

Project Risk Management

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PMG 621
Risk and Decision Analysis

Lecture 8



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Chapter 08

Introduction

Project risk management is about optimizing value. Decision analysis is the discipline for making decisions under uncertainty and provides a logical, consistent process for project management decisions.



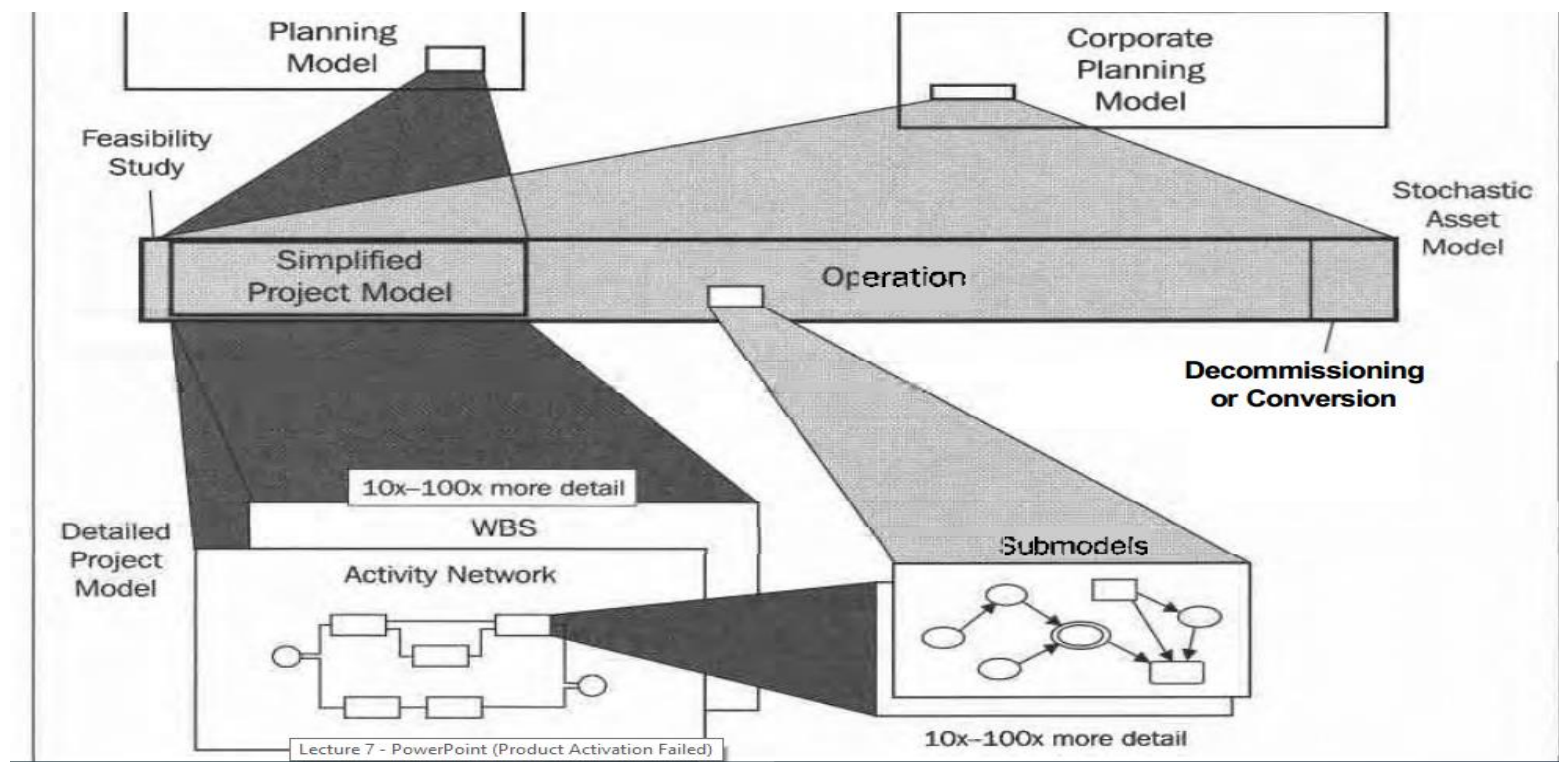
Chapter 08

The Business Perspective:

A Guide to the Project Management Body of Knowledge (PMBOKB Guide) - 2000 Edition defines project risk management (PRM) as "the systematic process of identifying, analyzing, and responding to project risk." In decision analysis, our understanding of a system is structured and quantified. Probability is the language of uncertainty, and experts express their judgments about risks and uncertainties as probabilities and probability distributions. In this discussion, I will emphasize quantification and value-based decision making beyond what the PMBOKB Guide suggests.

Model Scope

Most projects develop or build some form of asset. The asset life-cycle model represents how business value depends upon the completion date and changes in the asset's functionality or performance. Figure 8.1 illustrates relationships between the asset model and the project model. Both may incorporate the results of detailed sub models developed to understand particular processes, subprojects, or system components.



