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CHAPTER 17

RISKS

Risk?! Risk is our business!

Captain James T. Kirk

Risk Management is the art and science of dealing with risks. During planning this involves defining a comprehensive approach to risks: identifying them, quantifying them, and creating a risk response plan. During execution, the project manager monitors and controls risks.

Historically, risk management was considered an optional, add-on process, as distinct from activities such as project scheduling or cost estimating, which were always considered to be an essential part of project management.[1] However, the reality is that every project faces risks and, inevitably, some will materialize.

Starting in the mid-1980s project management standards, such as early versions of the PMBOK, formally began to recognize that comprehensive and integrated risk management is fundamental to project success. Today, managing risk is considered an indispensable and integral part of every stage of project management, and that it must be practiced diligently throughout the life of the project.[1]

Risk management is a proactive attempt to recognize what can go wrong and to plan ahead. Just as in medicine, prevention is better than cure. Here are some questions

[1]Greg Ballesteros, the former CEO of PMI, says "Risk Management is PM for grown-ups."

the project manager should ask: What can go wrong? How can we minimize the impact? What can be done in advance? What will our response be?

17.1 Risks

We begin with the definition of a risk:

> *A risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on the project.*

It often comes as a surprise that the definition of a risk includes the idea that a risk can be *positive*. People usually assume that a risk has only negative consequences, and that risk management consists of mitigating the impact of the things that can go wrong. However, it is as important to enhance the effects of the positive risks as it is to mitigate the impact of negative risks.

Consider the following examples of risks:

1. *The staff does not have the required technical skills.*

   This is a negative risk, and the job of the project manager is to develop a strategy either to prevent the risk from occurring (e.g., by changing staff assignments), or mitigating the risk (e.g., by implementing a training plan).

2. *The subcontractor can provide the deliverable earlier than planned.*

   This is a positive risk. If the deliverable is on the critical path, this may result in accelerating the schedule. The project manager should work to maximize the positive impact of the subcontractor's early delivery, perhaps by providing extra staff to help with delivery documentation.

Project managers should diligently investigate all risks and apply the correct tactic: Preventing and mitigating negative risks, and enhancing positive risks.

17.1.1 Risk Causes and Consequences

Risks have *causes*: For example, people get sick, the scope changes, a construction permit takes longer than anticipated.

Risks also have *consequences*: For example, some consequences associated with the above risks are:

Risk	Consequences
People get sick	Inexperienced, replacement personnel make mistakes.
The scope changes	The change in scope increases the cost.
Permit delayed	The completion date is delayed.

Notice that the cost increase is a *consequence*, not a risk. Technically, it is incorrect to say there is a *cost risk*. It is also incorrect to speak about a *schedule risk*. Instead, the project manager should explain that there are risk causes that may have schedule consequences, i.e., a delay in the schedule.

There are many sources of risks:

- Scope creep.[2]
- Insufficient or poor resources. An expert may be needed simultaneously in two places.
- Pressure to compress the schedule from customers or management.
- Pressure to reduce the cost from customers or management.
- Lack of a formal project management process. Uncontrolled changes are a major source of confusion and delay.
- Stakeholder friction. Stakeholders can hold up approvals if they feel their particular interests are not being satisfactorily addressed.
- Poor communications. Team members will not know what to work on, or how to prioritize their time. Customers will not understand the status of the project. Stakeholders will not know what is going on.

Examples of risks on a plumbing project are shown in Table 17.1. The consequences were that each one contributed to an increase in the cost.

17.1.2 Known Unknowns and Unknown Unknowns

When trying to identify risks, one is always looking into the future, so it is an uncertain business. For a risk, its degree of uncertainty can be classified as follows:

- *Known unknowns*: These are risks that can be *identified*. A good way to identify risks is by reviewing similar projects. An example from the New Kitchen project is:

[2] Can you make this small change for me?

Table 17.1: Sources of risk on the Kitchen project.

Risks in Cost Estimate	Source of Risk
Unforeseen circumstances.	When the plumber opened the cabinet to replace the faucets, he found rusted pipes that had to be replaced.
Use of wrong estimation parameter.	The estimator used the parameter for a new house, instead of a renovation.
Formula inaccuracy.	The estimation formula is only good to ±20%.
Optimistic estimate.	The PM knew the customer's budget, and agreed to do the project for that amount.
Junior plumber assigned.	The estimate assumed an experienced plumber.
The estimate was made by "analogy."	The project turned out not to be "analogous," it was completely different.
It took longer.	Sometimes, this just happens.

