

# **Risk Management in Infrastructure Projects**

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# Agenda

- I. Principles and Theory of Risk Management
- II. Risk Management Cycle
- III. Risk Management System Development
- IV. Project Risk Management Framework

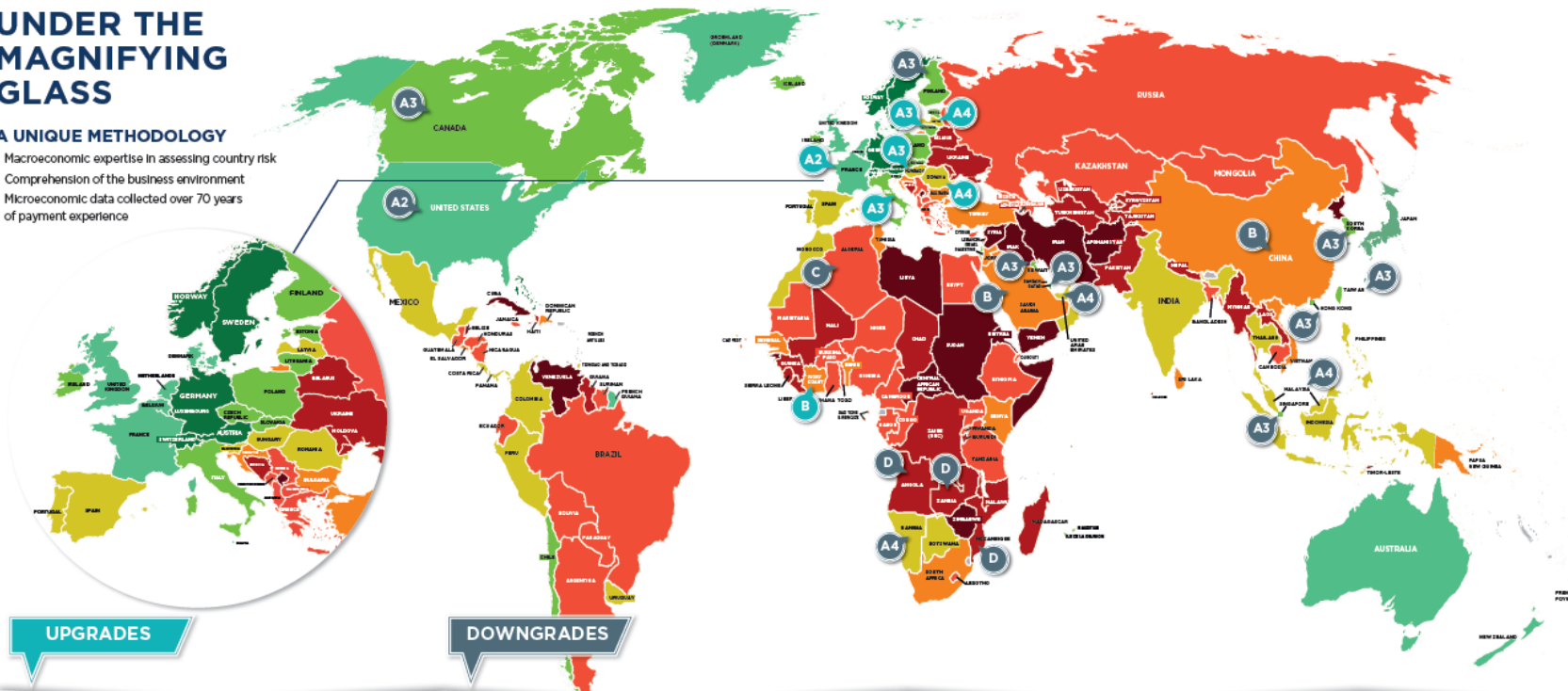
# ***I. PRINCIPLES AND THEORY OF RISK MANAGEMENT***

## 160 COUNTRIES UNDER THE MAGNIFYING GLASS

### A UNIQUE METHODOLOGY

- Macroeconomic expertise in assessing country risk
- Comprehension of the business environment
- Microeconomic data collected over 70 years of payment experience

### RISK OF BUSINESSES DEFAULTING



### FRANCE

**A2**

- Decrease in business insolvencies: -3.2% expected in 2016
- Higher corporate margins in 2016, supported by the growth in activity and government business support initiatives (CICE)
- First quarter showed the highest level of non-financial private investment since 2012

### ITALY

**A3**

- Activity is expected to strengthen in 2016 and 2017, mainly driven by private consumption
- Investments are expected to strengthen
- Insolvencies decreasing since 2015

### ALGERIA

**C**

- High dependence on the oil and gas sector
- Growth is expected to slow in 2016, due to fiscal consolidation
- FDI inflows remain weak, at 1% of GDP

### CHINA

**B**

- The effectiveness of stimulus measures is being hindered by overcapacity and excessive corporate indebtedness
- South Korea, Hong Kong, Singapore, Taiwan **A3** and Malaysia **A4** have been hit by a shock wave. Exports, tourism and investments have been particularly affected

### MOZAMBIQUE

**D**

- High probability of default on sovereign debt
- Investors lack confidence in the solidity of the government and its ability to manage its debt issues
- The IMF and World Bank have temporarily suspended financial aid, due to an undisclosed debt of USD 1.4bn

### SAUDI ARABIA

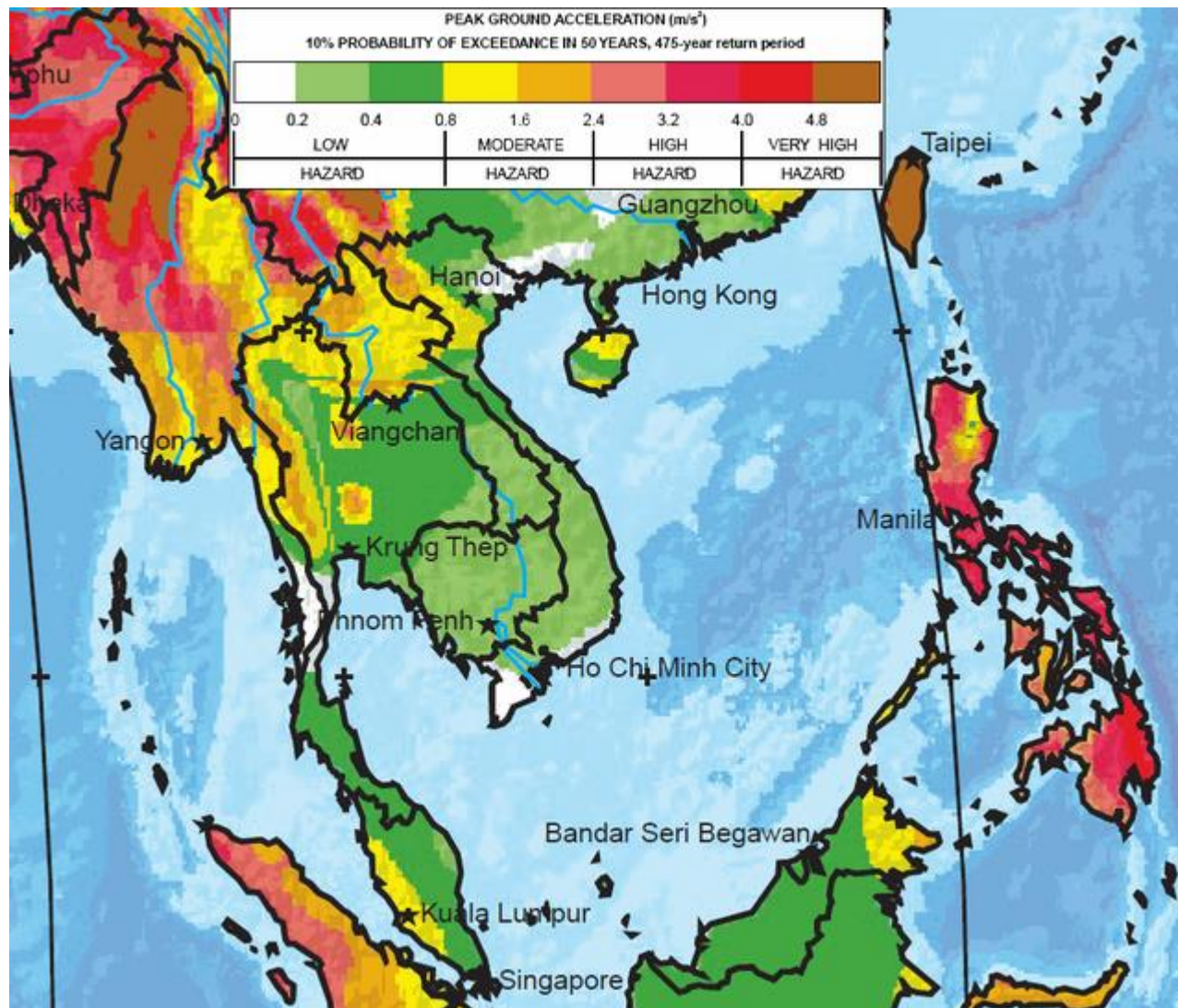
**B**

- Negative effects of the decline in oil prices
- Fiscal deficit is increasing. Public deposits have slackened, weakening the banking system

### UNITED STATES

**A2**

- The post-crisis turning point has been reached, resulting in a rise in business insolvencies for the first time since 2010
- Business profitability is eroding
- Investment is slowing



<http://geology.about.com/od/seishazardmaps/ss/World-Seismic-Hazard-Maps.htm>





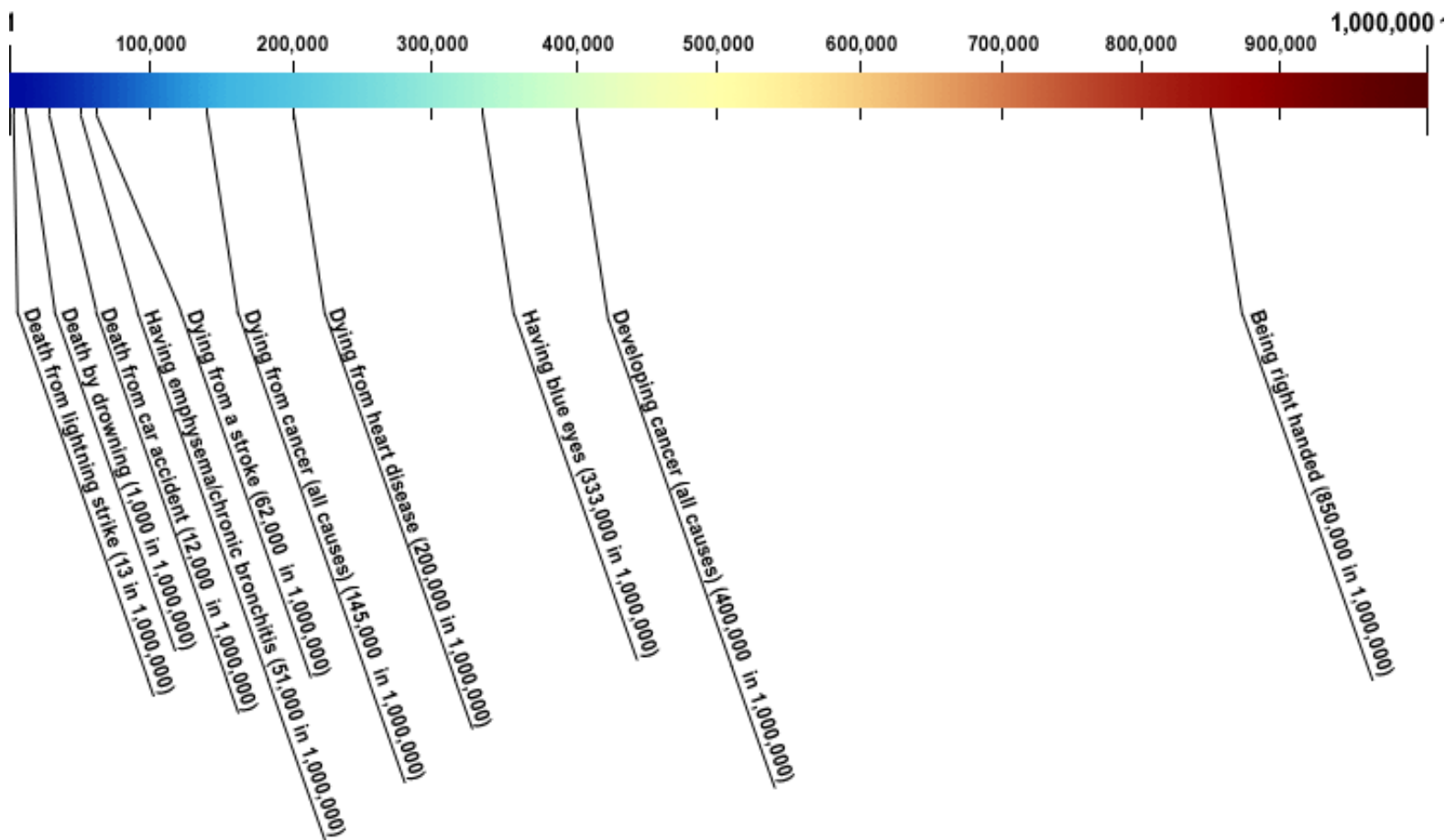
<http://www.news18.com/news/india/map-countries-most-threatened-by-tsunamis-2-464218.html>