The asset model, itself, may be part of a higher-level corporate or resource-planning model. The asset model should always be a stochastic model-that is, incorporating probability distributions-because every project has uncertainties. The asset model relates such elements as:

- Cost, time, and performance
- Value of early completion
- Impact of parameters, such as scope changes
- Project projections, including criticality indexes.

The detailed project model is typically deterministic, that is, without distributions. If less than, say, fifty activities, we might incorporate distributions into the detailed project model. The amount of detail appropriate, in either an asset or a project model, depends upon the situation and the capabilities of the analysis team. Models with hundreds or thousands of probability distributions would overwhelm most of us. Expert system assistants (Chapter 17) will enable us to develop, maintain, and apply larger models.

As Figure 8.1 illustrates, I'm advocating (a) a stochastic asset model with a lesser detailed project model inside, and (b) a deterministic project model for detailed planning (not evaluation) and control. We can do most risk-response evaluations on the side as simple decision analyses.

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2.1	Project Phases and the Project Life Cycle
4.1	Project Plan Development
5.2	Scope Planning
6	Time Management (project modeling)
7	Cost Management
8.1.2.1	Benefit/Cost Analysis
10.3.2	Tools and Techniques for Performance Reporting (variance analysis; earned value)
11	Project Risk Management
12.1.2	Tools and Techniques for Procurement Planning (contract type selection)
12.4	Source Selection

Table 8.1 Project Activities for Using Decision Analysis

PRM benefits from focusing on the key drivers, risk mitigation actions, and the effects of uncertainty. In contrast, project execution and control benefit from planning in great detail. Thus, the asset life-cycle model typically contains a simplified project sub model, developed initially before the detailed project model. The full project model contains typically ten to 100 times more detail as the asset model, in terms of resolution.

In modeling the project, do not neglect end of life. The asset may have a successor use or be saleable. We might decide to build-on into a next version or renovate to extend the planned life. Some assets will have significant decommissioning or abandonment costs.

Pre-Project Risk Management

Risk management begins in the feasibility study. A stochastic (probabilistic) model of the asset life cycle provides the basis for justifying the project. This includes a preliminary and coarse project model for calculating distributions for time and cost to do the project. The structure of the summary project model developed at this stage has a preliminary work breakdown structure (WBS) or other activity network representation. Include major discrete contingencies. Probability distributions, of course, express judgments about uncertain input variables.

We should maintain this asset model throughout the life cycle. Update this model as new information becomes available. As illustrated in Figure 8.1, there are two project models in different detail. Check the project model and asset model after revisions to ensure consistency. Important risks provide opportunities for improving the project. What alternatives exist to improve the project's risk-versus-value profile?

During the Project

The numbering on the following risk management functions matches the PMBOK® Guide.

11.1-Risk Management Planning

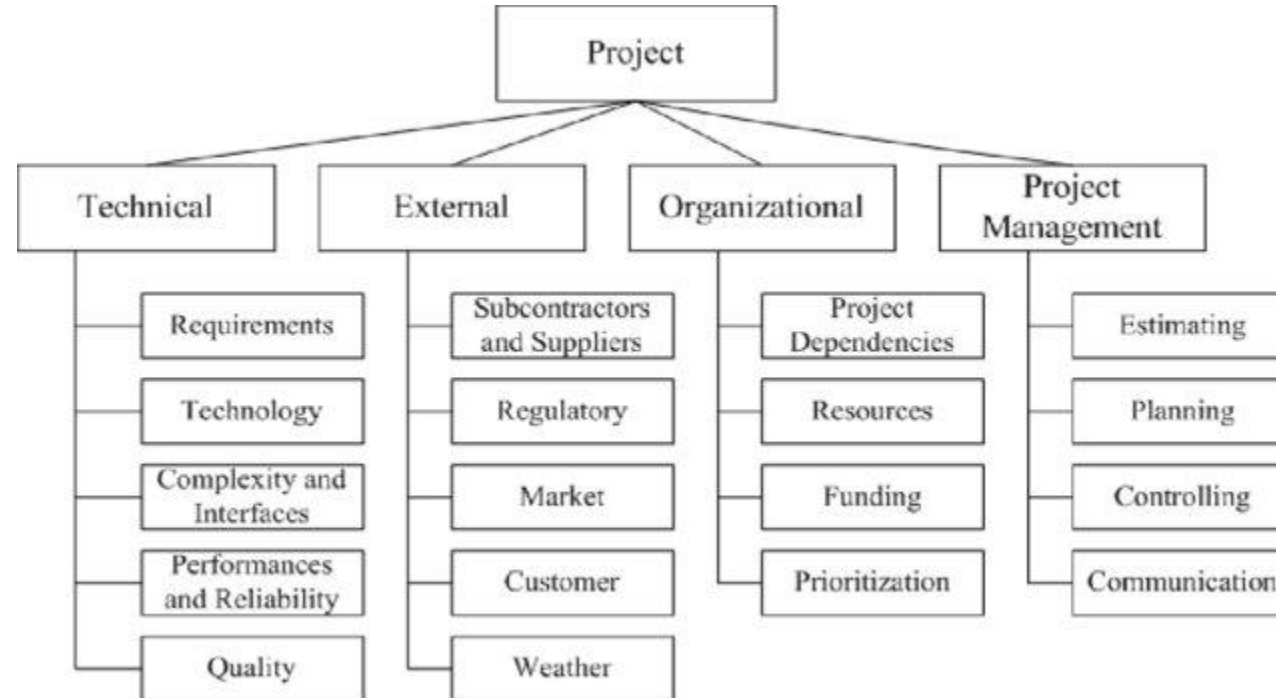
In the early stages of project initiation, we design and implement the formal risk-management methodology. This defines roles and responsibilities, databases, and control reporting.

