Chapter 9

Estimating Project Risk

<u>Key Concepts in this Chapter:</u>

Definition of Risk
Description of the Risk Management Process—Threats and Opportunities
Sources of Risk in Projects
Use of Qualitative and Quantitative Risk Techniques Control
Discussion Questions
Application Vignette
Homework, Exercises and Core Case

Planning for your projects is almost completed. This has taken much longer than you thought it would, but your team really believes you have a grasp on what it will take to get the project completed on time, within scope and at cost. However, several senior members of your organization keep asking very difficult, complex questions such as, "What if this happens?" and "Have you thought about this situation occurring?" You know they are trying to be helpful but some of these questions really bother you and your team. You begin to question whether you should consider every possible scenario and, if so, how this will affect your team dynamics. The more time you spend preparing to answer "what if" questions, the less time you have to actually do project management. This is a difficult balancing act you are performing but answering top management questions has to be done since they are key stakeholders in the project.

A colleague of yours is a risk management specialist and she offers some advice—"Learn as much as you can about projects that were similar to your projects. What went well? What went poorly? Find out the reasons behind these questions and then determine with your team if these conditions, problems, and issues apply to your projects or not." She even went as far as to say that risk management was really a hot-button area in project management these days, in which organizations typically build templates, or frameworks, for understanding all the different things that can happen on projects. Of course, the tried and true method for understanding risk on a project is to ask more experienced members of the organization, in order that you may gain their insight. Horror stories from past projects have a way of staying within the organization, especially at the water cooler and coffee pot, that sometimes seem too incredible to believe. How many of these stories are true? There are always myths about someone or something that have no basis in reality. Someone surely has written down lessons learned, put them into a database for future project managers to reference, and made *these lessons available to all. You hope that you do not have to operate "by the seat of your pants."*

You decide to ask around and find out as much as you can about the "do's" and the "don'ts" of previous projects that were similar in type to your projects. Maybe then you can feel a little better about the questions some of these senior members of your organization keep asking. You are definitely going to use your expert to gain all the valuable insight relative to project risk management you can from her.

Definition of Risk

The scenario that starts off Chapter 9 is one in which many project managers find themselves, especially when planning a project. When there is ample information on a project, a team can usually plan out the basics with regard to scope, cost and time. The lights begin to dim a little, however, when project information is not so readily available, planning has to be done, and you have stakeholders (like customers and top management) frequently asking nit-picky questions about "what if" scenarios. The key to project risk management is to convey confidence to reviewers of project plans that your project team has thought out how to deal with anticipated and unanticipated situations that could deter or improve project progress.

According to the PMBOK (p. 238), project risk "is an uncertain event or condition, that if it occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope, or quality" (see Figure 9-1). Project risk can be either a good or bad thing that happens on a project. Many times people think in terms of only the bad things, or threats, to a project. Typical threats include issues like being late on providing a product, service or documentation to a customer, key people leaving the project team, customer expectations not being met, technical solutions becoming unachievable, and many more. Certainly we have to manage threats to projects; planning ahead of time to reduce the impact of a threat is much more desirable than just reacting to a threat when it occurs. Almost assuredly, we also have to manage opportunities of which projects can take advantage of certain events occur. For instance, if technical solutions are achieved ahead of schedule, there could be a financial award for this achievement. Other project actions can either directly or indirectly increase the probability that your project will succeed. One can see this relationship frequently in corporate partnerships where project success can provide the impetus for future funding for other projects. Consider how the success of an information technology project, like the upgrade of a local area network, can lead to new services that were not previously available. To fully appreciate project risk, both threats and opportunities have to be considered together as part of project risk management.

Thus, *key elements* of project risk include an identifiable event, the probability of occurrence of that event, and the impact, or consequence, of that event occurring. If a risk event is identified for your project, then you should also give the probability of its occurrence and the impact to your project if it does occur. For example, on a financial project where a new bank loan product is being developed, a threat might be an unstable interest rate that, if it were to occur, would possibly decrease bank profits on the new loan. The bank would estimate the probability of this unstable interest rate occurring and the impact when it occurred. Probability can be measured in qualitative and quantitative terms which will be discussed later. Impact statements are usually associated with a cost and revenue amount. We will now discuss how the risk management process manages risk events both from planning and implementation points of view.