We have to install a gas line in the kitchen and on the last project the permitting process was delayed by 6 weeks.

Known unknowns are risks that we can "kind-of-anticipate." According to David Logan,[2] "much of the scientific research .... (about risks) .... is based on investigating known unknowns." That is, we tend to allow for the things we expect.

- *Unknown unknowns*: These are the events we did not expect, things we had no idea about, as in:

  What?! You can't quit, you're our best programmer!

  Technically, unknown unknowns are the risks that could not be identified. NASA space exploration missions provide fascinating examples of things that went wrong that no one could possibly have anticipated. On a more mundane level, it is just not humanly possible to anticipate all risks.[3]

The general process is as follows: First, the risks are *identified*, e.g., in a brainstorming session. It is quite easy to make a very long list of the things that can go wrong. Therefore, once you've identified the risks, you need a way to prioritize them and to decide which ones should be actively addressed. This is accomplished by performing a *qualitative* assessment in which risks are classified according to both their likelihood and their impact.

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Next, the risks that are both likely to occur and that may have a significant impact must be assessed in more detail. This is called a *quantitative* assessment and the goal is to estimate specific *contingency* amounts. Contingencies are additions to the cost and to the schedule.[4]

Finally, you should make an allowance for things that you just can't anticipate—the unknown unknowns. The allowance for these unexpected events is called the *management reserve*.[5]

The lesson for project managers is serious: Risks will materialize, so plan ahead.[6]

17.2 Risk Strategies

The approach to dealing with risks is to formulate a strategy for both negative and positive risks.

17.2.1 Strategies for negative risks

The negative risk strategies are: avoid, transfer, mitigate and accept.

- *Avoid:* If possible, this risk *prevention* strategy should be the first choice.

  A technique of risk avoidance is to change the scope, which changes the project's functionality so that the risk cannot occur. For example, if the kitchen does not have gas, and the installation of a gas stove introduces an unacceptable delay, then propose an electric stove.[7] Another avoidance strategy is to defer risky parts of the specification to a future delivery.

  The advantage of *avoid* is that you do not need any contingency funds or schedule buffers. You have eliminated the risk.

- *Mitigate:* In this approach, one attempts to reduce either the likelihood of the event occurring or its impact, or both. This can result in lowering the ranking of the risk from high to medium, or even low. In practice, it is unlikely that a risk can be entirely prevented from occurring.

  An example of *mitigation* is as follows: Assume that an information technology project plans to use a new, sophisticated development system, and the organization does not have any previous experience with it. One *mitigation* strategy is to send the inexperienced staff members for training.

  Notice that *mitigation* almost always involves extra cost. In the above case, training funds will be required to mitigate the risk of inexperienced staff.

[4] Identified risks (known unknowns) result in contingencies: additional funds and schedule buffers.

[5] There is considerable debate over the management reserve. Some organizations require it (e.g., The Federal Highway Administration), while in a competitive situation many companies automatically delete the reserve to lower their bid.

[6] You can't anticipate all eventualities. Plan to bury some funds and schedule some slack. You never know when you will need them.

[7] Of course, the customer may say "No way!" But at that point, she may also be willing to accept the delay.

- *Transfer:* In this strategy, we outsource the risk to a third party. Often, risk *transfer* involves investing in insurance, performance bonds, or warranties.

  An example of risk *transfer* is the hiring an expert consultant to build a difficult piece of the project. The transfer of risk usually involves extra funds.[8]

- *Accept:* In this strategy, we accept the reality that the risk can neither be avoided, mitigated, nor transferred. The project team then decides to take a chance and *accept* the risk. The team recognizes that they will have to deal with this risk if, and when, it occurs. To allow for the risk, the project manager should set aside contingency reserves of time, money and staff.

  An example of *accepting* a risk is: A deliverable is to be supplied by an unreliable subcontractor who holds a monopoly on the technology and there are no alternatives. The only option is to accept the risk.[9]

17.2.2 Strategies for Positive Risks

Positive risks can enhance the performance on a project. As there were with negative risks, there are four strategies for dealing with positive risks: Exploit, enhance, share, and accept. These strategies parallel those for negative risks.