It is hoped that, as with decision policy, the procedures and systems are not reinvented with a new project. Rather, the process is a proven, consistent, and well-understood part of the way the organization operates. Special circumstances may require some modification, and the purpose of Risk Management Planning is to fix the process for this project. Appendix 8B, Risk Management Plan, discusses plan elements in more detail.

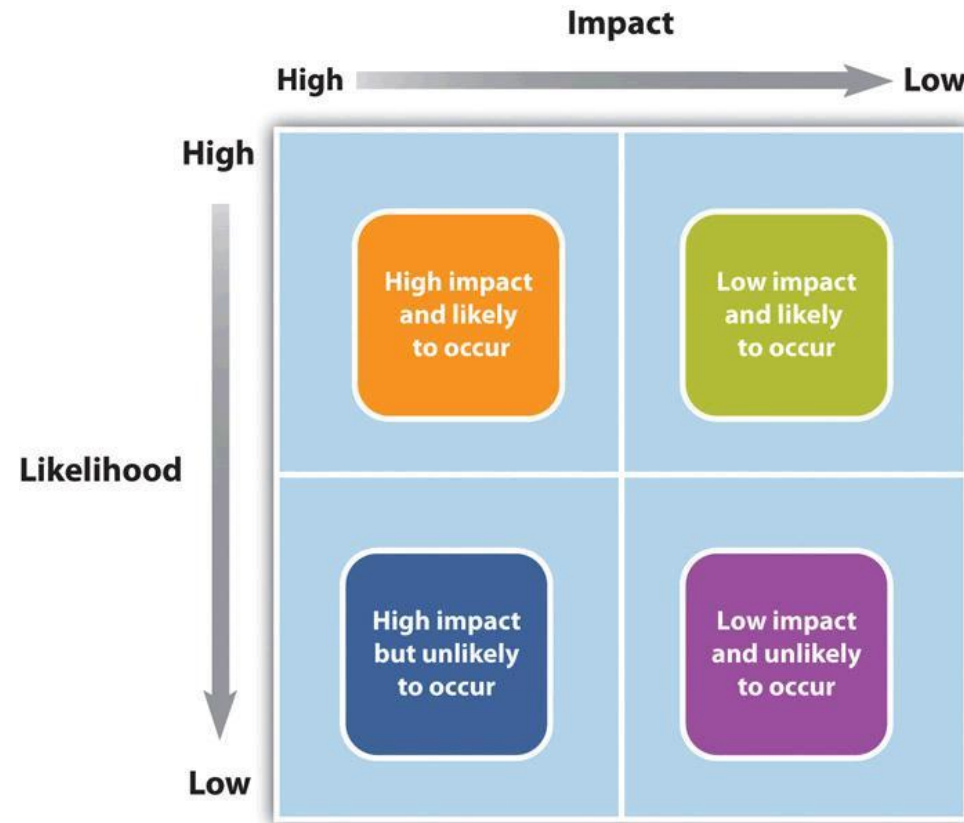
Risk Categories



Risk Categories



Defining Risk probability and impact levels

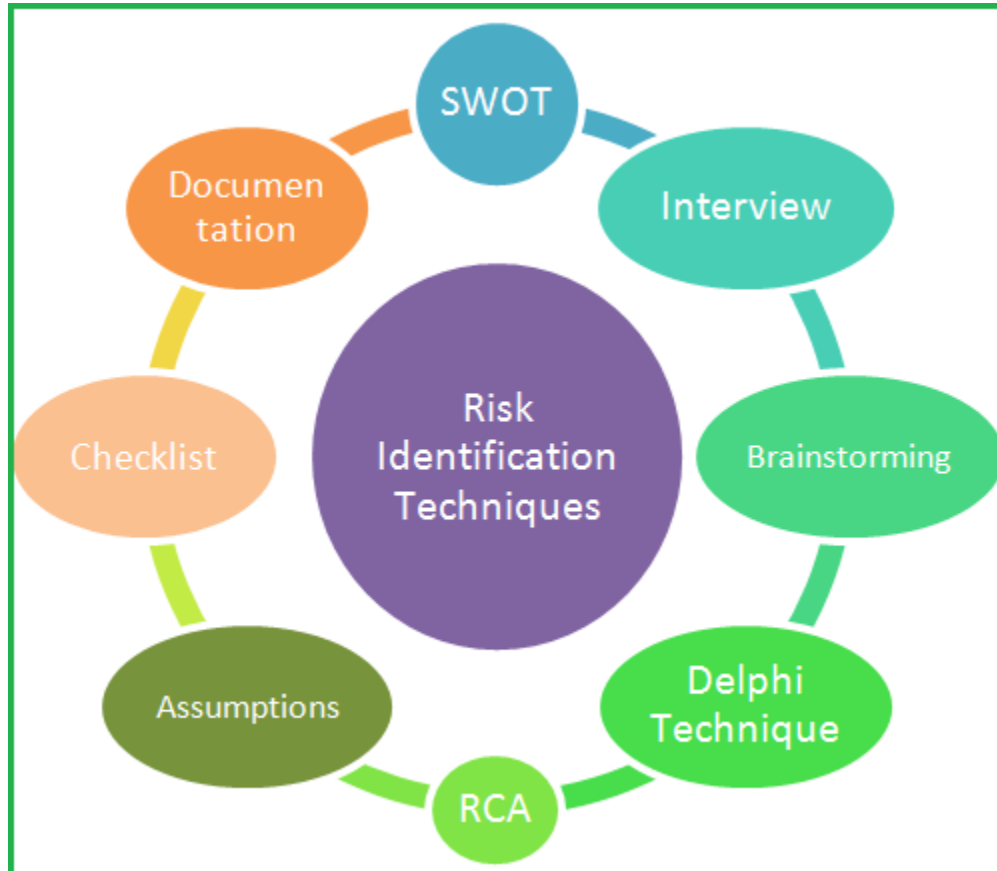


11.2-Risk Identification

In detailed project planning, the project team creates, as applicable, the bill of materials, WBS, and an activity network diagram. The project model details elements in schedule and cost estimation. Risk Identification is about reviewing every input variable, activity, key material, and resource.

What are the threats and opportunities? Checklists built-up from others' experiences are valuable in getting started and in ensuring completeness. Influence diagrams are able to represent relationships not evident in the activity network diagram. Classifying risks helps identify common and redundant entries. Also, consider potential changes in the environment as risks-i.e., the assumptions may change.

Risks identification methods and tools



Risks Breakdown Structure (RBS) for software project

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Product engineering	Requirements	Stability Completeness Feasibility ...etc...
		Design	Functionality Interfaces Testability ...etc...
		Code & unit test	Feasibility Testing Coding/implementation ...etc...
		Integration test	Environment Product System ...etc...
		Engineering specialities	Maintainability Reliability Security ...etc...
