2. **Recognize four key stages in project risk management and the steps necessary to manage risk.** There are four distinct phases of project risk management: (1) risk identification, (2) analysis of probability and consequences, (3) risk mitigation strategies, and (4) control and documentation. Risk identification focuses on determining a realistic set of risk factors that a project faces. In analysis of probability and consequences, the project team prioritizes its responses to these various risk factors by assessing the "impact factor" of each one. Impact factors are determined either in a qualitative manner, using a matrix approach and consensus decision making, or in more quantitative ways, in which all relevant probability and consequence parameters are laid out and used to assess overall project risk. The project team begins the process of developing risk mitigation strategies once a clear vision of risk factors is determined. The last step in the risk management process, control and documentation, is based on the knowledge that risk management strategies are most effective when they have been codified and introduced as part of standard operating procedures. The goal is to create systematic and repeatable strategies for project risk management.
3. **Understand five primary causes of project risk and four major approaches to risk identification.** The five primary causes of project risk are (1) financial risk, (2) technical risk, (3) commercial risk, (4) execution risk, and (5) contractual or legal risk. Among the most common methods for risk identification are (1) brainstorming meetings, (2) expert opinion, (3) past history, and (4) multiple or team-based assessments.
4. **Recognize four primary risk mitigation strategies.** Risks can be mitigated through four primary approaches. First, we can simply accept the risk. We may choose to do this in a situation in which we either have no alternative or we consider the risk small enough to be acceptable. Second, we can seek to minimize risk, perhaps through entering partnerships or joint ventures in order to lower our company's exposure to the risk. Third, we can share risk with other organizations or project stakeholders. Finally, when appropriate, we may seek to transfer risk to other project stakeholders.
5. **Explain the Project Risk Analysis and Management (PRAM) process.** PRAM is a generic project risk management approach that offers a model for the life cycle steps a project team might adopt in developing a risk management methodology. Nine distinct steps in the PRAM model present each phase of the process and its associated deliverables.