- *Exploit:* Here we leverage our strengths and attempt to take advantage of the risk. For example, the company might have talented programmers and assigning them to critical deliverables may result in early completion at a lower cost.

- *Enhance:* In this strategy, we attempt to increase either the likelihood or the impact of the risk occurring. An example of risk enhancement is as follows: If an activity is finished early freeing up staff, then they can be assigned to activities on the critical path to shorten the schedule.

- *Share:* Here, we enhance the opportunity for project success by teaming with a third party and delegate to them pieces they are better equipped to perform. Large projects usually share risks among several companies, each with their own expertise. For example, Boeing subcontracts the design and development of jet engines to third parties.

- *Accept:* Here we acknowledge that we cannot construct a viable strategy for maximizing the benefits of the positive risk, so we accept the status quo.

[8]Do you want to add travel surance for your trip?

[9]Note that almost all risk rategies involve adding costs ıd time–the contingencies. ›u did put those in your ıdget and schedule, didn't ›u?

17.2.3 Risk Response

Despite the team's best efforts to mitigate them, some risks will actually occur, and often in unexpected ways. Therefore, the final piece of the strategy is to *respond.*

We emphasize that one should not sit around waiting to respond to a risk materializing. The project manager creates a *Contingency Plan*, which defines how the team will react to the risks *before* they materialize. The plan should include responses for both positive and negative risks.

17.3 Planning Risk Management

The purpose of the *Plan Risk Management* process is to create the overall management approach to risks. Since this is a plan, the most appropriate tool is a template, the key components of which are:

- Risk management scope and objectives.
- The methodology to be used for risk identification, assessment, quantification, and response, as well as for monitoring and control.
- The participants in the risk analysis process.
- The risk analysis tools to be used, and identification of helpful templates and other organizational process assets.
- Risk prioritization, e.g., risks impacting cost take priority over schedule. Risk weights, labels, and selection guidelines.
- The communications approach for risks when distributing status reports, including protocols for elevating risks to sponsors and senior management.

17.4 Identify Risks

The goal of the *Identify Risks* process is to create the *Risk Register*, which contains a list of risks, and evolves to include their assessment and ranking in importance.

PMI introduced a *Practice Standard for Risk Management* [29], which contains a comprehensive description of risk analysis tools and techniques, their strengths and weaknesses, as well as critical success factors for their effective application. The standard suggests that a useful method of identifying risks is to continually repeat the following mantra:

Because of **<one or more causes>**, **<risk>** might occur, which would lead to **<one or more effects>**.

The following is a list of risk identification techniques:

- *Assumptions and Constraints Analysis:* Each assumption and constraint in the project scope statement represents a risk. This can be used as a starting point to identify risks during the planning stage.[10]
- *Brainstorming:* The project team, and other stakeholders, should be encouraged to generate a list of risks in a facilitated process.
- *Cause-and-effect (Ishikawa) diagrams:* This visual diagram promotes brainstorming, clarifies root causes, and helps develop mitigation strategies.
- *Checklists:* By examining historical data from similar projects, a list of relevant issues can be developed. Project lessons are sometimes available in industry databases, and are a great source for risk identification.
- *Delphi Technique:* This is similar to brainstorming, but is a structured and formal process that requires formal facilitation and anonymity.
- *Influence Diagrams:* Risks can be inferred from this diagram, which shows the main project entities and decision points, uncertainties and outcomes, and the relationships among them.
- *Interviewing:* This is similar to brainstorming in that expert consultants are interviewed to help identify and understand risks.
- *Historical information:* Organizations with good project management assets have a repository of lessons learned—an invaluable resource for identifying risks.
- *Questionnaires and Software:* Software that prompts the project team or stimulates creativity can help with risk identification.
- *Risk Breakdown Structure (RBS):* The RBS is a valuable tool for identifying and classifying risks. An example of an RBS is shown in Figure 17.1
- *SWOT analysis:* A SWOT analysis might be available, since it is often part of the business case. If not, the team can perform a SWOT analysis, focusing on threats and weaknesses.

Assumption: The permit
ill be available in 30 days ...
isk: Permit schedule delay.