	Development environment	Development process	Formality Process control Product control ...etc...
		Development system	Capacity Reliability System support ...etc...
		Management process	Planning Project organisation Management experience ...etc...
		Management methods	Monitoring Configuration management Quality assurance ...etc...
		Work environment	Cooperation Communication Morale ...etc...
	Program constraints	Resources	Staff Budget Facilities ...etc...
		Contract	Type of contract Restrictions Dependencies ...etc...
		Program interfaces	Customer Subcontractors
			Corporate management ...etc...

Risks Breakdown Structure (RBS) for construction project

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Environment	Statutory	Planning approval delay
			Legislation changes
			Ecological constraints
			...etc...
	Industry	Market	Increase in competition
			Change in demand
			Cost/availability of raw materials
			...etc...
	Client	Client team	Client representative fails to perform duties
			No single point of contact
			Client team responsibilities ill-defined
			...etc...
		PM team	Inadequate project management controls
			Incorrect balance of resources & expertise
			PM team responsibilities ill-defined
			...etc...
		Targets	Project objectives ill-defined
			Project objectives changed mid-design
			Conflict between primary & secondary objectives
			...etc...
		Funding	Late requirement for cost savings
			Inadequate project funding
			Funds availability does not meet cashflow forecasts
			...etc...
		Tactics	Brief changes not confirmed in writing
			Change control procedure not accepted
			Unable to comply with design sign-off dates
			...etc...
	Project	Team	Poor team communication
			Changes in core team
			Inadequate number of staff
			...etc...
		Tactics	Cost control ...
			Time control ...
			Quality control ...
			Change control ...
		Task	Site...
			Design...