Project Risk Management

-Definition of a project risk includes:

--Any uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective

-Key elements of risk include:

-An identifiable event

-Probability of occurrence

-Impact, or consequence, of occurrence

Figure 9-1. Definition of Risk and Key Elements

Description of the Risk Management Process—Threats and Opportunities

The management of project risk encompasses six main processes:

a. Risk Management Planning
b. Risk Identification
c. Qualitative Risk Analysis

d. Quantitative Risk Analysis
e. Risk Response Planning
f. Risk Monitoring and Controlling

Risk Management Planning is deciding how to approach, plan and execute all the risk management activities for a project. During risk management planning, issues are presented, such as the consideration and discussion of risk activities. Planning this discussion should entail making the following decisions: whether the discussion should be a formal meeting, who should be there, will there be adequate resources set aside for risk events, what the risk approach should be with both low-to-high probability risk events and low-to-high impact risk events, and where a project team should draw the boundaries with regard to project management oversight. These kinds of decisions get discussed and then written into the risk management plan which becomes part of the overall project plan.

Project Risk Management

An Example of a Qualitative Risk Assessment (i.e. very subjective)

-<u>High</u> (Risk event is very likely to occur)
- If risk event occurs, then a significant impact on cost, schedule, and quality affecting customer satisfaction will occur)

-<u>Medium</u> (Risk event is likely to occur)
- If risk event occurs, then a moderate impact on cost, schedule, and quality affecting customer satisfaction will occur)

-<u>Low</u> (Risk event is unlikely to occur)
- If risk event occurs, then a small impact on cost, schedule, and quality affecting customer satisfaction will occur)

Figure 9-2. Categories of Risk Assessment

Risk Identification entails making risk events known by documenting them into the risk register. The risk register is unique to each project as it describes the risks, both for threats and opportunities, which can occur on a project. Thus, *Risk Identification* relies on corporate knowledge, documentation, assumptions, organizational templates, and lessons learned from similar projects to identify what could go wrong and what could go well on your project. Those risk events that apply to your project would be documented in a risk register for your project. Root causes of each risk event could be included in the risk register as well as a list of potential responses to each risk event.

Once risks are identified, then you can conduct a *Qualitative Risk Analysis* of each risk event. A *Qualitative Risk Analysis* assesses the priority of each risk event with a subjective analysis of probability and impact. Probability estimates usually have categories like "High Probability," "Medium Probability," or "Low Probability" (see Figure 9-2). The same classification applies to impact as in "High Impact," "Medium Impact," and "Low Impact." These subjective ratings are developed by the project team and serve to focus project team management and project oversight to the highest impact and probability scenarios. Thus, one of the main products of the *Qualitative Risk Analysis* is a ranking, or priority listing, of project risks according to their significance.

Quantitative Risk Analysis usually follows the *Qualitative Risk Analysis* based on the priority rankings of risk events. Because *Quantitative Risk Analysis* can be labor-intensive, many project managers only do this type of analysis on high-priority items. *Quantitative Risk Analysis* uses such tools as probability distributions, sensitivity analyses, expected monetary value (EMV) calculations, and modeling and simulation techniques to better understand key risk events. We will discuss both *Qualitative* and *Quantitative Risk Analysis* techniques in more detail later in this chapter.

Risk Response Planning is the act of developing responses to risk events should they occur. An underlying theme in *Risk Response Planning* is for each project team to decide how to limit threats and maximize opportunities should these risk events occur. The PMBOK (pp. 261-263) lists several generic risk response strategies for both threats and opportunities:

Threats

Avoid—try to eliminate the threat. For instance, maybe clarifying ambiguous project requirements will eliminate customer dissatisfaction.

Transfer—try to shift negative impacts to a third party. For instance, warranties and insurance might transfer risk to another party but these do not eliminate the risk event itself.

Mitigate—try to reduce the probability, impact or both for a risk event. For instance, conducting more software testing might reduce the probability of low software quality.

Opportunities

Exploit—try to eliminate any uncertainty that the opportunity would NOT occur.

For instance, putting top-notch people on the project might show commitment to a project to a customer or prospective partner. Thus, the customer or prospective partner would also commit to the project.

Share—try to share a positive risk event with someone more suited to take advantage of the situation. For instance, finding a partner firm that specializes in an area in which you are weak would complement your assets and project resources.

Enhance—try to modify the "size" of the opportunity by increasing the probability or impact of the risk event. For instance, increasing the financial pay-off or reducing the costs of the project might improve the probability that the project will succeed.