*Tacoma Bridge (July 1 – Nov 7, 1940)*

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# Statistical Probabilities



# *What is risk?*



The **chance** of something happening that will have an **impact** upon **objectives**  
[AS/NZS 4360 (1999)]

The combination of the **frequency (probability)** of occurrence and the **consequence** of a specified **hazardous event**  
[AS/NZS 3931 (1998)]



Threat (or opportunity)  
which could affect adversely  
(or favorably) achievement  
of the objectives of an  
investment (ICE et al. 2005)

- Downside risk (-)
- Upside risk (+)

A condition in which  
there is a possibility of an  
**adverse deviation** from a  
**desired outcome** that is  
**expected** for  
(Vaughan 1997)



## *Components of risk*

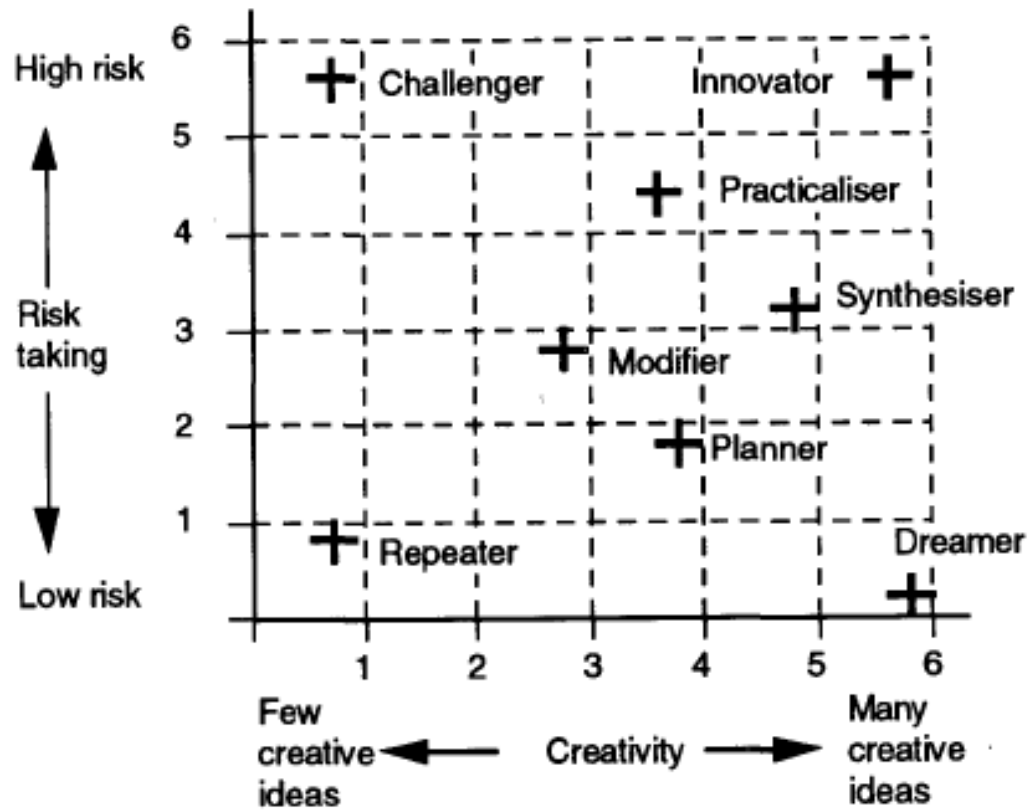
- Bad (or good) event and its nature
- Likelihood (chance, probability) that an event will occur
- Consequences (impact) of that event
- Period of exposure to the event (and to its consequences if relevant)

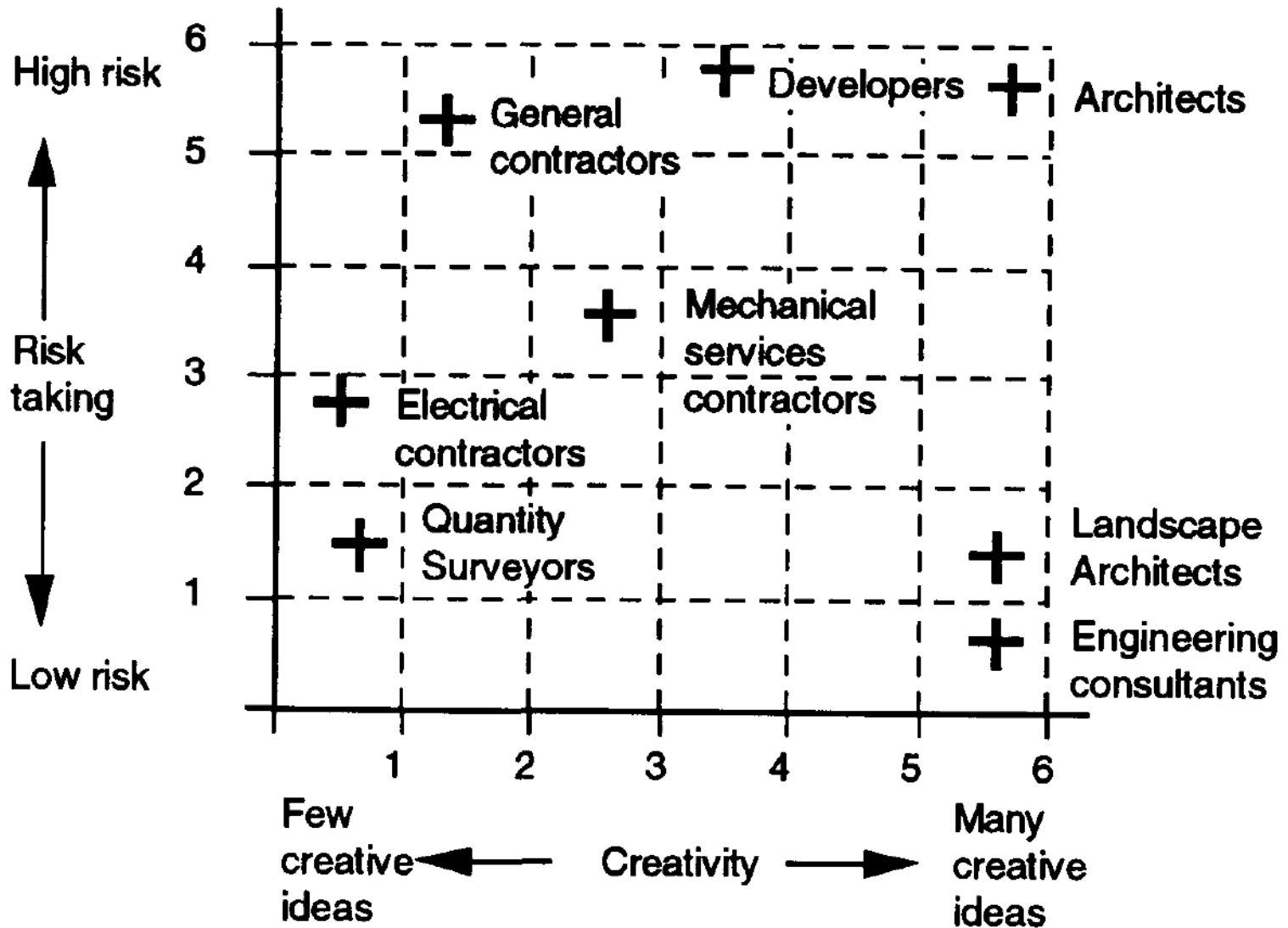
Risk event	Probability	Assumptions
Head on toss of coin	1/2	Unbiased coin Properly tossed Does not end on edge
Black King or Queen on draw of card	1/13	Selected at random Normal pack of 52 cards
Toll bridge being closed at Royal Opening (in above example)	$17/200 = 0.085$	Closure enforced if 60 mile/h winds at any time in day Wind limit does not change Weather system unchanged over last 10 years

***Table 4. Probabilities and assumptions for specific risk events***

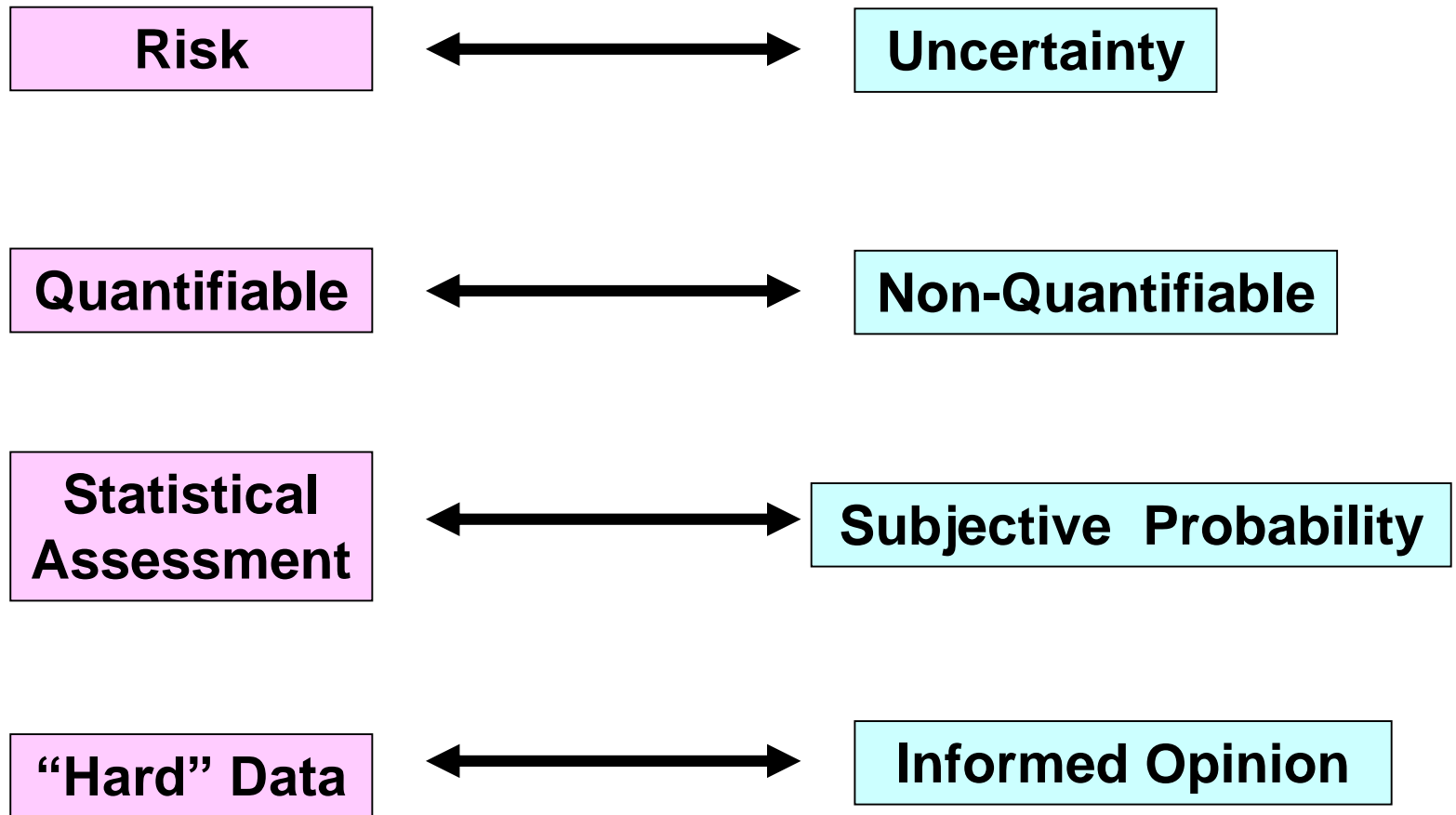
Risk events	Outcomes	Impact (NPV): £ million
Ground subsidence due to tunnelling for underpass	Damage to 6 buildings	Cost of compensation 2.0
New competitor enters market for bus service	Loss of passengers	Reduced revenue 3.7
Major contractor is bankrupt	Extra cost and delay for re-tendering	Increased capital cost 1.0 Loss of early revenue 1.5

***Table 5. Examples of impact of risk events (if they occur) expressed as the NPV of the resulting variations in cash flows***