Risk Register

Lp.	The main of risks	Owner of risk	Reason/cause	Effect	Risk assessment			Risk response strategy	Cost of strategy
					Probability	Impact	Level of risk		
Designing risk									
1	Lack of acceptance by Investor of design proposals	Investor	Delays in approval	Increase in costs due to the suspension of work of the design team	5-40%	50thous.-500thous.	Low	Market observation, alternative designing solutions	0
2	Delays and difficulties in obtaining opinions and permits	Investor	Delay of designing work, unknown scope of design	Disturbed designing process	5-40%	500thous.-2millions	Medium	Earlier diagnosis of the situation in local authorities offices, organization of meetings preceding designing process	50thous.
3	Conflict among designing team members	Designer office	Insufficient flow of information among team members	Disturbed designing process	0-5%	50thous.-500thous.	Low	Response of a team leader to all form of conflicts - mediation in a team	15thous.
4	Too optimistic assessment of employee workload	Designer office	Approval of unrealistic deadlines for individual work	Delay of designing work	5-40%	50thous.-500thous.	Low	Proposing for employees to work overtime or ordering of part of work to another designing team	120thous.
5	Incorrect information from investor/lack of clear guidelines	Investor	Design may be issued with duplicate error or detected error can generate timing constrains	Verification of errors will increase costs and increase time due to the development of the next revision of design	40-70%	2-5 millions	High	Application to investor for extension of time to complete a design due to additional circumstances	20thous.
6	Staff do not have sufficient knowledge about the subject of design	Designer office	Errors in design	Verification of errors will increase time due to the repeated checks of designing work	5-40%	2-5 millions	Medium	Designing team leader strengthens control over work, providing for employees consultation with an expert	65thous.
Time risk									
7	Acceptance of unrealistic deadlines in contract	Designer office	Faulty contractual provisions	Deterioration of design quality of failure to meet the deadline	40-70%	2-5 millions	High	Employment of new employees or ordering part of work to another party during a contract	105thous.
Budget risk									
8	Underestimation of design budget	Investor	Budget may not be sufficient to carry out designing tasks	Deterioration of design quality	40-70%	2-5 millions	High	Limiting scope of design to necessary minimum	40thous.

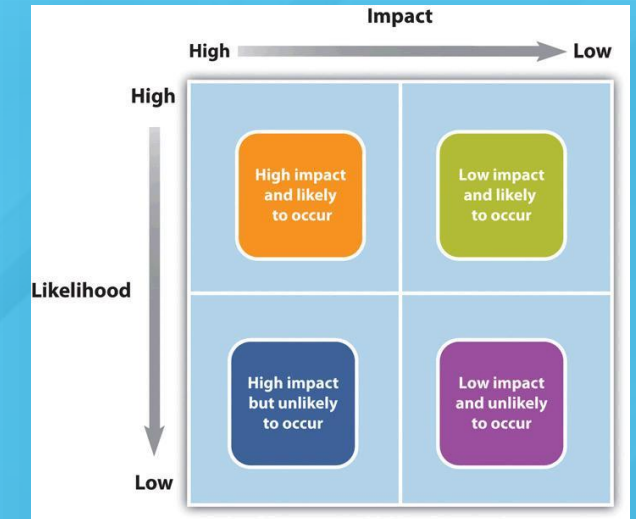
11.3-Risk Assessment

The project base plan is a single scenario where the inputs are EVs for continuous chance variables. For a discrete variable, I use the outcome nearest the EV. Stochastic calculations at an appropriate level, perhaps the asset model, are the means to evaluate schedule, cost, and performance. We need judgments for the values of every input variable in the model. The list includes, especially, risks from Risk Identification. Typically, the most capable available persons judge these values. Their assessments include:

Single values for variables that are well known or can be calculated with precision; single values also suffice for less-important variables (prioritized subjectively at this stage) Probability distributions for important uncertain values in the project model Probabilities for discrete risk events Probability distributions for impact variables that become relevant when the associated risk events occur (e.g., remedial action cost incurred because of a delayed shipment) Single-value or probability distributions for contingency plan implementation costs.

Defining Risk level in a matrix

Likelihood	Consequences				
	Insignificant <i>Risk is easily mitigated by normal day to day process</i>	Minor <i>Delays up to 10% of Schedule Additional cost up to 10% of Budget</i>	Moderate <i>Delays up to 30% of Schedule Additional cost up to 30% of Budget</i>	Major <i>Delays up to 50% of Schedule Additional cost up to 50% of Budget</i>	Catastrophic <i>Project abandoned</i>
Certain <i>>90% chance</i>	High	High	Extreme	Extreme	Extreme
Likely <i>50% - 90% chance</i>	Moderate	High	High	Extreme	Extreme
Moderate <i>10% - 50% chance</i>	Low	Moderate	High	Extreme	Extreme
Unlikely <i>3% - 10% chance</i>	Low	Low	Moderate	High	Extreme
Rare <i><3% chance</i>	Low	Low	Moderate	High	High



11.4-Risk Analysis

Risk Analysis is about understanding overall project risk. The stochastic asset model is the basis for credible forecasts. Some practitioners carry stochastic calculations through the detailed project model as well, though this may be overkill.

A common display of project risk is a cumulative distribution diagram, such as the solid curve in Figure 8.2. The Base Case is only one scenario, used here as the zero reference.

Cumulative distributions show the possibilities. Here we view project cost distributions (which may incorporate cost-equivalent considerations for schedule and performance) both before and after implementing risk-mitigation actions. An asset's value distribution would be similar (assuming the model includes all life-cycle effects), though the x-axis would instead be the asset value outcome (usually PV).