Project teams, of course, can accept threats and opportunities as they are; this might also be an appropriate response to a risk event. This approach would be an appropriate action if it was in the risk management plan and not an ad hoc risk response strategy. Remember that the purposes of *Risk Response Planning* are to minimize crisis management, support proactive thinking, limit surprises and problems, and manage escalation issues, like conflict and turnover, that could hurt project progress.

The final process in project risk management is *Risk Monitoring and Controlling*. *Risk Monitoring and Controlling* is a feedback mechanism that determines how well the project is proceeding. New risks need to be frequently identified and managed. Techniques like variance analysis and audits are typically conducted to see what risks are occurring and which ones will likely occur from that point on into the future. Thus, the risk register is a living document that gets updated periodically, based on the results of project management activities associated with *Risk Monitoring and Controlling*. The process of monitoring and controlling reviews the sources of risk on a project and how they might affect project success. The sources of project risk will be discussed next.

Sources of Risk in Projects

There are typically five sources of project risk: technical, programmatic, supportability, cost and schedule. We will discuss each and give an example of how these need to be incorporated into the risk management plan.

Technical risk is a measure of the technical complexity of the project and its subsystems that need to be developed to meet customer requirements. The development of functional and technical requirements is a direct indication of the technical risk of a project. An analysis of the scope of the project would give risk managers an indication of how difficult it will be to integrate all elements of the project together. *Technical risk* reflects how well the products and services were designed, developed and tested before they were provided to the customer. *Technical risk* is really a feedback mechanism of how well the project team, especially the technical experts, worked together in meeting customer requirements.

Programmatic risk is usually a function of the difficulty in getting equipment, people, facilities and funding together to do all that is required in the project plan. For instance, test equipment may not be available when it is needed; this would be a potential risk event in the risk management plan. Sometimes funding to pay vendors is short, so this might be a financial risk with vendors in the risk management plan. *Programmatic risk* is a function of how well the organization provides necessary resources to conduct the project in a way that meets the project plan.

Supportability risk typically includes all the "variables" associated with providing the scope of the project. Sometimes this is called a logistics support, or supply-chain management, concern. Managing all the "variables" on a project can drive project managers crazy, as they typically are interrelated. For instance, making something more reliable may make it less maintainable. A good example of this is in the airline industry. Airlines want reliable pieces of equipment. Sometimes this requires that the equipment be built of heavier materials or put in places abroad an aircraft that are less dangerous. Maintaining this equipment now becomes more difficult, as you have to remove other equipment to get to the safer unit tucked away somewhere in the aircraft. We see this in cars as well when the hood is opened. Cars are more reliable but harder to maintain. *Supportability risk* is primarily focused on how products and services flowing out of projects meet established support goals and project scope.

Cost risk is a function of how many "gray areas" there are on a project that cannot be accounted for either directly or indirectly. In cost management terms, we call untraceable costs "indirect costs." The more "indirect costs" or "overhead" costs there are on a project, the more *cost risk* there is as the management of costs becomes more difficult. *Cost risk* also reflects the maturity levels of cost support in the cost estimating and reporting aspects of project management. If cost estimating and reporting is being done by novices, then the cost estimates associated with the project as part of the triple constraint will not be as accurate as if an experienced, and possibly certified, cost estimator had done the estimate.

Finally, *Schedule risk* is derived based on several key aspects of the project's schedule. The degree of concurrency, or overlapping, of project activities increases schedule risk as project teams are betting on a relatively smooth flow of project activities with minimal rework between activities. Is this a realistic assumption? Sometimes products and services have to be redesigned, redeveloped and retested many times; this causes *Schedule risk* to increase dramatically as delays in project completion can be expected.

Another driver of *Schedule risk* are big chunks of ambiguous work in the schedule network. For instance, what does "Database Management Functions" really mean? Ambiguous work packages indicate that the project team did not do a good job in defining the work to be performed. This leads to mismanagement of tasks on the schedule as no one really knows what the task means or what they are supposed to do with regard to the project schedule.

These five sources of risk are helpful to project managers in anticipating where potential threats and opportunities may exist. Once risk events are identified, then project managers can develop more information about these risk events using qualitative and quantitative techniques. We will discuss these next.