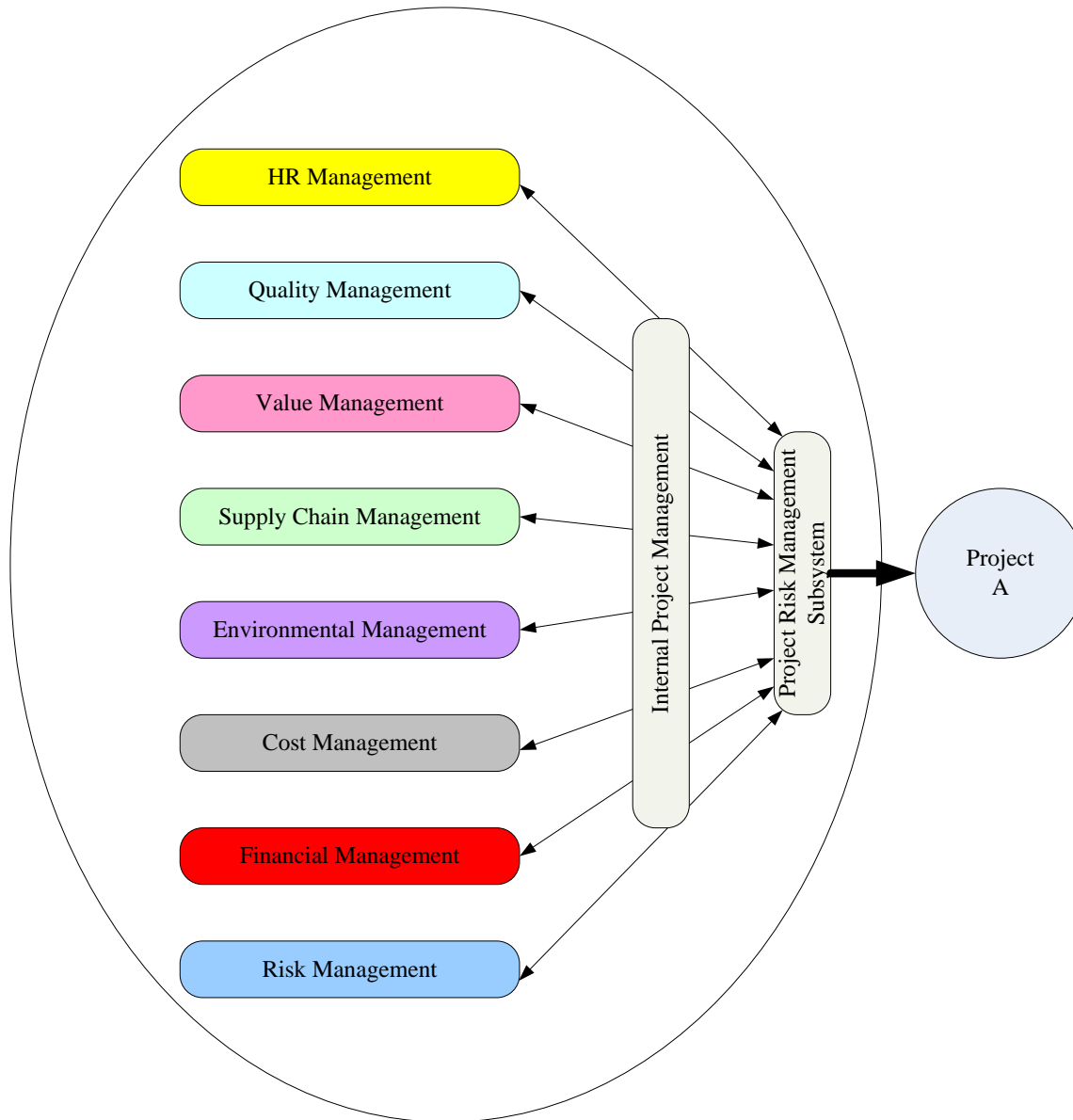
# Risk vs. Uncertainty





(Source: <http://www.analytix.co.za/Consulting/EnterpriseRiskManagement.aspx>)

# Stakeholder Organization S1



## ***II. RISK MANAGEMENT CYCLE***

# General Steps of Risk Management Process

1. Establish appropriate **risk context**
2. **Identify project risks** the stakeholder organization will face
3. **Analyze** (assess, evaluate) the identified risk
4. Develop **response measures** to those risks
5. **Monitor and control** the risks during the project
6. Allow post-project capture of **risk knowledge**

# Step 1: Establish Appropriate Risk Context

- To delineate the **boundaries** of the RMS
- Not too wide, not too narrow
- Begin with the **organization's objectives for the project**
- Multiple objectives → each must be examined

# Hierarchy of project objectives:

## Strategic Objectives

*What is the client trying to achieve with this project?*

## Functional Objectives

*What is the project required to do?*

## Procurement Objectives

*Project cost, completion time, and quality?*

Also consider:

- Project environment
  - Needs, budget, design, contract, etc.
- Project elements and sub-elements
  - Break down the project by task, technology, resource, project organizational elements and sub-elements

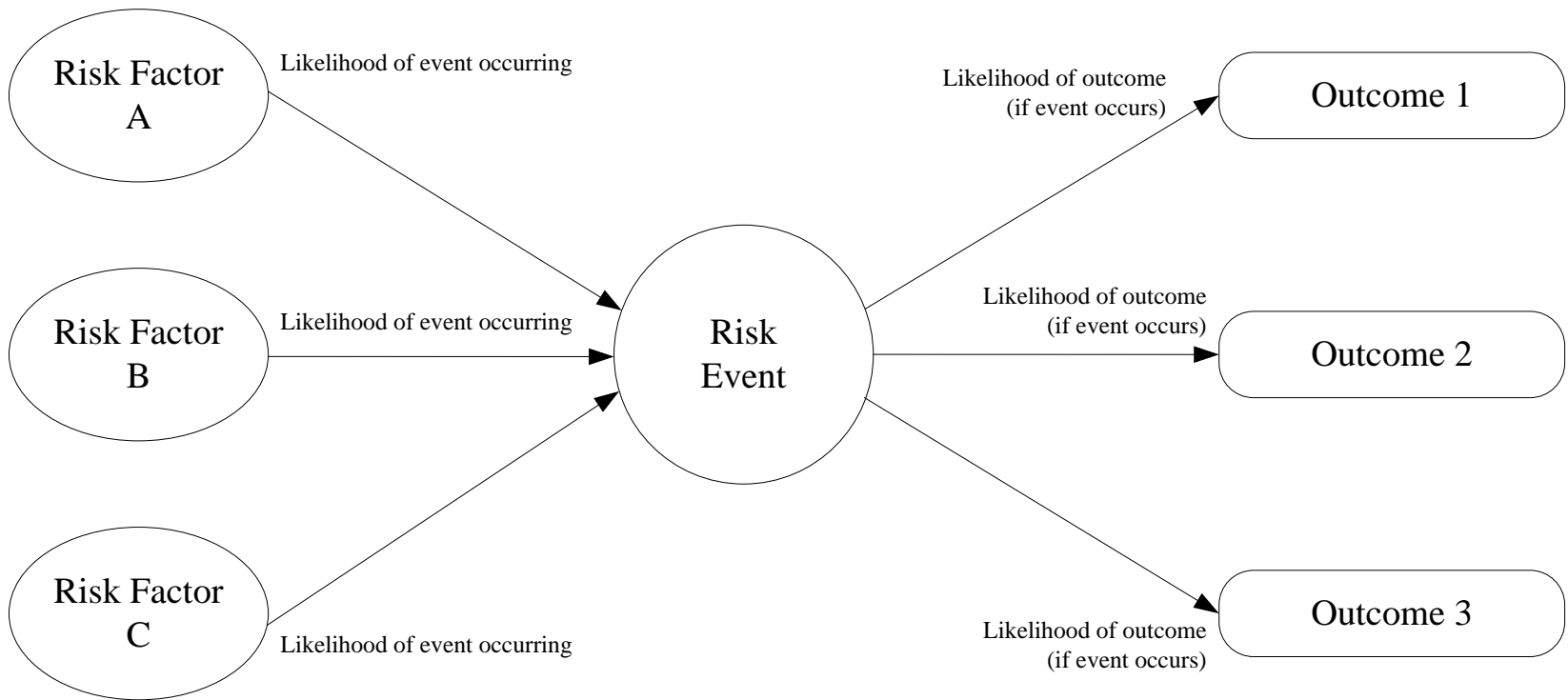
## Step 2: Identify project risk

- To answer the question:

*What could threaten the achievement of this objective, the completion of this task, the application of this technology, the acquisition of this resource, or the performance of this organization?*

*What could happen to make this project decision a bad one?*

- Should emphasize on the **risk event**, rather than the consequence (i.e., on cause rather than effect)



***Components of Risk***  
***[Source: ICE et al. (2005), Figure 6, p.76]***

Possible Sources	Event	Possible Effects
Lack of safety provisions	Injury to workman on site	Death of workman
Inadequate safety checks on site		Serious injury to workman
Specialist contractor not familiar with the system of working		Project being stopped by the Health and Safety Officer with the issuing of a prohibition notice
Defective equipment		Project being delayed
Inexperienced workforce not suitable for the type of work to be undertaken		Loss of morale and poor labour relations amongst the workforce
Unforeseen weather conditions		Prosecution and fine by statutory authorities
Lack of care by the workman		Cost of loss production and welfare payments to injured workman
		Future increased cost of insurance provision

## **Risk identification approach and techniques:**

- Brainstorming
- Workshop
- Checklist
- Risk source categorization
- Project environments and elements
- Cause-effect diagram
- Fault-tree analysis
- Etc.

# Example of Risk Checklist

[Source: ICE (2005), Appendix 3, p. 94]

Investment Stage / Risk Event	Source of Risk											
	1. Political / Social			2. Business			3. Economic		4. Project			
	a) Government	b) Public opinion	c) Environmental change	d) Legislation	e) Wars, terrorism, riots	f) Poor public relations	g) Crime		a) Demand failure	b) Competition	c) Premature obsolescence	d) Safety standards
<b>1. Opportunity Identification</b>												
<i>No significant risk</i>												
<b>2. Appraisal</b>												
<i>No significant risk</i>												
<b>3. Investment Planning and Preparation</b>												
<i>Promotion of concept</i>												
loss of intellectual property (IP) rights							•					
claims for infringement of IP rights												
<i>Design</i>												
non compliant design (failure to meet specified standards)												
design based on inadequate site investigation data												
professional negligence							•					
<i>Contract negotiation</i>												
failure to agree development framework with sponsor												
failure to resolve conflicts of interest within promoting consortium												
contractual terms and conditions worse than expected												
<i>Project approval</i>												
failure to obtain approval / consents	•	•										
long delay before approval granted	•	•				•						
unforeseen modifications to project	•	•										
cost of obtaining approval higher than expected	•	•										
inclusion of contingent liabilities (e.g., environmental clean up)	•	•										
introduction of regulatory controls (fares, competition policy)	•		•	•								

# Step 3: Analyze project risk

Two main steps:

- Assess:
  - Likelihood of occurrence
  - Consequence
- Combine likelihood of occurrence and consequence →  
*Risk severity*
- Approaches:
  - Qualitative – description
  - Quantitative – number / calculation
  - Semi

## Interval Descriptors for Likelihood

*[Source: Edwards and Bowen (2005), Table 7.1, p.118]*

Level	Interval Descriptor	Details
1	Rare	May only occur in exceptional circumstances
2	Unlikely	Could occur in certain circumstances
3	Possible	Might occur at some time
4	Likely	Likely to occur in most circumstances
5	Almost certain	Expected to occur in most circumstances

## Interval Descriptors for Impacts

*[Source: Edwards and Bowen (2005), Table 7.2, p.120]*

Level	Interval Descriptor	Details
1	Insignificant	Low financial loss
2	Minor	Medium financial loss
3	Moderate	High financial loss
4	Major	Major financial loss
5	Catastrophic	Huge financial loss

<b>Risk Impact</b>	Catastrophic					
	Major					
	Moderate					
	Minor					
	Insignificant					
		Rare	Unlikely	Possible	Likely	Almost certain
<b>Likelihood of Occurrence</b>						

## Risk Matrix

## Likelihood

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

Consequence

	Rare	Unlikely	Possible	Likely	Almost Certain
<b>Severe</b> <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	<b>MEDIUM</b>	<b>MEDIUM</b>	<b>HIGH</b>	<b>EXTREME</b>	<b>EXTREME</b>
<b>Major</b> <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	<b>LOW</b>	<b>MEDIUM</b>	<b>MEDIUM</b>	<b>HIGH</b>	<b>EXTREME</b>
<b>Moderate</b> <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	<b>LOW</b>	<b>LOW</b>	<b>MEDIUM</b>	<b>MEDIUM</b>	<b>HIGH</b>
<b>Minor</b> <i>Eg. Potential First Aid injury</i>	<b>LOW</b>	<b>LOW</b>	<b>LOW</b>	<b>MEDIUM</b>	<b>MEDIUM</b>
<b>Minimal</b> <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	<b>LOW</b>	<b>LOW</b>	<b>LOW</b>	<b>LOW</b>	<b>LOW</b>