Risk probability and impact matrix

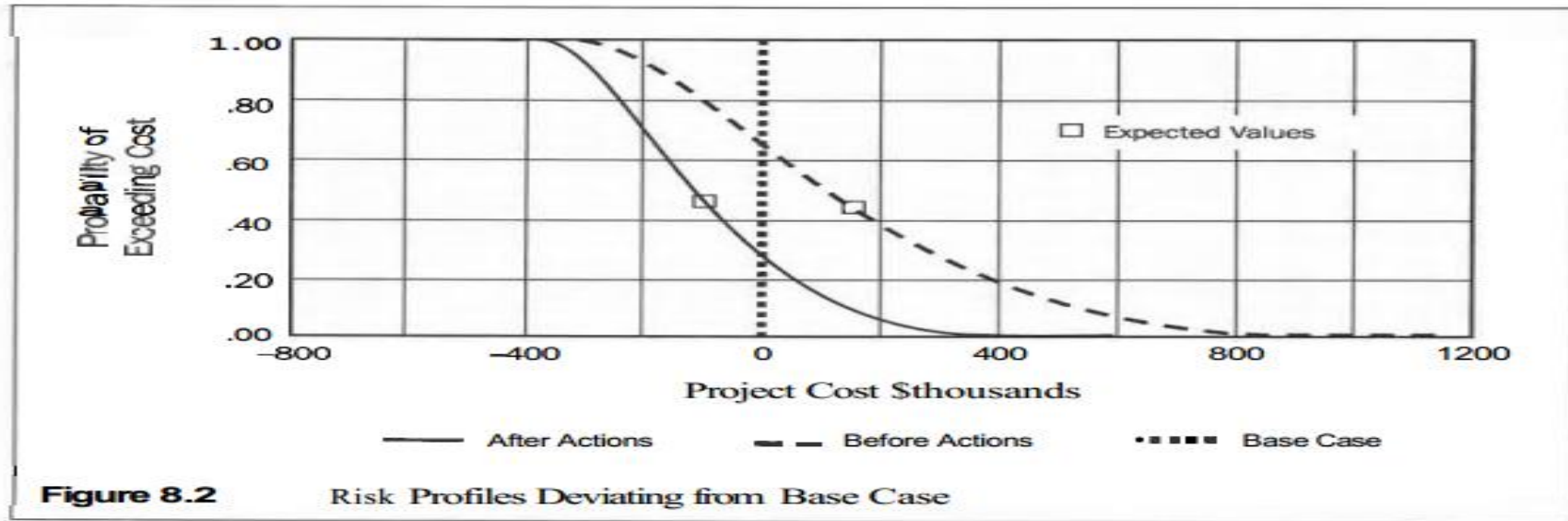
		IMPACT				
		Negligible	Minor	Moderate	Significant	Severe
LIKELIHOOD	Very Likely	Low Med	Medium	Medium	High	High
	Likely	Low	Low Med	Medium	Medium	High
	Possible	Low	Low Med	Medium	Medium	Medium
	Unlikely	Low	Low Med	Low Med	Medium	Medium
	Very Unlikely	Low	Low	Low Med	Medium	Medium

Risk Analysis

SIMPLE SAFETY RISK REGISTER TEMPLATE

RISK DESCRIPTION	IMPACT DESCRIPTION	IMPACT LEVEL	PROBABILITY LEVEL	PRIORITY LEVEL	MITIGATION NOTES	OWNER
Brief summary of the risk.	What will happen if the risk is not mitigated or eliminated.	Rate 1 (LOW) to 5 (HIGH)	Rate 1 (LOW) to 5 (HIGH)	(IMPACT X PROBABILITY) Address highest first.	What can be done to lower or eliminate the impact or probability.	Who's responsible?
Leaks from roof during rain make the floor slippery	Slips and falls	3	5	15	- Order "slippery when wet" signs - Have mops on hand - Fix roof	Allen
Shortage of eye protection	Increase in injuries Production delayed Increased insurance premiums	5	1	5	- Increase supply - Low inventory warnings - Find alternative suppliers	Linda
		4	5	20		
		5	5	25		
		2	1	2		
		3	4	12		
		1	1	1		
		2	4	8		
		4	4	16		