Use of Qualitative and Quantitative Risk Techniques

Qualitative Risk Analyses categorize risk based on a subjective rating system. One example of a qualitative risk analysis tool is the "Poor Man's Hierarchy" (see Figure 9-3). The "Poor Man's Hierarchy" depicted in Figure 9-3 shows four different risk

	John	***Susie***	***Matt***
Risk Event I	High	Low	Medium
Risk Event II	Low	High	Medium
Risk Event III	Medium	Low	High
Risk Event IV	Low	Medium	High

Figure 9-3. Poor Man's Hierarchy in Qualitative Risk Assessment

events. Each is ranked by three project team members—John, Susie and Matt—with regard to which one has the highest, medium and lowest probability of occurrence. You can see that each team member ranked the four events differently. This is not necessarily bad since this type of tool opens up dialogue between project team members as to the assumptions and issues underlying each ranking. When team members give rankings that are diametrically opposed in position, usually this indicates that there is information known to a few team members but not known throughout the

Project Risk Management

An Example of a Descriptive Risk Assessment

Risk Event A is commonly referred to as the lack of timely delivery of documentation to support Product X. While our division has a history of not being able to deliver a full set of supporting technical manuals and user guides, the likelihood of this occurring on this project is low for several reasons: new personnel, policies, and procedures in accordance with ISO 9000. The impact of being late with supporting documentation will reduce our customer satisfaction and possibly impact the sales of future products.

Figure 9-4. Descriptive Technique in Qualitative Risk Assessment

entire team. If rankings between individuals are similar, then there is consensus on the probability or impact of the risk event occurring. Thus, *Qualitative Risk Analysis* can be a very useful tool to communicate information and discuss alternative courses of action.

Another form of *Qualitative Risk Analysis* is called the "Descriptive" method. Here project team members categorize risk using text to describe a general scenario or outcome. Figure 9-4 displays a "Descriptive" scenario regarding the lack of timely delivery of project documentation. Again, this type of qualitative method is useful for communicating complex and ambiguous ideas regarding risk events that can occur. Team members can dialogue about the potential threat or opportunity creating the possibility for a proactive plan in case the risk event does occur.

Quantitative Risk Analyses categorize risk using statistics to rank order risk events by impact. Forecasting and trend analysis are areas that rely on quantitative risk assessment. We are going to discuss two quantitative methods that are the most used techniques in industry today—Probability Distributions and Expected Monetary Value.

Probability Distributions

We can apply probability distributions to consider *Schedule risk* in a project. Recall how PERT was used in developing a network analysis for a project. In Figure 9-5, we have three tasks derived from the WBS with three time estimates for each task: optimistic (O), most likely (ML) and pessimistic (P). Using PERT provides an excellent opportunity to apply probability distributions in risk analysis. If you recall,

$$\textbf{Expected time } (\mu) \textbf{ of each task } = \frac{O + 4ML + P}{6}$$

Thus, the expected time for each task in working days is as follows:

Task 1 μ: $(3+4(6)+9)/6 = 6$
Task 2 μ: $(2+4(3)+4)/6 = 3$
Task 3 μ: $(6+4(8)+10)/6 = 8$

Project Risk Management

An Example of a Quantitative Risk Assessment

Task #	Optimistic (O)	Most Likely (ML)	Pessimistic (P)
1	3	6	9
2	2	3	4
3	6	8	10

Figure 9-5. Example of Quantitative Risk Assessment

$$\textbf{Standard Deviation } (\sigma) \textbf{ of each task} = \frac{P - O}{6}$$

Thus, the standard deviation for each task is as follows:

Task 1 σ:	(9-3)/6 = 1
Task 2 σ:	(4-2)/6 = 0.33
Task 3 σ:	(10-6)/6 = 0.66

Now with an expected, or mean, time and standard deviation for each task, we can use probability distribution techniques assuming these tasks are normally distributed. If you recall the standard normal distribution curve, we can plot the expected time and standard deviations. As you may also recall, one standard normal deviation from the mean equates to roughly 68.3% of the time, two standard normal deviations from the mean equates to roughly 95.5% of the time, and three standard normal deviations from the mean equates to roughly 99.7% of the time (see Figure 9-6).