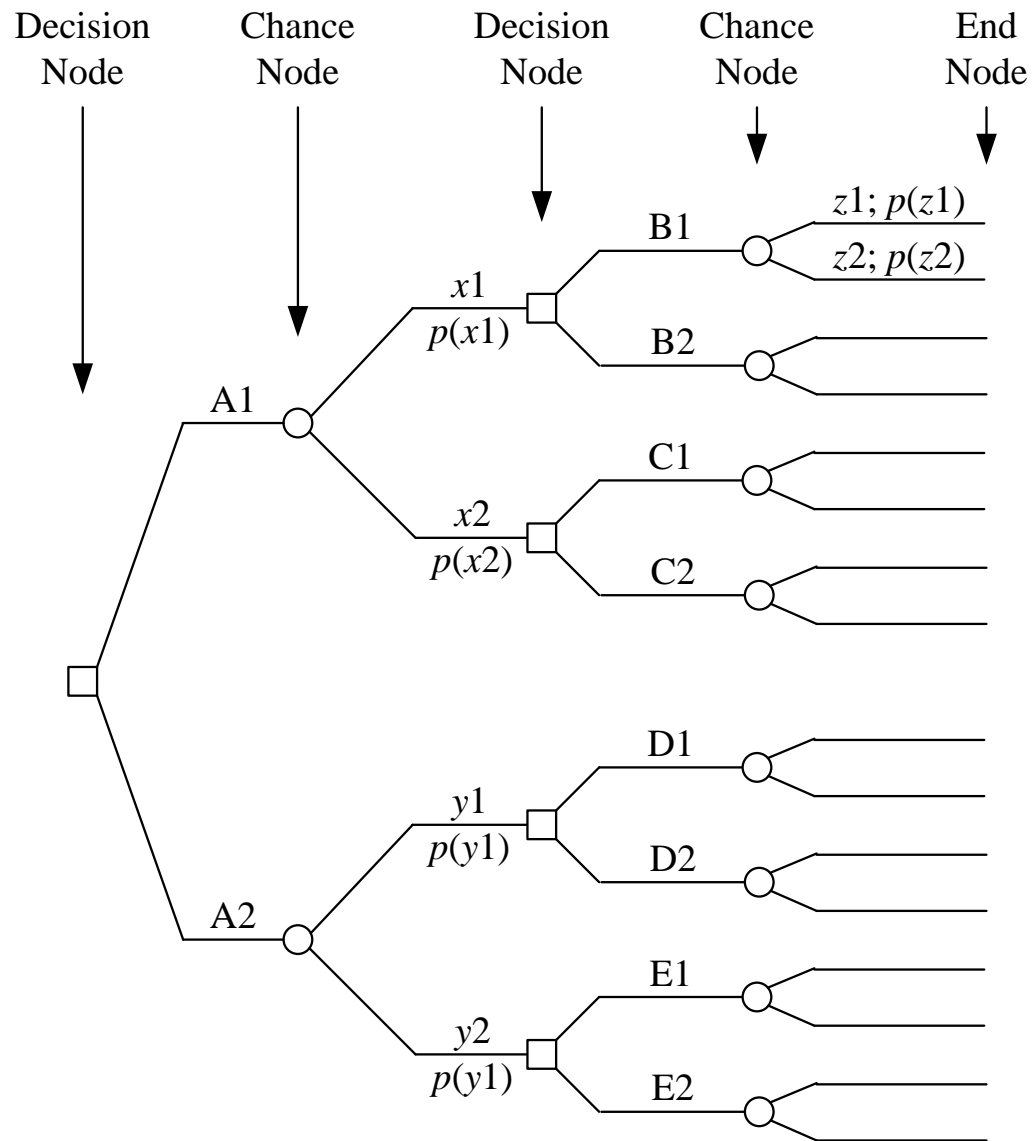
<https://www.newcastle.edu.au/current-staff/working-here/work-health-and-safety/managing-health-and-safety-risks>

## Risk ranking:

- Low
  - Moderate
  - High
  - Extreme
- 
- Need to define the definition of each clearly!!!

## Other risk analysis techniques:

- Expected Monetary Value (EMV)
- Expected Utility Value (EUV)
- Decision tree
- Monte Carlo simulation
- Etc.



*Decision Tree*

**Table 5.4 Probabilistic scenario analysis**

		OPTIMISTIC	MOST LIKELY	PESSIMISTIC
Substructure	Outcome	£720 000	£800 000	£1 000 000
	Probability	0.2	0.5	0.3
Superstructure	Outcome	£1 800 000	£2 000 000	£2 500 000
	Probability	0.2	0.6	0.2
Inflation	Outcome	9%	12%	16%
	Probability	0.2	0.5	0.3

$$\text{EMV (sub)} = (0.2 \times 720\text{k}) + (0.5 \times 800\text{k}) + (0.3 \times 1000\text{k}) = \text{£}856\,070$$

$$\text{EMV (sup)} = (0.2 \times 1800\text{k}) + (0.6 \times 2000\text{k}) + (0.2 \times 2500\text{k}) = \text{£}2\,060\,000$$

$$\text{EMV (inf)} = (0.2 \times 9\%) + (0.5 \times 12\%) + (0.3 \times 16\%) = 12.6\%$$

$$\text{EMV (project)} = [\text{EMV(sub)} + \text{EMV(sup)}] \times \text{EMV (inf)}$$

$$\Rightarrow \text{EMV (project)} = [856\,070 + 2\,060\,000] \times 1.126$$

$$\Rightarrow \text{EMV (project)} \text{ £}3\,282\,500$$

**Table 5.5** Net income projections

STATE OF THE INDUSTRY				
Year		Declines (£)	Remains steady (£)	Growth accelerates (£)
Net income: Year 1		170 000	180 000	200 000
Year 2		150 000	200 000	250 000
Year 3		150 000	200 000	250 000
Year 4		150 000	200 000	250 000

**Table 5.6** States, probabilities and NPVs

STATE	PROBABILITY	NPV (£)
Steady state	0.6	142 680
Growth	0.2	280 200
Decline	0.2	14 420

			£
Steady	$£142\,680 \times 0.6$	=	85 608
Growth	$£280\,200 \times 0.2$	=	56 040
Decline	$£14\,420 \times 0.2$	=	2 884
ENPV		=	<u>144 532</u>

# Step 4: Develop response measures

## Possible risk response measures:

- *Risk avoidance* – walk away
- *Risk reduction* – mitigate risk, training
- *Risk transfer* – insurance
- *Risk retention* – do nothing
- *Risk absorbing and pooling*
- Combination

## Risk Reduction and Elimination

- Most fruitful area for exploration
- To reduce or eliminate either the probability of occurrence of a particular risk event or the adverse consequences if it occurs (or both)

## Examples

- Acquire additional data/information about system
- Change design
- Use different materials or different method of assembly
- Use a better labor relations policy
- Train staff
- Improve site security
- Advance ordering of key components
- Good signing
- Liaison with local community
- Locate staff appropriately

## Risk Transfer

General principle of effective risk management strategy:

*“Risks should be borne wherever possible by the party which is best able to manage (and thus mitigate) them.”*

## Principal ways:

- Use **contracts and agreements**
- Pass to an insurance company, which in turn for a payment (premium) linked to the probability of occurrence and magnitude of hazard associated with the risk

## Insurance

- *Straight insurance* for expensive risks with a low probability (e.g., fire)
- *Performance bonds*, which ensure that the project will be completed if the contractor defaults
- *Hedge contracts* to avoid such risks as unanticipated losses in foreign exchange markets

## Risk Absorbing and Pooling

- Where risks cannot (or cannot economically) be eliminated, transferred, or avoided, they must be absorbed.
- Need sufficient margin in the project's finances to cover the risk event if it occurs
- Risk can be reduced by pooling contractors (a consortium of contractors)
- Joint venture, partnership

**Table 3 B    Event - likelihood of damage to adjoining buildings as a result of pile driving**

<i>Likelihood</i> <i>Severity</i>	Improbable	Rare	Possible	Probable	Very likely
<b>Negligible</b> (up to £100)	Retain	Retain	Retain	Retain	Retain
<b>Small</b> (£100 - £1,000)	Retain	Retain	Partial Insurance	Partial Insurance	Partial Insurance
<b>Moderate</b> (£1,000 - £5,000)	Retain	Partial Insurance	Insure	Insure	Insure
<b>Large</b> (£5,000 - £50,000)	Insure	Insure	Insure	Insure	Insure
<b>Disastrous</b> (over £50,000)	Insure	Insure	Cease activity	Cease activity	Cease activity

# Strategic Risk Management

*[Source: Edwards and Bowen (2005), Table 8.1, p.135]*

Level	Interval Descriptor	Details
1	Minimal	Manage by exceptional flagging only
2	Low	Manage by routine procedures
3	Moderate	Specify management responsibility level and periodic attention
4	High	Require frequent senior management attention
5	Extreme	Immediate and/or continuous action required; highest level of organizational responsibility assigned

## Ways of responding to upside risks

- Increase the project's scope
- Improve the asset's design
- Maximize expected revenues
- Relax the perceived constraints
- Reduce expected capital costs and timescales

- Reduce expected ongoing costs and operating failures
- Extend the project's expected life
- Seek the best financial and tax structure
- Transfer upside risks to another party that is better able to manage them
- Take no action

- Carry out research to find better ways of handling the upside risks
  - Often expensive and time consuming
- Focus on risks where
  - Only minimum research effort is likely to be needed and there is a real possibility of positive results
  - An improvement would make a major difference to the NPV of the project

## Developing a risk response strategy

Each risk response option should be evaluated by assessing

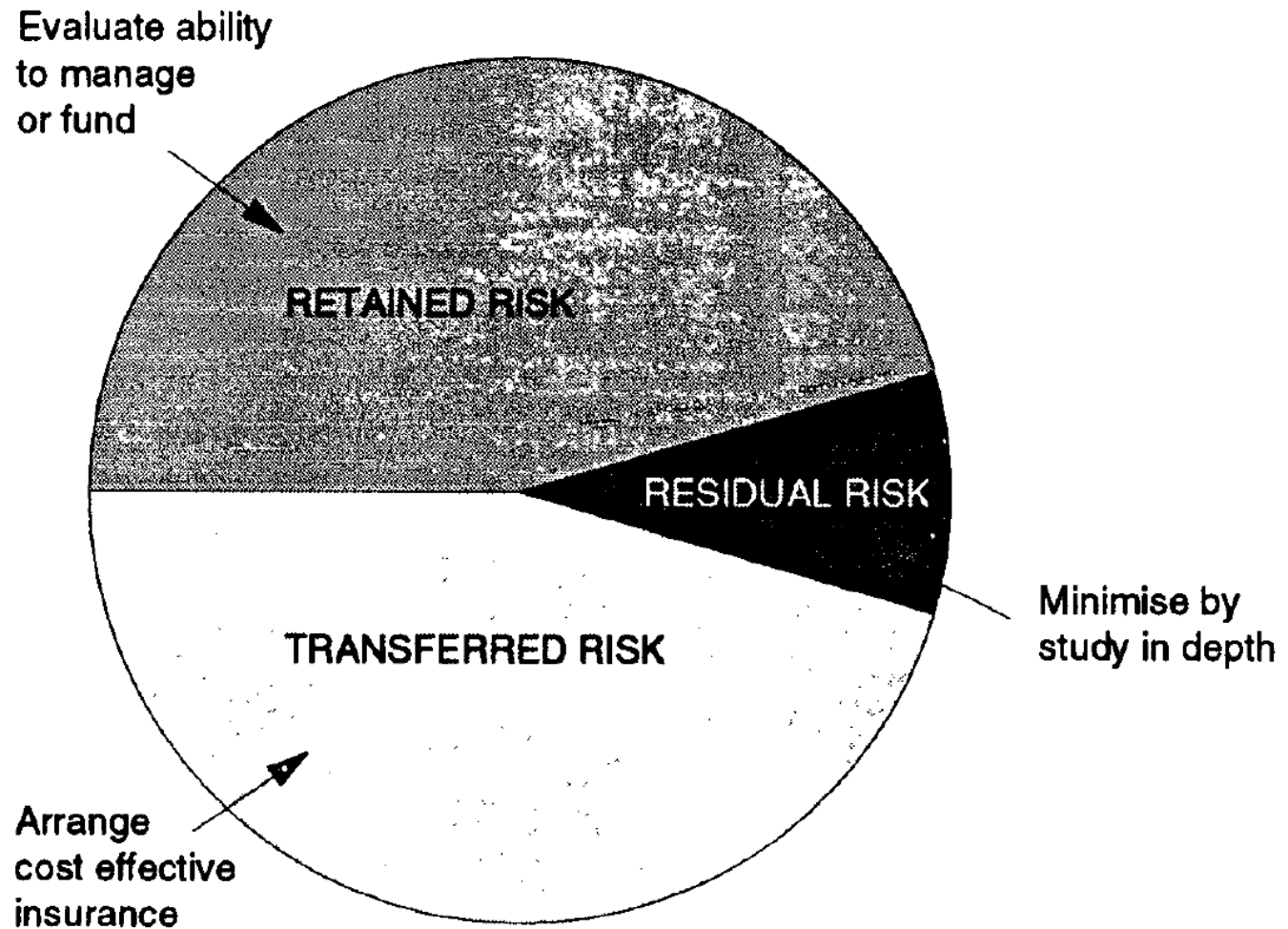
- Likely effect on risk, consequence, and expected value
- Feasibility and cost of implementing the option
- Overall impact of each option on cash flows

- Often, the cost of a response has to be incurred long before the benefits are realized.
- Indeed, the benefits may never be certain because it is often impossible to say whether the risk event would have occurred if the measure had not been adopted.