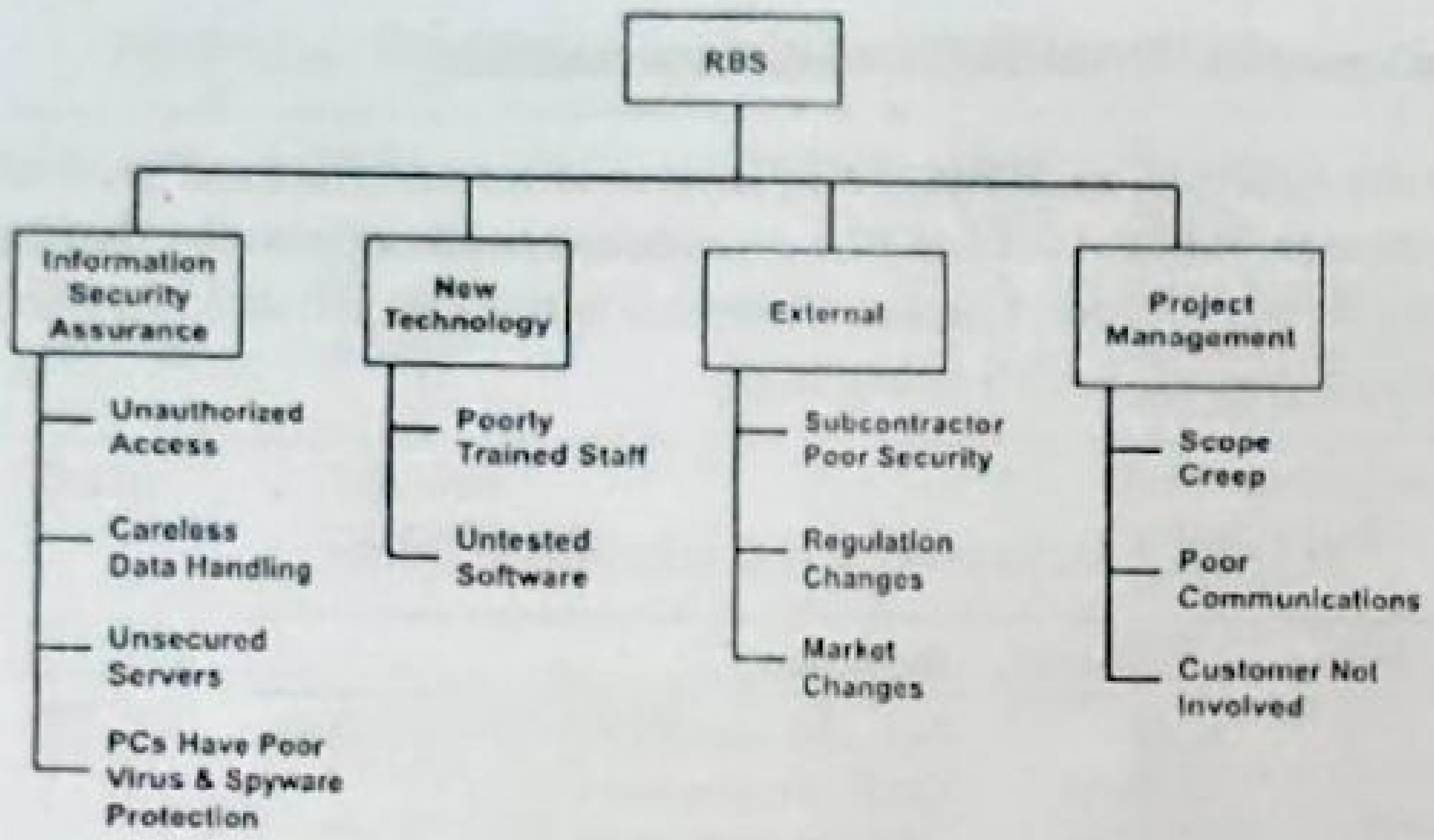

Figure 17.1: A *Risk Breakdown Structure.*

- *WBS:* This provides a comprehensive overview of all activities and can act as a starting point for brainstorming another source of risks.

The *Risk Identification* process results in a *risk register,* in which each risk has the following attributes: ID, Name, Description, Impact (area and at what stage), Type (positive or negative), Likelihood, and Estimated Severity.