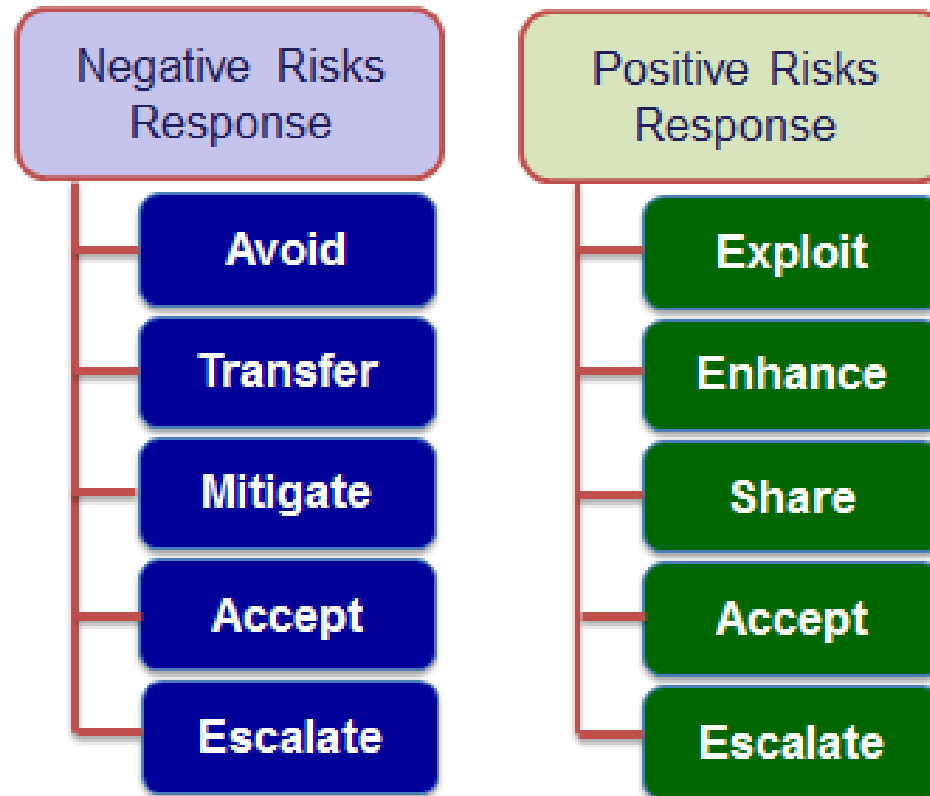
	5	5	10	15	20	25
5	5	10	15	20	25	
4	4	8	12	16	20	
3	3	6	9	12	15	
2	2	4	6	8	10	
1	1	2	3	4	5	
	1	2	3	4	5	



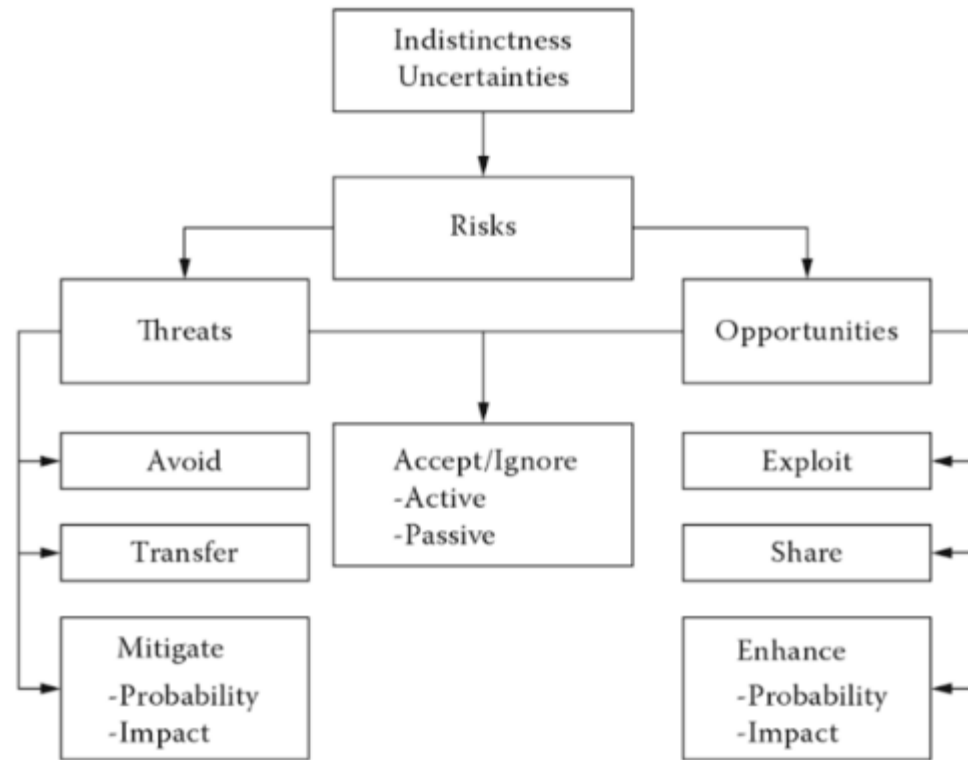
11.5-Risk Response Planning

What we do about the risks? This is the topic of Risk Response Planning. Figure 8.4 shows the hierarchy of this process. Use brainstorming and checklists again to identify candidate actions for mitigating each risk (or enhancing opportunities). Appendix 8C, Mitigating and Avoiding Risks, may provide you with some ideas. For this discussion, we will assume risks are only of the "threat" variety. Actions typically reduce or eliminate risk or affect the impact, should the risk event occur.