- Sometimes, risk responses generate their own secondary downside risks, which need to be taken into account.
- Two groups of risk
  - Risks where there are apparently worthwhile response options
  - *Residual risks*

**Figure 3.7 Risk on construction projects**

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- The aim is to reach a state of risk efficiency, if practical, using a **trial and error process**
- Thus, risk response is essentially a practical subject but a complex one, where there is a need for a methodical approach, clear thinking, and imagination.

## Residual risks

- Those remaining after response measures are taken.
- Need to evaluate their overall impacts using the same techniques – Residual risk analysis
- + unexpected risks → *contingency allowance*

# Planning for Risk Control

## Risk Response Plan

- To minimize the probability of and contain the impact of all the remaining **downside risks**, which cannot be economically or practically avoided, transferred, or prevented.
- To maximize the probability of occurrence of and the impact of all the remaining **upside risks**

- Assign the responsibility for the residual risk to an appropriate “*risk custodian*”
- Devices
  - Containment plan
  - Opportunity plan
  - Contingency plan
  - Contingency budget
- Crisis committee

## Risk review report

- Outlining the results of the review
  - Main risks
  - Likely effects
  - Overall riskiness
  - Main lessons which have been learned
- Decide when the next risk review will take place and how it should be conducted

- Communicate risk response strategy and plan
- Risk custodians and other parties involved in executing strategies and responses should be supplied with the appropriate extracts.
- Verify that they receive, understand, and are committed
- Encourage to comment and make suggestions

## Implementing risk strategy and plan

- Require a rigorous and comprehensive structure for implementing the results of risk review
  - Residual risk analysis
  - Risk response strategy
  - Risk response plan
- As part of the mainstream management

- Continue to be *monitored and updated* regularly as risk exposures change and risk events occur in between risk reviews
- There is full accountability with single responsibilities and accountabilities assigned to named individuals for each action
- There is *effective follow up* to verify that the plans and actions are implemented in a timely and satisfactory manner.

### ***Rules for risk taking***

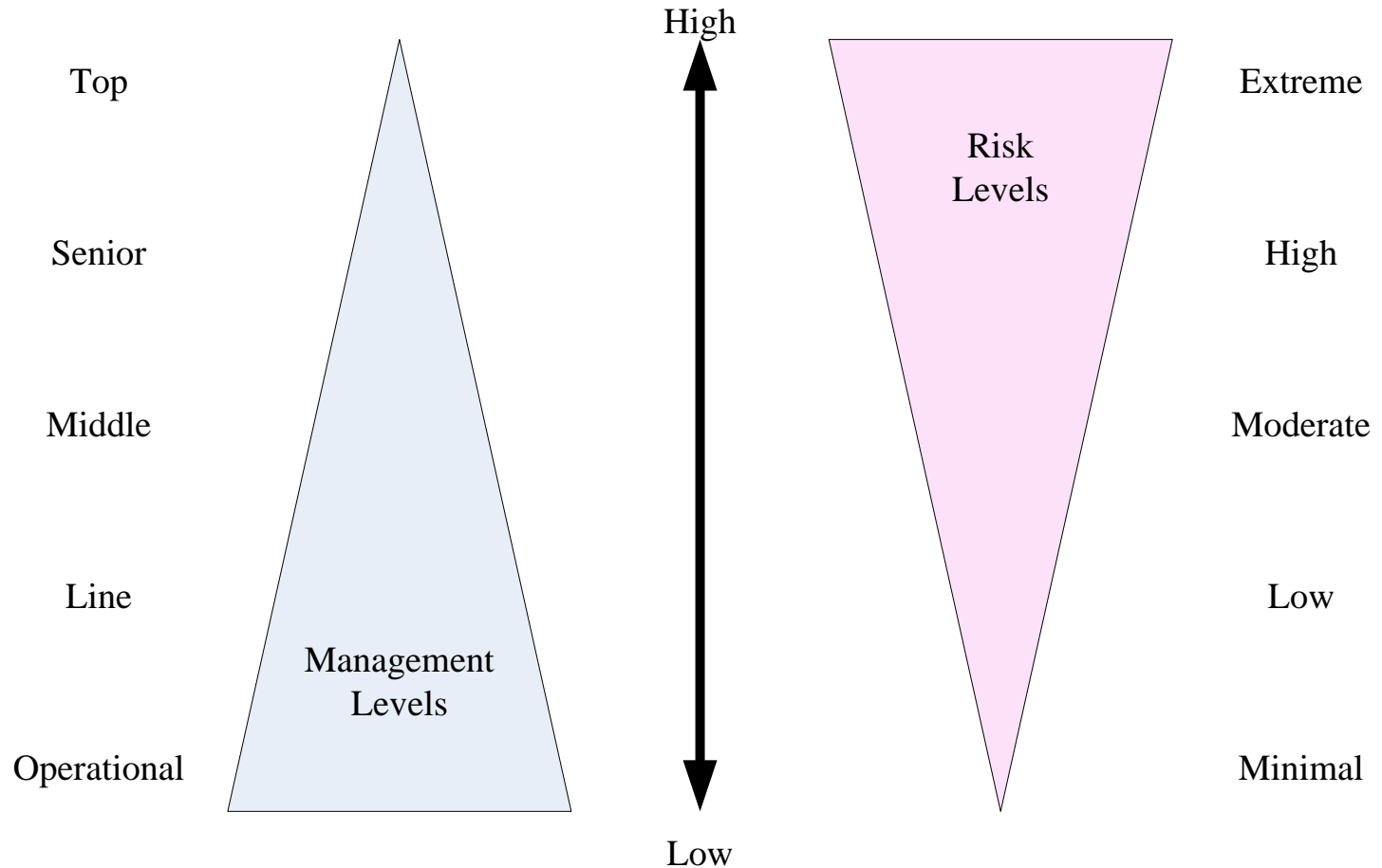
- ☐ **Don't risk a lot for a little.**

**The Watergate fiasco was a good example of failing to follow this rule. Nobody had seriously considered the consequences of being 'found out', which eventually led to the downfall of the President.**

- ☐ **Always plan ahead**
- ☐ **Always analyse both the source and the consequences of risks**
- ☐ **Devise alternative options as a contingency measure**
- ☐ **Don't use other people as an excuse for inaction**
- ☐ **Don't take risks purely for reasons of principle**
- ☐ **Don't take risks to avoid losing face**
- ☐ **Never risk more than you can afford to lose**
- ☐ **Be prepared to seek advice from the experts**
- ☐ **Consider the odds and what your experience and intuition tells you**
- ☐ **Consider the controllable and the uncontrollable parts of the risk.**

# Step 5: Monitor and control risk

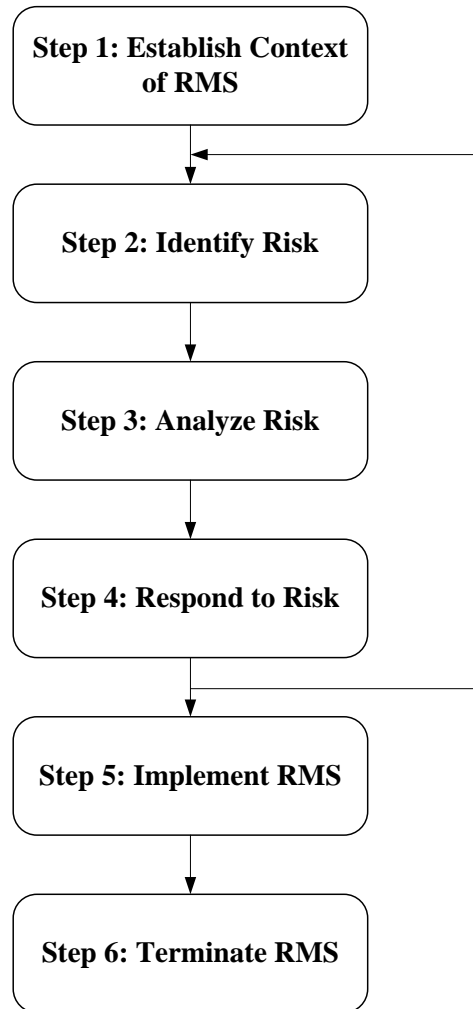
- Important, but often neglected
- Issues:
  - Which risks are to be monitored
  - Assignment of responsibility
  - Type and frequency of monitoring required
  - Reporting methods
  - Identification and treatment of new risks
  - Remedial or recovery planning and processes



## Risk Severity & Management Responsibility Levels

*[Source: Edwards and Bowen (2005), Table 8.2, p.138]*

### ***III. RISK MANAGEMENT SYSTEM DEVELOPMENT***



***Steps of RMS Development  
[Modified from ICE et al. (2005)]***

# Step 1: Establish Context of RMS

## *(1) Plan, organize, and begin RMS*

- Confirm perspective
- Appoint risk management manager and team
- Define investment
- Determine timing of risk management
- Decide level, scope, and purpose of RMS
- Establish budget for RMS

## *(2) Establish baseline*

- Set objectives and key parameters of investment
- Create baseline plans
- Make underlying assumptions

# Step 2: Identify Risk

## Sources of Risk

### Natural Systems

- ☐ Climate / weather
- ☐ Geological
- ☐ Biological
- ☐ Extra-terrestrial

### Human Systems

- ☐ Social
- ☐ Economic
- ☐ Political
- ☐ Financial
- ☐ Cultural
- ☐ Technical
- ☐ Health
- ☐ Managerial
- ☐ Legal

Table 2. Risk identification in PPP projects

No.	Risk factors	Literature review									
		A	B	C	D	E	F	G	H	I	J
1	Government's intervention				✓			✓	✓		✓
2	Delay in project approvals and permits				✓	✓	✓	✓		✓	✓
3	Corruption					✓		✓	✓	✓	✓
4	Expropriation and nationalization				✓	✓		✓	✓		
5	Political instability			✓							
6	Inadequate law and supervision system					✓	✓			✓	✓
7	Change in laws and regulations				✓		✓	✓	✓	✓	✓
8	Change in tax regulation				✓	✓		✓	✓	✓	✓
9	Financial market risk		✓				✓		✓	✓	
10	Interest rate fluctuations				✓	✓		✓	✓	✓	✓
11	Foreign exchange fluctuations				✓	✓		✓	✓		✓
12	Inflation				✓	✓		✓	✓	✓	✓
13	Price change				✓	✓					
14	Insufficient financial audit								✓		
15	Poor public decision-making process				✓	✓			✓		✓
16	Lack of transparency in the bidding								✓		
17	Subjective project evaluation method					✓			✓		✓
18	Supporting incentive of government risk									✓	
19	Conflicting or imperfect contract					✓		✓	✓	✓	
20	Unfair process of selection of private sector					✓					
21	Inadequate allocation of responsibility and risk							✓	✓	✓	
22	Low capacity of SPV						✓				
23	Scope change of projects						✓			✓	
24	Land acquisition and compensation		✓		✓		✓	✓	✓		✓
25	Problems due to partner's different practice				✓		✓	✓		✓	✓
26	Lack of supporting infrastructure					✓		✓	✓		✓
27	Environmental protection risk						✓		✓	✓	
28	Force majeure risk				✓	✓	✓	✓	✓	✓	✓
29	Material/labor non-availability					✓					
30	Completion risk		✓			✓	✓	✓	✓	✓	✓
31	Early termination of concession by concession company				✓	✓					✓
32	Toll fee issues		✓								
33	Payment risk					✓		✓	✓		
34	Demand risk	✓	✓			✓				✓	✓
35	Operator inability	✓								✓	
36	Residual assets risk (after concession period)				✓	✓		✓			
37	Cost escalation risks	✓									
38	Supply risk	✓									

**Reference:** A = Dias and Ioannu, 1995; B = Thomas et al., 2003; C = Ng and Loosemore, 2007; D = Toan and Ozawa, 2008; E = Xu et al., 2010; F = Iyer and Sagheer, 2010; G = Karim, 2011; H = Ke et al., 2011; I = Hwang et al., 2012; and J = Ezeldin and Badran, 2013

Table 3. Principal risks encountered in previous PPP transportation projects of Vietnam