17.5 Risk Assessment

Given a list of risks in the *Risk Register,* the next step is to assess them, and there are two steps: qualitative and quantitative. The *qualitative assessment* considers all risks and calibrates them in terms of their likelihood of occurring and potential impact. The risk data are updated in the risk register by adding both their likelihood and impact, which, at this stage, are usually just in terms of high, medium, and low. Unlikely risks and those with little impact may be placed on a "watch list."

The goal of the *qualitative* assessment is to develop a list of risks with the potential to significantly affect project outcomes, either negatively or positively. These significant risks are then further investigated in a *quantitative* analysis, the goal of which is to estimate the required contingencies (cost and schedule).

17.5.1 Techniques for Qualitative Risk Assessment

In a qualitative risk analysis, each risk is analyzed to determine its likelihood of occurring and its impact. Tables 17.2 and 17.3 provide examples of how the likelihood and impact might be defined for a project. Risks are scored on a scale from 1 to 5 in both likelihood and impact, with 5 being 'high.'

Table 17.2: Definition of risk *Likelihood* values.

Rating	Likelihood	Definition
1	Rare	Occurs in exceptional circumstances
2	Unlikely	Could occur at some time
3	Possible	Might occur at some time
4	Likely	Will probably occur in the project
5	Very Likely	Expected to occur in most situations

Table 17.3: Definition of risk *Impact* values.

Rating	Impact	Definition
1	Insignificant	No Damage or Loss No cost or schedule impact
2	Minor	Minor damage or loss Minor cost or schedule impact
3	Moderate	Some damage and/or loss Significant cost or schedule impact
4	Major	Extensive loss and damage Extensive cost and/or schedule impact
5	Catastrophic	Damage to reputation Huge financial loss Unrecoverable cost and/or schedule impact

Table 17.4 shows an example of a risk assessment for the PMA project, it lists all risks as well as their likelihood and potential impact.

These scores are then used as coordinates on the *Risk Assessment Matrix*, which is a useful visual aid—see Figure 17.2. Likelihood is plotted on the *y-axis* and impact on the *x-axis*. In the *Risk Assessment Matrix*, bands of color help to categorize the risks. The top right hand corner is red, and risks in this area have *high likelihood* of occurring and *high impact* if they occur. Many risks in this area is a sign of trouble. The middle band represents medium risks, while the bottom left corner represents *low likelihood* and *low impact*.

Table 17.4: The *Risk Assessment* for the PMA web site.

Risk ID	Category	Risk	Impact	Likeli-hood	Mitigation Action
1	Infra-structure	Not set up in time.	3	2	Select highly recommended VAR for servers.
2	Design	PMA Data may be hacked.	5	5	Select developer skilled in tools. Backup: Alternate tools.
3	PM	Aggressive schedule. Schedule fixed, possible delays.	3	5	Accept the risk. Monitor progress closely . Re-assess if slip occurs.
4	Skills	Key resources part time.	4	3	Tool easy to learn. Conduct training sessions.
5	Technology	Fixed price, contract. Added content may need to be purchased.	1	2	Include contingency $2,500 for unforeseen expenses.

17.5.2 Tools for Quantitative Risk Analysis

The risks in the upper right quadrant of the *Risk Assessment Matrix* are classified as significant candidates for further investigation, which is accomplished using a *quantitative* analysis. When a risk occurs, it affects (usually negatively) the cost and the schedule and the goal of the quantitative assessment is to *numerically* estimate its impacts.

Not all identified risks will materialize. Therefore, to fund the risks that actually occur, one assigns contingency funds and time buffers. There should be a contingency for cost (in dollars) and a contingency for schedule (in weeks), which is often called a time buffer.

The following analysis tools can be used to estimate contingencies.