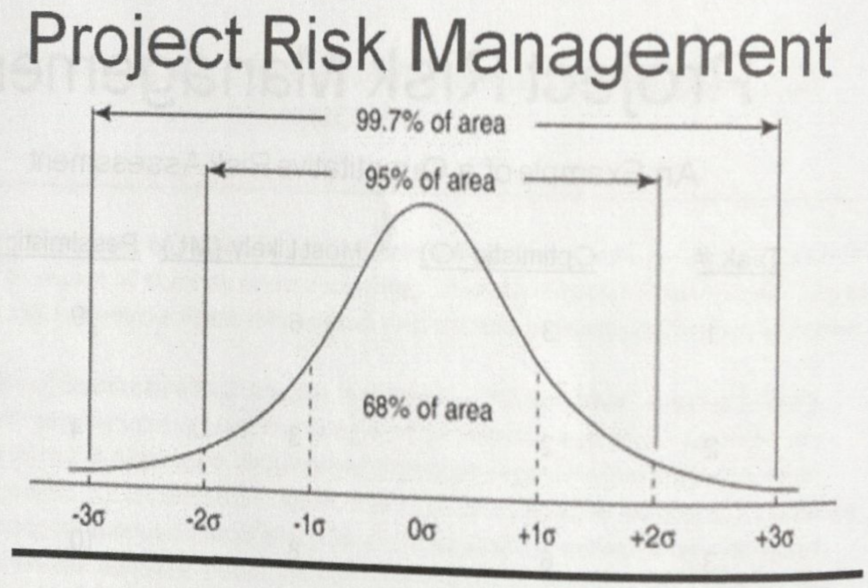

Figure 9-6. Areas Under a Standard Normal Probability Distribution

Thus, we can forecast the following with regard to the three tasks:

	+/- 1 σ	+/- 2 σ	+/- 3 σ
Task 1	5 to 7	4 to 8	3 to 9
Task 2	2.67 to 3.33	2.34 to 3.66	2.01 to 3.99
Task 3	7.34 to 8.66	6.68 to 9.32	6.02 to 9.98

In looking at the probability distributions of these three tasks, you can see that Task 1 has the larger standard deviation and, thus, the largest range, especially at three standard deviations. There is, therefore, more risk for Task 1 given this larger range since you can be sure with 99.5% confidence that Task 1 will take between 3 to 9 days. Task 2 has the least amount of deviation and, hence, the least amount of risk. Task 2 is the most predictable from 2.01 to 3.99 days at 95.5% confidence. Of the three tasks, Task 3 has medium schedule risk with results indicating at 95.5% confidence that it will take between 6.02 and 9.98 days.

Many stakeholders ask "what if" questions like, "What is the probability of completing Task 1 in 5 days or less (as an example we chose 5 days when it could have been any number of days)?" Assuming a standard normal probability distribution, you can answer that question given the information already available using the Z score. The Z score is based on calculating a number that represents the area under the normal curve. The Z score formula is as follows:

$$Z = \frac{x - \mu}{\sigma}$$

Back to the question about completing Task 1 in under 5 days, we use the following information to calculate the Z score.

x = 5 days
μ = 6 days
σ = 1 day

Thus, the Z score would be (5 – 6)/1 or 1.0. In looking up the Z score in Table A, we can see that a Z score of 1 is 0.1587 or there is a 15.87% probability of completing Task 1 in 5 days or less. Positive and negative signs are unimportant if you graph the question on a piece of paper and use the Z score table correctly.

Another example of a Z score problem might be from a customer who asks "What are the odds of completing Task 3 in 9 days or less?" Again, we know the following information about Task 3:

x = 9 days
μ = 8 days
σ = 0.66 days

The Z score for this question would be (9-8)/0.66 which would equal 1.52. The preceding graph would indicate the question being asked. The Z score indicates a number of 0.0643 or 6.43% in Table A. Since Table A indicates the area under the normal curve from left to right, you must take away this percentage from 100%. Thus, the answer is: there is a 93.57% probability that Task 3 will be completed in 9 days or less.

Finally, you might be asked a question that looks at boxing in the time estimate for any given task. For instance, a customer might ask, "What is the probability that Task 2 will be completed between 2.4 and 3.5 days?" Now you have a range to consider but this is an easy question if you graph the question properly onto a standard normal curve and use the Z score table correctly. Here is the information you know regarding Task 2:

x = 2.4 and 3.5 days
μ = 3 days
σ = 0.33 days

It does not matter which of the two limits, 2.4 or 3.5 days, you use first. Let's choose 3.5 days. The Z score would be equal to (3.5-3)/0.33 or 1.52. We know from our previous calculation that a Z score of 1.52 equals 0.0643 or 6.43%. Again, since this is the reverse of the area represented under the curve in Table A, we have to subtract out 6.43% from 100%, which leaves 93.57%.