Categories	ID	Risk factors	Case No.									
			1	2	3	4	5	6	7	8	9	10
General risks	Politics	P1 Government's intervention			✓	✓						
		P2 Delay in project approvals and permits			✓	✓			✓			
		P3 Corruption					✓					
	Law	L1 Inadequate law and supervision system			✓							
		L2 Change in laws and regulations										✓
		L3 Change in tax regulation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Commerce	C1 Financial market risk				✓						
		C2 Interest rate fluctuations		✓								
		C3 Foreign exchange fluctuations				✓						
		C4 Inflation		✓		✓						
Project-specific risks	Design and Procurement	D1 Poor decision-making process			✓						✓	
		D2 Lack of transparency in the bidding			✓	✓					✓	
		D3 Subjective project evaluation method	✓	✓	✓	✓					✓	
		D4 Supporting incentive of government risk				✓						
		D5 Unclear about state participant portion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		D6 Conflicting or imperfect contract				✓	✓				✓	
		D7 Breach of contract by Government	✓			✓				✓		
		D8 Inefficient feasibility study	✓	✓	✓	✓	✓	✓	✓		✓	
		D9 Unfair process of selection of private sector									✓	
		D10 Inadequate allocation of responsibility and risk	✓	✓	✓	✓		✓				
		D11 Low capacity of SPV		✓		✓	✓	✓	✓		✓	
	Construction	Co1 Scope change of projects	✓				✓			✓	✓	✓
		Co2 Land acquisition and compensation	✓	✓	✓		✓		✓	✓		
		Co3 Problems due to partner's different practice									✓	
		Co4 Lack of supporting infrastructure	✓		✓	✓				✓		
		Co5 Environmental protection risk										
		Co6 Force majeure risk	✓	✓		✓						
	Operation	O1 Completion risk	✓	✓	✓	✓	✓	✓	✓			
		O2 Early termination of concession by concession company	✓		✓	✓		✓	✓			
		O3 Toll fee issues		✓		✓		✓				
		O4 Payment risk					✓	✓	✓	✓		
		O5 Demand risk		✓	✓	✓						
		O6 Operator inability										✓

Case 1: Binh Trieu II Road Bridge; Case 2: Yen Lenh Bridge; Case 3: Ong Thin Bridge; Case 4: Phu My Bridge; Case 5: BOT 1A National Highway, An Suong - An Lac; Case 6: 13 National Highway, HCM-Binh Duong; Case 7: 1K National Highway, HCM-Bien Hoa; Case 8: BOT My Phuoc-Tan Van Highway; Case 9: Deo Ca Tunnel; Case 10: Co May Bridge

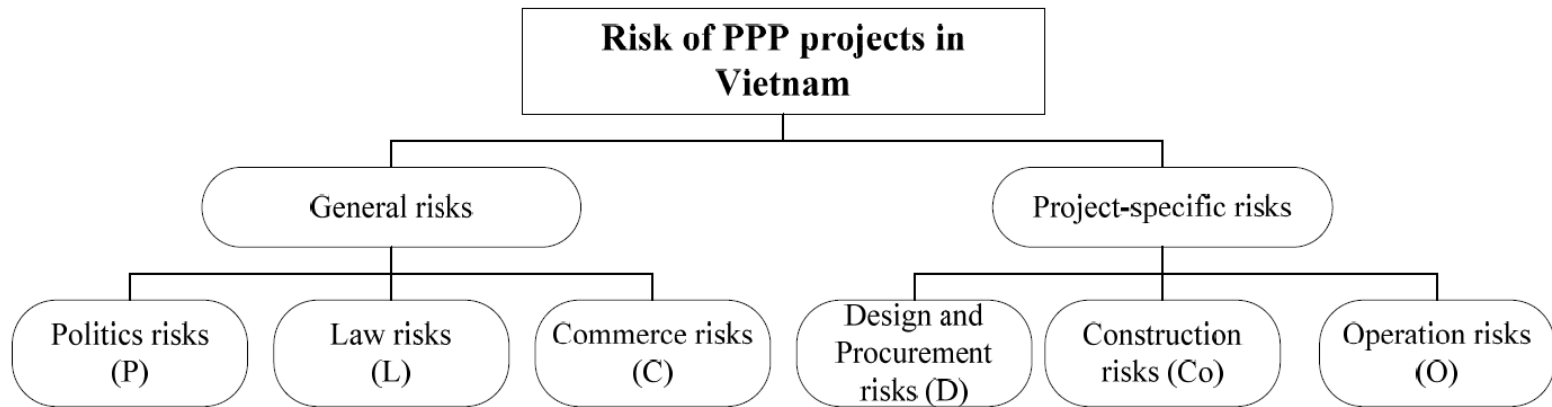


Figure 3. Hierarchical risk breakdown structure of PPP transportation projects

# Step 3: Analyze Risk

Choose appropriate analytical methods:

- Qualitative vs. Quantitative
- Static vs. Dynamic
- Simple vs. Sophisticated
- Etc.

### Risk Assessment Table - Likelihood

Description	Scenario	Probability	Scale Value
Highly likely	Very frequent occurrence	> 0.85	16
Likely	More than even chance	0.50 - 0.85	12
Fairly likely	Quite often occurs	0.21 - 0.49	8
Unlikely	Small likelihood but could well happen	0.01 - 0.20	4
Very unlikely	Not expected to happen	Less than 0.01	2
Extremely unlikely	Just possible but very surprising	Less than 0.01%	1

*Source: ICE et al. (2005), Appendix 4, p. 95*

### Risk Assessment Table - Consequence

Description	Scenario	Scale Value
Disastrous	Business investment could not be sustained (e.g., bankruptcy).	1000
Severe	Serious treat to business or investment	100
Substantial	Reduce profit significantly	20
Marginal	Small effect on profit	3
Negligible	Trivial effect on profit	1

*Source: ICE et al. (2005), Appendix 4, p. 95*

### Risk Assessment Table - Degree of Risk

Likelihood		Consequence				
		Disastrous (1000)	Severe (100)	Substantial (20)	Marginal (3)	Negligible (1)
Highly likely	(16)	16,000	1,600	320	48	16
Likely	(12)	12,000	1,200	240	36	12
Fairly likely	(8)	8,000	800	160	24	8
Unlikely	(4)	4,000	400	80	12	4
Very unlikely	(2)	2,000	200	40	6	2
Extremely unlikely	(1)	1,000	100	20	3	1

*Source: ICE et al. (2005), Appendix 4, p. 96*

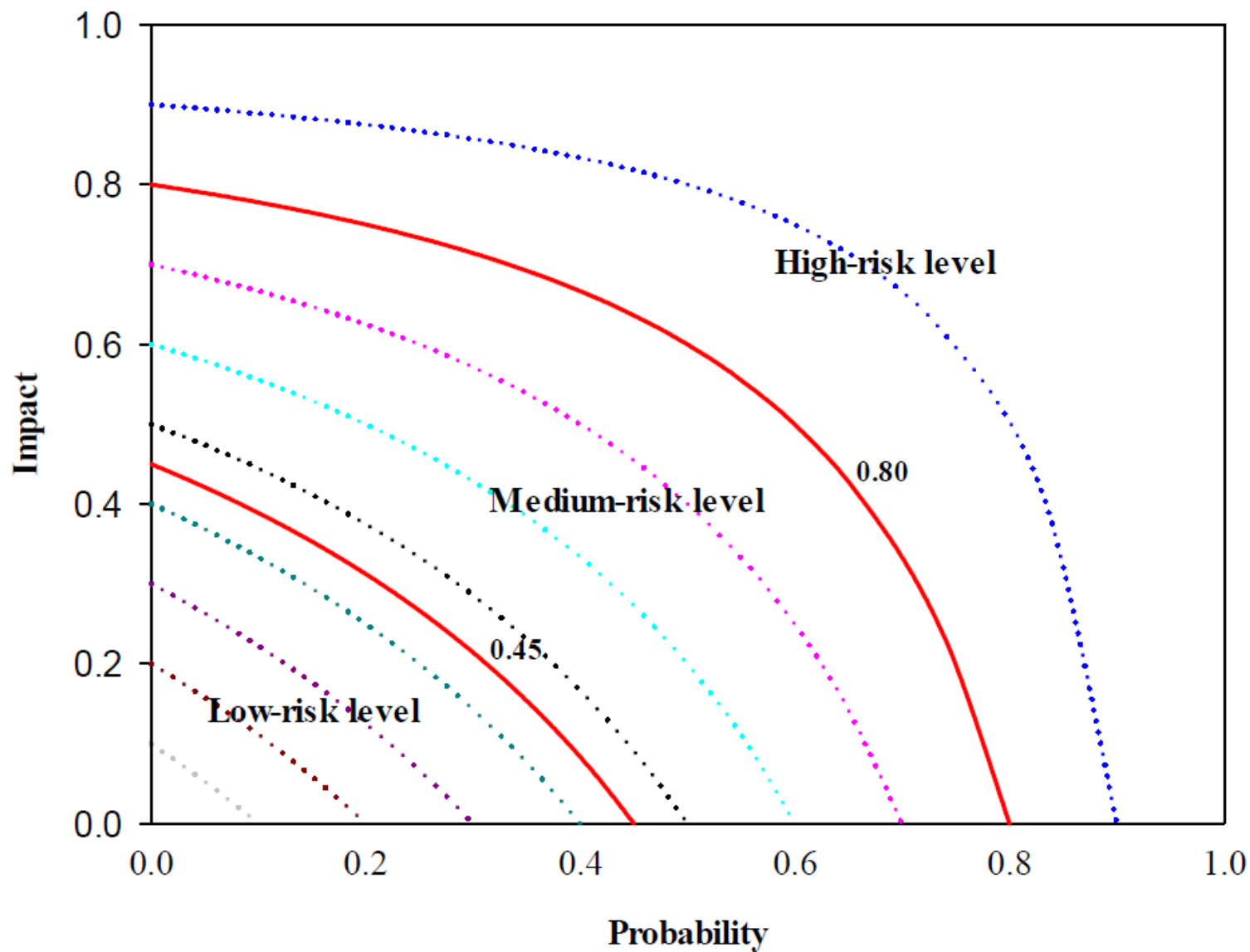


Figure 2. Risk contour diagram low-medium-high risk

Table 5. Perception of respondents concerning the level of CRFs in PPP transportation projects

ID	CRF	Overall		Public sector		Private sector	
		Mean	Rank	Mean	Rank	Mean	Rank
Co2	Land acquisition and compensation	0.924	1	0.904	1	0.929	1
P2	Delay in project approvals and permits	0.912	2	0.886	2	0.919	2
D8	Inefficient feasibility study	0.878	3	0.830	7	0.891	3
C1	Financial market risk	0.852	4	0.838	5	0.856	6
D3	Subjective project evaluation method	0.851	5	0.840	3	0.854	7
L2	Change in laws and regulations	0.847	6	0.839	4	0.849	8
C2	Interest rate fluctuations	0.837	7	0.799	11	0.846	9
P3	Corruption	0.835	8	0.698	27	0.868	4
Co1	Scope change of projects	0.834	9	0.736	22	0.859	5
D4	Supporting incentive of government risk	0.829	10	0.803	9	0.837	11
D1	Poor decision-making process	0.829	11	0.801	10	0.836	12
D10	Inadequate allocation of responsibility and risk	0.829	12	0.787	13	0.840	10
O5	Demand risk	0.828	13	0.829	8	0.827	17
L1	Inadequate law and supervision system	0.823	14	0.790	12	0.831	13
Co4	Lack of supporting infrastructure	0.813	15	0.766	18	0.824	18
O1	Completion risk	0.812	16	0.780	15	0.820	19
O4	Payment risk	0.811	17	0.739	20	0.829	15
D2	Lack of transparency in the bidding	0.811	18	0.727	25	0.831	14
C4	Inflation	0.809	19	0.727	24	0.829	16
O3	Toll fee issues	0.808	20	0.773	16	0.818	20
D9	Unfair process of selection of private sector	0.804	21	0.753	19	0.816	21
D6	Conflicting or imperfect contract	0.802	22	0.785	14	0.807	22