Expected Monetary Value (EMV)

EMV is a technique used to calculate a weighted average, or expected cost, when the outcomes are uncertain. We illustrate the EMV technique with three examples:

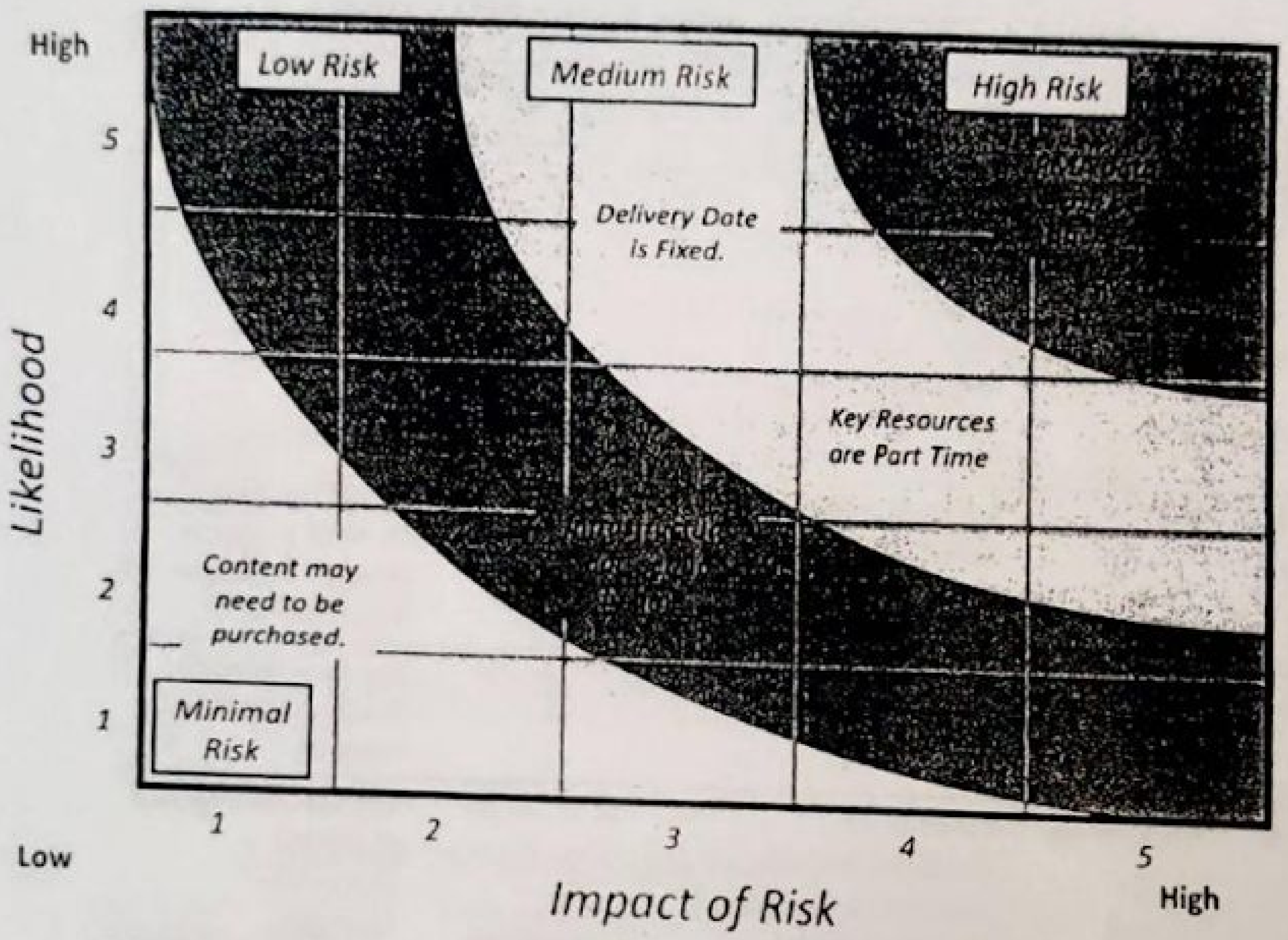

Figure 17.2: The *Risk Assessment Matrix* tool for *Qualitative Assessment*.

1. *Rank Ordering Risks:*

   EMV is a good tool to prioritize and rank order risks. Suppose that all the risks in the risk register are negative. First, we express the risks in monetary form, e.g., *The cost of a one-week delay is $10,000.*

   Next we assign a probability to each risk, e.g., *The probability of the risk is 50%.* Finally, we multiply the monetary impact by the probability to determine the expected value of this event:

   $$\textit{Expected Value of Risk} = \$10,000 \ x \ 0.50 = \$5,000. \qquad (17.1)$$

   One can then rank order all of the risks by their expected monetary value to reveal which ones are most important and require more attention.