However, we are not done yet since we have to also figure out how the other time constraint of 2.4 days affects the answer. Using the Z score method again, (2.4-3)/0.33 equals 1.82 or 0.0344 area under the curve. Since this represents the area from 2.4 days to the tail of the curve, we have to subtract out this amount from 93.57%. This gives us a revised probability estimate of 90.13%; there is a 90.13% probability that Task 2 will be completed between 2.4 and 3.5 days.

Probability distribution analysis is a good technique to use when you might be encouraged to perform tasks within a certain time limit. You can discover the probabilities of accomplishing tasks within a certain time frame and this might be valuable information to have for top management or in the performance of a contractual requirement. Many organizations use "Six Sigma" as a term derived from using a six standard deviation benchmark for quality. The underlying goal for "Six Sigma" is that there will be no more than approximately 3.4 errors per one million parts (or 99.9997% accuracy). That's a high standard of quality that is measured using the basics of the standard normal probability distribution.

Expected Monetary Value (EMV)

EMV is another *Quantitative Risk Analysis* tool that can help project managers evaluate risk. Figure 9-7 explains the concept of EMV. Basically, EMV is developed as a statistical assessment of the value of risk, not necessarily as a complete project cost estimate. The project cost estimate would have to be adjusted given what the EMV assessment indicated with regard to risk for the project. The formula for EMV is as follows:

EMV = probability **X** impact

Project Risk Management

The Concept of Expected Monetary Value

- Expected Monetary Value (EMV) is developed as a statistical assessment of the value of risk, not a prediction of final cost should a risk event occur or not occur

- EMV = probability X impact

For threats, EMV is called *exposure*
For opportunities, EMV is called *leverage*

- Project-level EMV equals the sum of the EMVs for each risk event

Figure 9-10. Expected Monetary Value Definition

As Figure 9-7 states, for threats EMV is called *exposure* and for opportunities EMV is called *leverage*. With regard to project management, in a threat situation you would want to limit exposure and in any given opportunity you would want to maximize leverage. The total amount of EMV for the project is the sum of all EMVs for each risk event in the risk register.

For example, in Figure 9-8, we have three risk events (or threats, since they are overruns) as identified by the project team. There are no opportunities identified in this short example. Each risk event has a probability of occurrence and an impact if they were to occur. Using the EMV formula, the probabilities and impacts for each risk event are multiplied together. Risk Event 1 has an EMV of $25,000, Risk Event 2 has an EMV of $12,500 and Risk Event 3 has an EMV of $10,000. If these three risk events comprised the complete risk register for the project, then the project's cost estimate would have to be increased by $47,500.

EMV is most applicable from a financial perspective. This allows project managers to adjust project cost estimates to more accurately reflect the *cost risk* of the project or risk events inherent in the project.

Project Risk Management

An Example of a Quantitative Risk Assessment

Risk Event	Probability	X	Impact	=	Expected Monetary Value (EMV)
1	10%	X	$250,000	=	$25,000
2	25%	X	$50,000	=	$12,500
3	50%	X	$20,000	=	$10,000
			Total Project EMV	=	**$47,500**

Figure 9-8. Expected Monetary Value Example

Discussion Questions

1. What are the key elements of project risk?
2. Describe the six processes of project risk management.
3. Compare and contrast the five sources of risk.
4. Differentiate between *Risk Monitoring and Controlling* and *Risk Response Planning.*
5. What are the generic risk response strategies for threats?
6. What are the generic risk response strategies for opportunities?

7. When would project managers most likely use *Qualitative Risk Analysis*?
8. Are *Quantitative Risk Analysis* tools helpful? Why or why not? Explain how you would apply them in a fast-food restaurant situation.

Application Vignette

Project Gold is under review by top management. They have asked you a series of questions regarding how to best allocate resources given one *problem* task in your project--Task F. Here is what you know about Task F:

Most likely completion time:	12 days
Pessimistic completion time:	18 days
Optimistic completion time:	5 days

a. Using a simple 3 point estimate technique, calculate the estimated time
for this project.

b. Using PERT, calculate the estimated time for this project.

c. Based on PERT, top management would like to know the probability of completing Task F in 14 days or more.

d. Based on PERT, top management also has additional resources they can throw your way to lighten the load of Task F. If they do this, what is the probability of completing Task F, keeping everything constant, in 5 days or less?

e. Finally, based on PERT, top management might accept a range of task completion times. What is the probability of completing Task F in 7 days or more but in less than 13 days?