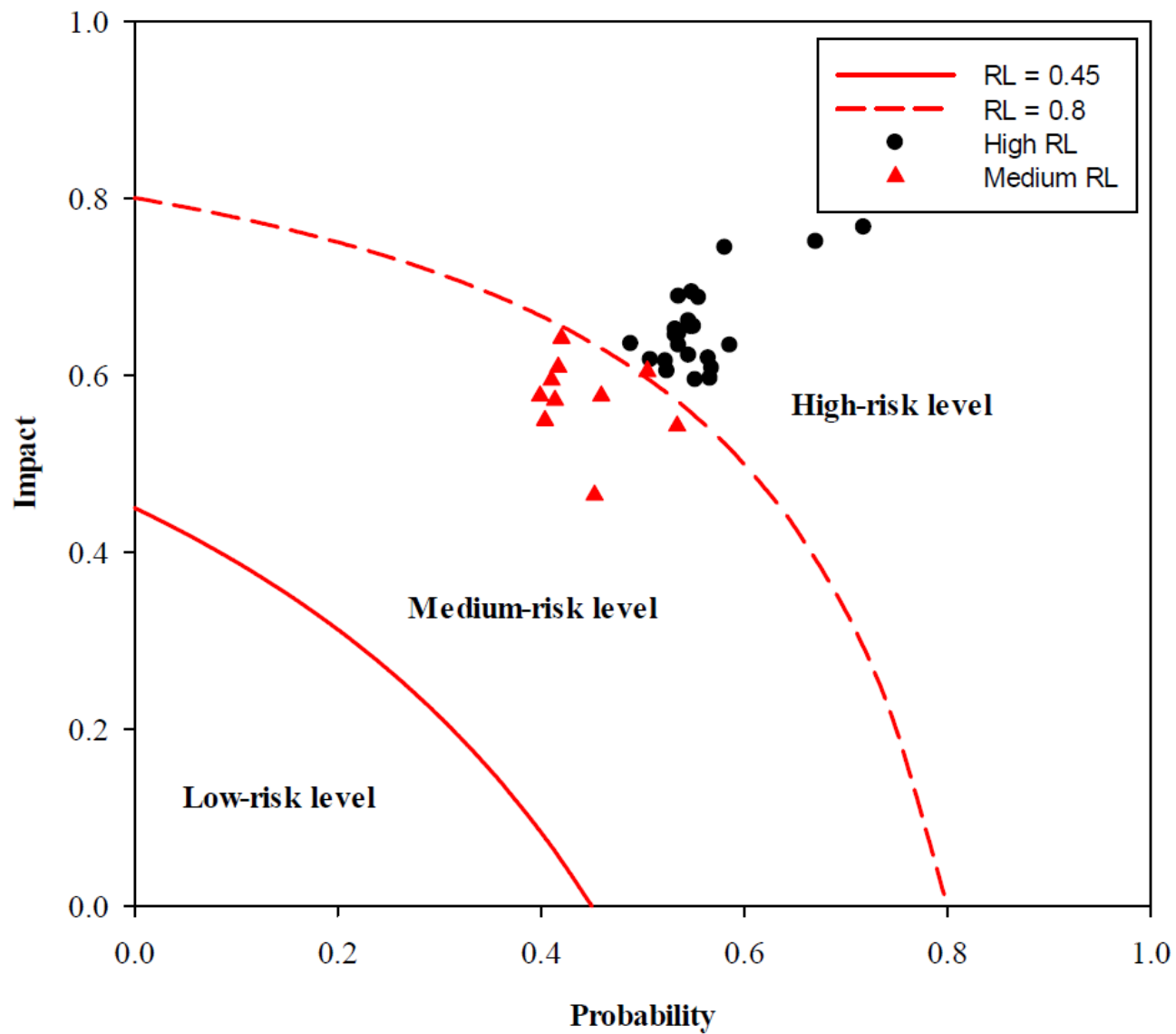


Figure 4. Risk perception of all stakeholders

Table 6. Ranking of degree of **probability (P)** of risk categories

Risk categories	Overall		Public sector		Private sector	
	Mean	Rank	Mean	Rank	Mean	Rank
Politics	0.558	1	0.442	6	0.587	1
Law	0.494	5	0.456	4	0.504	5
Commerce	0.532	3	0.508	1	0.538	4
Design and Procurement	0.524	4	0.467	3	0.538	3
Construction	0.537	2	0.486	2	0.550	2
Operation	0.493	6	0.449	5	0.504	5

Table 7. Ranking of degree of **impact (I)** of risk categories

Risk categories	Overall		Public sector		Private sector	
	Mean	Rank	Mean	Rank	Mean	Rank
Politics	0.664	1	0.586	4	0.684	1
Law	0.635	4	0.600	1	0.645	4
Commerce	0.642	2	0.577	5	0.658	2
Design and Procurement	0.636	3	0.595	3	0.647	3
Construction	0.598	6	0.538	6	0.614	6
Operation	0.616	5	0.597	2	0.620	5

# Step 4: Respond to Risk

## *(1) Devise measures:*

- Reduce (mitigate)
- Eliminate
- Transfer
- Insure
- Avoid
- Pool
- Etc.

## Possible Risk Response Actions

Risk Score	Category	Action Required
Over 1,000	Intolerable	Must eliminate or transfer risk
101 - 1,000	Undesirable	Attempt to avoid or transfer risk
21 - 100	Acceptable	Retain and manage risk
Up to 20	Negligible	Can be ignored

*Source: ICE et al. (2005), Appendix 4, p. 96*

## *(2) Define response strategy*

***Contrasting “threat” and “opportunity” response options in project risk management  
[Source: Edwards and Bowen (2005), Table 10.2, p. 180]***

<b>Risk “threat” response option</b>	<b>Description</b>	<b>Risk “opportunity” response option</b>	<b>Description</b>
Avoid	Take another course of action that does not involve the risk	Exploit	Aggressively seek to obtain the maximum benefit from the opportunity
Transfer	Pass the risk on to another stakeholder	Share	Pass on the risk opportunity to another project stakeholder, or come to co-operative sharing arrangement for any benefit
Reduce	Mitigate one or more of the risk threat components and retain the residual risk	Enhance	Improve one or more of the risk opportunity components before exploiting or sharing it.
Retain	Retain the whole risk without further treatment	Ignore	Do not take any action over the risk opportunity for this project.

**Table 22. Risk response options**

<b>Risk</b>	<b>Likelihood</b>	<b>Impact</b>	<b>Chosen action</b>
Planning consent denied	low	very high	discuss with planners at early stage
Towns A and B do not expand at expected rate	low	high	none
Fire, hurricane, earthquake or terrorist activity	low	high	insure
More efficient ferry service	low	high	buy ferry company
Tunnel collapses	low	high	use proven methods and quality contractors
Discovery of archaeological remains	low	medium	add contingency plan and budget
Higher maintenance costs than expected	high	low	none
Capital cost overrun	high	low	obtain fixed price contract
Ferry company reduces prices to take more traffic	medium	high	buy ferry company
Petrol tax imposed, resulting in reduced traffic	low	low	none
Bridge collapses	low	very high	impose quality regime, and incentivise designers and contractors
Heavy repairs needed	low	medium	impose quality regime, and incentivise designers and contractors
Ship collides with bridge	low	medium	work with harbour authority and design for high visibility
Tolls prohibited by new legislation	low	very high	none
Nationalisation of bridge company	low	high	none
Weather more severe, limits availability	low	medium	insure
Tolls diverted through fraud	medium	medium	insure with fidelity bonds/improve financial management
Premature obsolescence	low	medium	design-in maximum flexibility

**Table 3. Risk response methods for each tunneling risk factor**

Risk code	Risk factor	Alternative risk response methods									
		Rt	Rd1	Rd2	Rd3	Rd4	T1	T2	E	C	N
F1: Economics, Politics, and Laws											
F11	Variation of construction material prices	o				o				θ	
F12	Fluctuation of currency exchange rates	o				o			θ		
F13	Changes in legislation, policy, and regulation										•
F2: Force Majeure											
F21	Adverse weather conditions	o						o			θ
F22	Natural disasters							o			θ
F23	Force majeure resulting from humans							o			θ
F3: Physical and Construction Site											
F31	Unforeseen site conditions		•							o	
F32	Differing site conditions		•							o	
F33	Inadequate site investigation		•							o	
F34	Misinterpretation of site information provided by owner		θ								θ
F35	Problems with land expropriation and acquisition	•									
F36	Delays in site transfer	θ									o
F37	Relocation of existing utilities and ground settlement	θ	o								
F38	Problems with site accessibility	o									θ
F4: Project Personnel											
F41	Incompetent contractor's workforce				•						
F42	Incompetent subcontractor's workforce		o		θ						o
F43	Inadequate contractor's workforce										•
F44	Inadequate subcontractor's workforce		o								θ
F45	Poor coordination between on-site personnel										•
F46	Financial problems of contractor										•
F47	Financial problems of subcontractor		o								θ

Note:

Rt: Risk retention

Rd1: Risk reduction by addition information acquisition

Rd2: Risk reduction by physical protection

Rd3: Risk reduction by personnel management

Rd4: Risk reduction by work adjustment

o Adopted by 1-3 experts

θ Adopted by 4-6 experts

• Adopted by 7-9 experts

T1: Risk transfer by subcontracting

T2: Risk transfer by construction insurance

E: Risk elimination (avoidance)

C: Contingency allowance

N: Risk not considered by Contractor

**Table 5. Criteria for choosing risk-response measures for the F3 risk group**

Risk code	Risk factor	Criteria							
		Cost	Project delivery system	Project payment method	Contract provisions	Owner's policy	Contractor's policy	Project's characteristics	Contractor's experience
F31	Unforeseen site condition	•	•						•
F32	Differing site condition	•	•						•
F33	Inadequate site investigation	•			•				•
F34	Misinterpretation of site information provided by owner		•						•
F35	Problems about land expropriation and acquisition				•			•	•
F36	Delay in site transfer				•			•	
F37	Relocation of existing utilities and ground settlement				•			•	
F38	Problems about site accessibility							•	

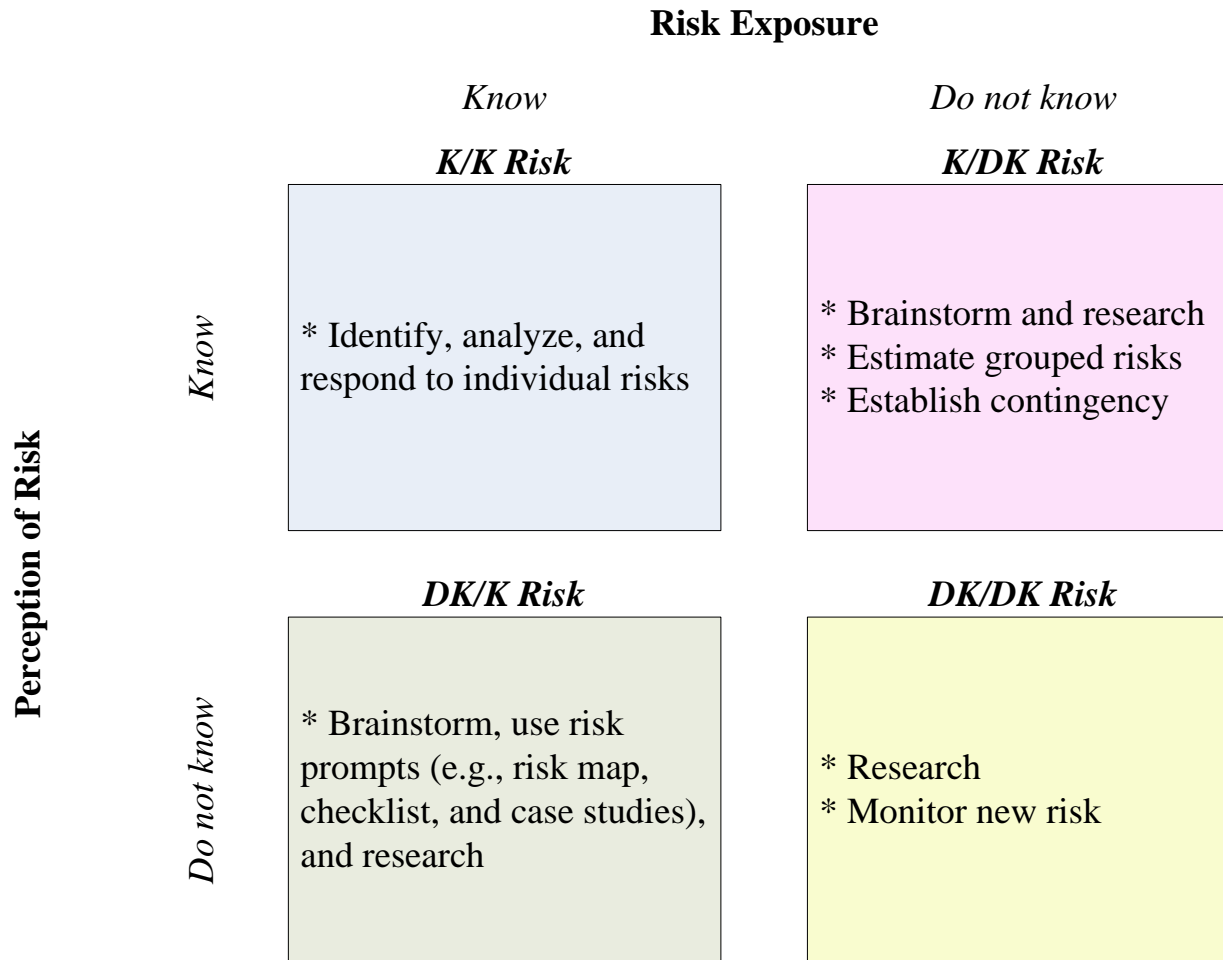
### *(3) Assess and plan responses to residual risk*



**Don't let one risk hide another.**

*We worry about meningitis. What about otitis media? Streptococcus pneumoniae and non-typable Haemophilus influenzae cause otitis media or meningitis. Both diseases can slow down children's development. This is why remedial solutions should cover both bacteria. Let's protect children from both Sp and NTHi.\**

## ***Hidden Risk***



***Four Categories of Risks***  
***[Source: ICE et al. (2005), Figure 13, p.84]***

### *K/K Risk*

- Identify, evaluate, and respond to individual risks using RMS

### *DK/K Risk*

- Conduct brainstorming sessions,
- Use risk prompts (e.g., risk map, risk matrix, checklists, and case studies)
- Undertake research to suggest possible risks which are then put in the K/K category

## *K/DK Risk*

- If not possible or practicable to identify and evaluate individual risks, then either estimate grouped risks (e.g., may overall allowance for unspecified 'design' risk or 'commercial' risk) or allow for risks in a general *contingency budget*

## *DK/DK Risk*

- Undertake research to identify risks and monitor emerging risk,
  - Put in category K/K if they can be evaluated individually
  - Put in category K/DK if they are better treated as part of a risk group or a general contingency allowance

# Step 5: Implement RMP

## *(1) Communicate risk response strategy and plan*

- Very important but extremely challenging!