2. *Calculating Contingency Amounts:*

   The contingency budget is the amount allocated to cover the cost of the risks. (There should be a similar allowance for the schedule.) The contingency

budget can allow for the fact that some risks are positive and some negative, as shown in Table 17.5.

Table 17.5: Calculation of the contingency budget.

Risk Event	Amount at Stake	Probability	Contingency (EMV)
Project will incur cost overrun resulting in financial penalty	-$50,000 (Loss)	0.80	-$40, 000
Vendor supplies component early. Early completion of project	+$10,000 (Gain)	0.50	+$5,000
Potential Project Impact			-$35,000

Table 17.5 suggests the project manager should set aside around $35,000 to cover the losses associated with identified risks.[11] The probabilities, gains, and losses are all *estimates*. A wise project manager will conduct a sensitivity analysis in which the amounts and probabilities are varied, and a range of values determined for the contingency funds.

3. *Alternative Outcomes:*

   When calculating the contingency budget, several alternate outcomes for risk events might have to be considered. To show how this is accomplished, we expand the EMV calculation to include several possible events. We then weight the outcomes by their probability of occurrence.

   To the above case, we add the idea that the 'reward' can be either high or low. We assess that the probability of the reward being high is 0.6, and of being low is 0.4. We multiply the Amounts at Stake by the probabilities to obtain the total Potential Project Impact—see Table 17.6.

Decision Tree Analysis

A decision implies there are several alternative approaches, each with different potential outcomes. The *decision tree* is a tool for evaluating decisions, and showing which alternative provides the highest payoff.

We illustrate a decision tree with an example from the PMA case. The PMA board proposed a campaign to increase membership, and the team thinks the quality of the web site will be a significant factor in the success of the campaign. Therefore,

[11] This does not guarantee that this is the right amount, it is simply the best guess. Both (or neither!) of the risks might occur.

Table 17.6: Calculation of the contingency budget using multiple outcomes.

Outcome	Amount at Stake	Probability	Contingency (EMV)
When reward is High: Demand for new software results in financial penalty	$40,000	0.6	-$24,000
If reward is Low: No financial penalty	$10,000	0.4	-$4,000
Potential Project Impact			$20,000

the team proposed investing in a development environment, which would cost around $50,000.