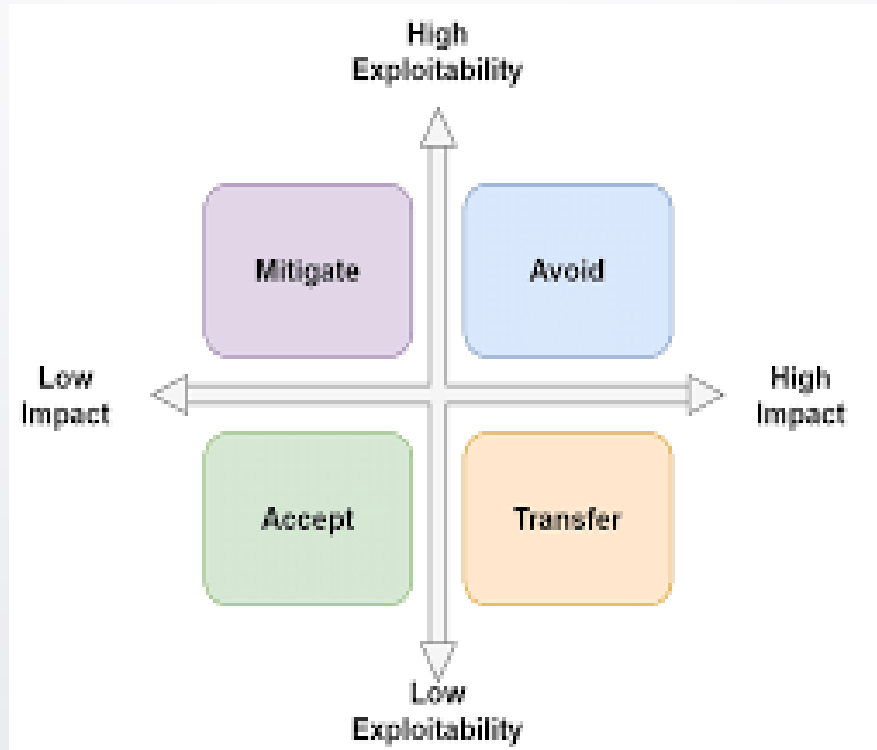
Risk Response (Treatment) strategies



Risk Response (Treatment) strategies



Threat - Risk Response (Treatment) strategies



Opportunities - Risk Response (Treatment) strategies





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From among the potential actions, which are cost effective to implement? The optimal project plan incorporates the combination of actions that adds most value to the organization.

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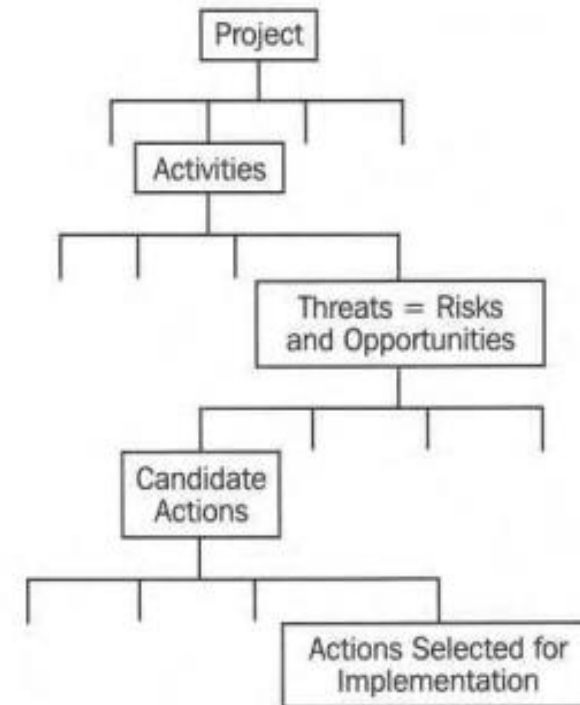


Figure 8.4 Risk Response Planning Hierarchy

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In a simple world, we could do a risk/cost/benefit analysis on every candidate action. The decisions would be simple: Implement those actions that add more EV benefit than their EV cost, However, correlations cloud the picture:

A risk mitigation action may affect more than one risk. Synergies: "Killing two birds with one stone."



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Several actions may be candidates for mitigating one risk. Either action may appear feasible, but together they are not. "Diminishing returns." Implementing actions may affect the feasibility of mitigating other risks and the effects of other actions (both in probability and impact).



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These are common problems in portfolio analysis. Here, instead of a portfolio of investments, we have a suite of actions and are selecting portfolio of response actions. There is much subjectivity in analysis work, and part of the analysis discipline is focusing on elements that matter most.



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What if there isn't enough money (or other constraining resource) to perform all worthwhile risk-abatement actions? Like elsewhere in life, we prioritize. Instead of implementing every thug with a positive EMV- notwithstanding the portfolio issues just mentioned-we would prioritize to do the best with what we have. Most practitioners use a return on investment-like criterion.



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The most popular ranking criterion, discounted return on investment

$$DROI = \frac{EMV}{E(PV \text{ Investment})}$$

Choose to implement those actions with the highest DROI first.



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11.6-Risk Monitoring and Control

An inventory of risks and actions is core to risk management. A database repository is the foundation. Data fields include various classifications, responsibilities, watch points, and time windows. Recording original estimates and actual outcomes is key to judgment performance feedback. Appendix 8B, Risk Management Plan, provides more details about this database.



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At major milestones or other suitable points, post-implementation reviews are essential for participants' learning and for capturing knowledge. This is perhaps the single most important way in which to improve an organization's planning and evaluation processes and skills.

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Recourse:
RISK and DECISION ANALYSIS
in Projects
Second Edition
By: John Schuyler

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Thank You