Homework, Exercises and Core Case

1. Project risk can BEST be thought of as:
   a. a threat.
   b. an opportunity.
   c. both a threat and an opportunity.
   d. an activity on the critical path.
   e. only technical in nature.

2. Which source of risk is concerned with the degree of concurrency on a project?
    a. Technical
    b. Programmatic
    c. Supportability
    d. Cost
    e. Schedule

3. Using the PERT framework, what is the expected time to complete a task with estimated times of 3, 4, and 7 days (d)?
    a. 3 d
    b. 4 d
    c. 4.3 d
    d. 4.7 d
    e. 7 d

4. Which source of risk is concerned with the "variables" on a project?
    a. Technical
    b. Programmatic
    c. Supportability
    d. Cost
    e. Schedule

5. What is a "Poor Man's Hierarchy"?
    a. A quantitative risk analysis tool
    b. A risk register technique
    c. A method for generating PERT estimates
    d. A qualitative risk analysis tool
    e. None of the above

6. Which of the following is NOT one of the risk management processes?
    a. Risk Management Planning
    b. Risk Identification
    c. Qualitative Risk Analysis
    d. Risk Evaluation
    e. Risk Response Planning

7. What risk management process BEST describes making a risk event known?
    a. Risk Management Planning
    b. Risk Identification
    c. Qualitative Risk Analysis
    d. Risk Evaluation
    e. Risk Response Planning

8. One typical risk response to a "threat" is:
   a. Share
   b. Enhance
   c. Exploit
   d. Transfer
   e. None of the above

9. One typical risk response to an "opportunity" is:
   a. Avoid
   b. Share
   c. Transfer
   d. Mitigate
   e. None of the above

10. The primary difference between <u>enhance</u> and <u>mitigate</u> risk response strategies are:
   a. that the former tries to increase the probability of the event occurring while the latter tries to decrease the probability of the event occurring
   b. that the former tries to decrease the probability of the event occurring while the latter tries to increase the probability of the event occurring
   c. both try to increase the probability of the event occurring
   d. both try to decrease the probability of the event occurring
   e. None of the above

<u>Exercise 9-1—The Three Risk Event Project</u>

A project has the following risk events (threats) and their respective probabilities and impacts. What is the 'Expected Monetary Value' (EMV) of these risk events for this project?

Risk Event	Probability	Impact
1	30%	$40,000
2	10%	$200,000
3	70%	$100,000

a. Total Project EMV = $12,000.
b. Total Project EMV = $20,000.
c. Total Project EMV = $70,000.
d. Total Project EMV = $102,000.
e. Total Project EMV = $112,000.

Based on your answer to Exercise 9-1, how would the project cost estimate be affected by your assessment after accounting for risks?

a. increased.
b. decreased.
c. no change.
d. new cost elements would have to be added to your cost estimate.
e. less confidence in your cost estimate.

Exercise 9-2—The Sources of Risk

A new part was just received from one of your major vendors. You have heard through the grapevine that the company supplying the part is going through some difficult financial times right now and has been cutting corners in their production processes, laying people off, and possibly going bankrupt.

Using the five sources of risk, what might you anticipate for each source of risk with regard to this unstable supplier? For instance, *Technical risk* might include poor quality, poorly executed manufacturing procedures, or a lack of appropriate technical personnel.

Core Case—The 'Boom' Project

The following table represents a plan (in days) for the "Boom" project:

Job No.	Predecessor Job(s)	a	m	b
1	--	2	3	4
2	1	1	2	3
3	1	4	5	12
4	1	3	4	11
5	2	1	3	5
6	3	1	2	3
7	4	1	8	9
8	5,6	2	4	6
9	8	2	4	12
10	7	3	4	5
11	9,10	5	7	8

a. Construct a network analysis for this project.

b. Indicate the critical path.

c. What is the expected completion time for the Boom project?

d. You can accomplish any one of the following at an additional cost of $1,500:

(1) Reduce job 5 by two days.
(2) Reduce job 3 by two days.
(3) Reduce job 7 by two days.

If you save $1,000 for each day that the earliest completion time is reduced, which action, if any, would you choose?

e. What is the probability that the project will take more than 30 days to complete?