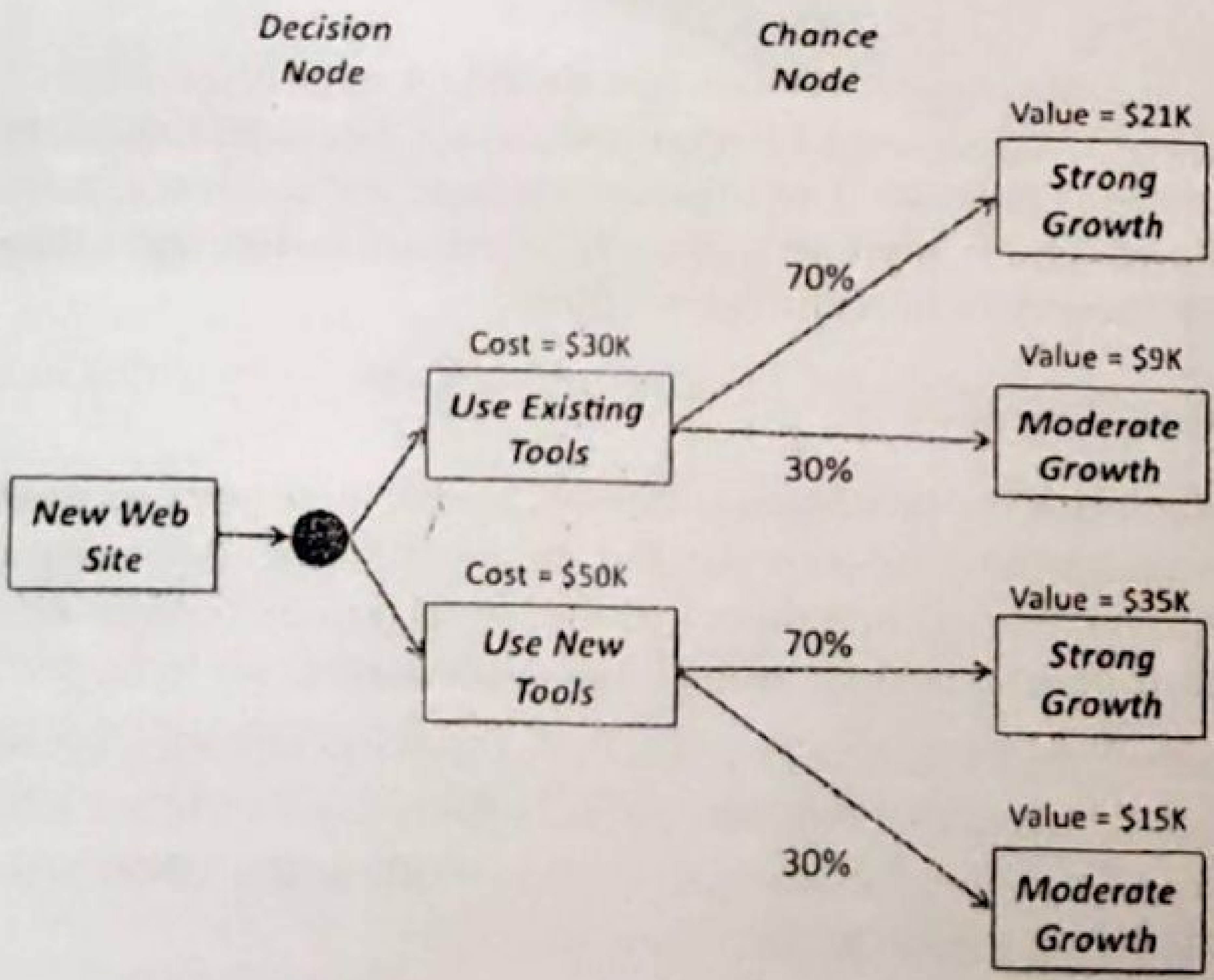

Figure 17.3: A *Decision Tree* analyzing the investment in new web site tools.

Figure 17.3 shows the way in which a decision tree is structured. The decision node, which is represented on the diagram by a small circle, has two options:

1. *Use Existing Tools:* In this option, the investment is $30,000, which is the estimated cost of upgrading the existing tools. This should include staff costs to implement the upgrades, training, and any new hardware.

2. *Use New Tools:* In this option, the investment is $50,000, which is the investment amount for new tools, including staff, training, and hardware.

Next we allow for multiple outcomes, which is accomplished by assessing and evaluating the potential of the campaign to increase membership. After some analysis, the team proposes that there are two likely outcomes:

1. *Strong Growth. Likelihood: 70%:* The team believes that the campaign is very likely to succeed, and they propose that there is a 70% chance that the membership growth campaign will be successful.
2. *Moderate Growth. Likelihood: 30%:* Since nothing is certain, the team admits that there is a 30% chance that the membership campaign will be only moderately successful.

We now calculate the payoff for each outcome. The team estimated that each new member is worth around $1,000 to the organization. Therefore, to determine the payoff, we must estimate the increase in membership for each branch of the tree.

When the team uses the existing tools and the growth is strong, they estimate an increase of 21,000 members. However, when new tools are used, that number should increase to 35,000, as the new tools will allow the team to reach a wider audience and process potential new members more efficiently. For moderate growth, the corresponding numbers are 9,000 for existing tools, and 15,000 for new tools.

The final analysis step is to determine which is the most effective option. To do this, we calculate the *Expected Monetary Value* of each branch of the tree:

Existing Tools	= -$30,000 + $21,000 x 0.7 + $9,000 x 0.3	= -$12,600.
New Tools	= -$50,000 + $35,000 x 0.7 + $15,000 x 0.3	= -$21,000.

The decision with the highest payoff is *"Existing Tools"*.[12]

Because both options have negative payoff, one may reasonably ask what happens if the team decides to do nothing. That is, what is the impact of conducting the campaign with no upgrade of web tools at all?

In that case, we can add a third decision, *Do Nothing*, with an investment of zero. Further, suppose we estimate that the growth in membership for the two scenarios are *Strong = 2,000* and *Moderate = 1,000*. If we add the *Do Nothing* decision node to the diagram, we will get the following EMV for that branch:

$$\textit{Do Nothing} = -\$0 + \$2,000 \times 0.7 + \$1,000 \times 0.3 = +\$1,700. \quad (17.2)$$

[12]It has the smaller negative number.