## *(2) Implement risk response strategy and plan*

- Integrate with main stream management
- Manage the agreed risk response initiatives
- Risk monitoring
- Report changes

### *(3) Control risks*

- Ensure effective resourcing and implementation
- Monitor progress
- Continually review and categorize trends
- Identify and evaluate emerging risks and changes

***Performance Review Focus***  
***[Source: Edwards and Bowen (2005), Table 9.3, p. 171]***

<b>Step</b>	<b>Performance Focus</b>	<b>Suggested Performance Criteria</b>
Risk identification	Effectiveness of risk identification techniques and processes	<p>What difficulties did staff experience in using techniques?</p> <p>What logistical problems were encountered in the identification process?</p> <p>How many foreseeable risks were missed and subsequently discovered later in the project?</p> <p>How realistic were the subjective assessments?</p>

Risk analysis	Effectiveness of risk analysis techniques and processes	<p>How accurate and reliable were any quantitative assessments?</p> <p>How effective were risk mitigation plans?</p>
Risk response	Appropriateness and effectiveness of risk response decisions	<p>How effective was risk transfer action?</p> <p>What comparisons can be made between before/after treatment risk severity scores or cluster maps (for a sequential series of projects)?</p> <p>Has the contingency spend rate per project decreased?</p>

Risk monitoring and control	Effectiveness of risk monitoring and control procedures	<p>Do any procedures overlap with other management actions (e.g., value management, quality management, and safety management)?</p> <p>Entry rate for new entry material decreasing?</p>
Risk recording and archiving	Adequacy and effectiveness of risk register	<p>Is the risk severity of new entry material increasing or decreasing?</p> <p>Has the risk register yielded information of added value for case studies, disaster recovery plans and rehearsals?</p>

# Step 6: Terminate RMP

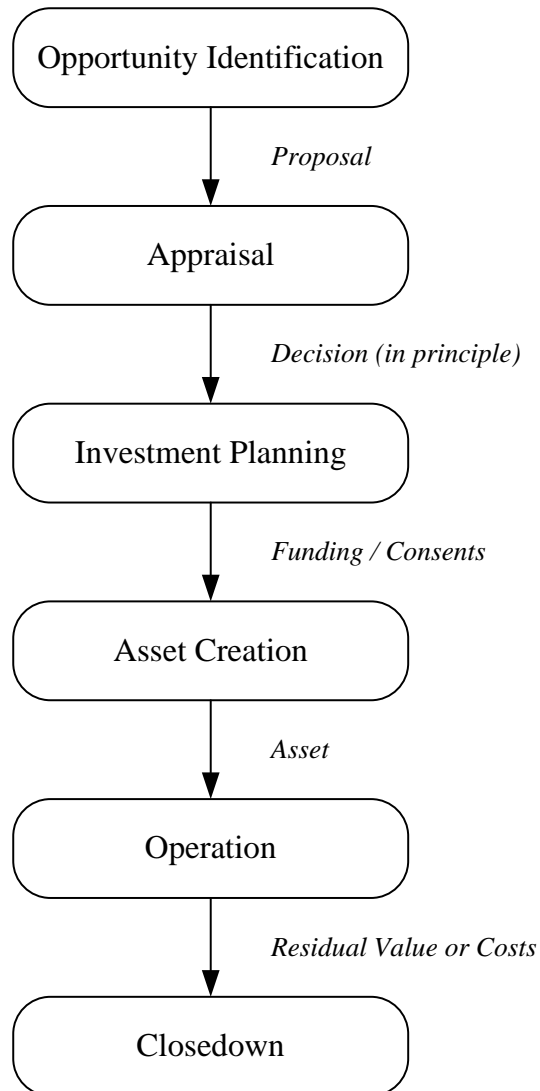
## *(1) Assess investment results*

- Consider results of investment against original objectives
- Compare risk impacts with those anticipated

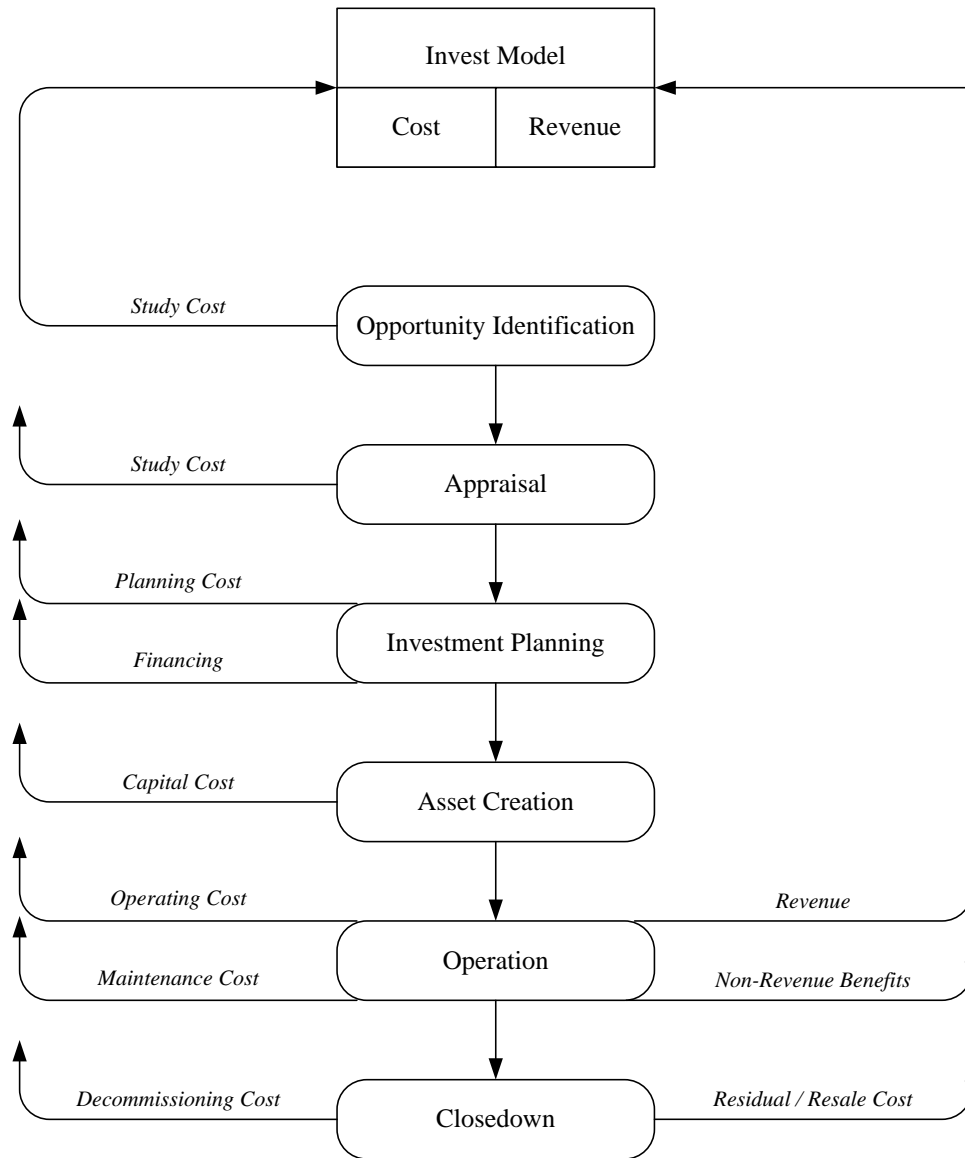
## *(2) Review RMS*

- Assess effectiveness of process and its application
- Draw lessons for future investments
- Purpose improvements to process
- Communicate results

## ***IV. PROJECT RISK MANAGEMENT FRAMEWORK***



***Investment Life Cycle***  
***[Source: ICE et al. (2005), Figure 2, p. 22]***



## Cash Flow for Most Likely Scenario

Year	Cash Flow
0	-1,000
1	300
2	400
3	400
4	400

## NPV Calculation ( $i = 0.06$ or 6%)

Year	Cash Flow	Present Worth
0	-1,000	(1,000)
1	300	283
2	400	356
3	400	336
4	400	317

<b>NPV =</b>	<b>292</b>
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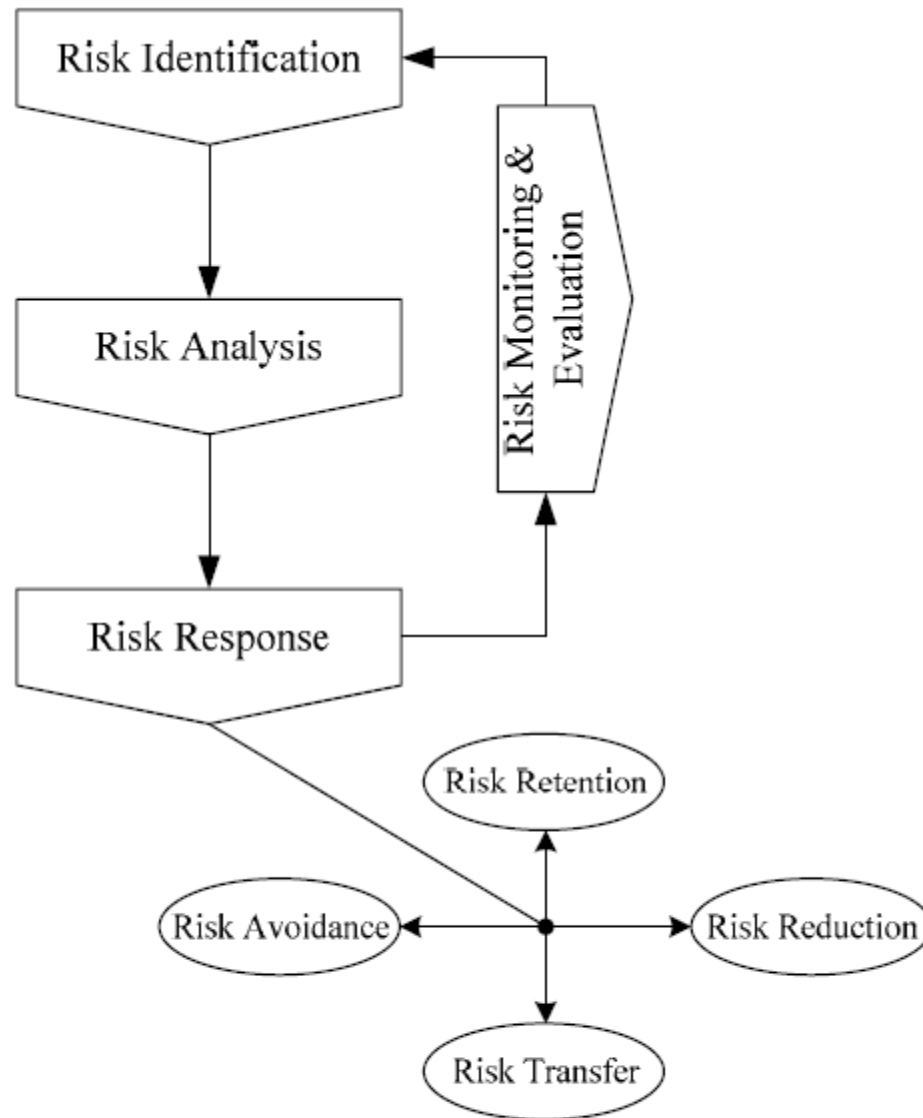
<b>Scenario</b>	<b>Type of Risk</b>	<b>Risk Event</b>	<b>Probability of Occurrence</b>	<b>Expected Impact</b>
A	Most likely	None	0.55	None
B	Upside	System know-how can be sold to other companies.	0.10	Revenue 200 more in year 1
C	Downside	Technological delay	0.15	System takes extra year and cost increased by 300
D	Downside	System does not work well.	0.10	Revenue reduced by 100 each year
E	Downside	Technological delay and system does not work well.	0.10	As in Scenarios C and D

Year	Scenario				
	A	B	C	D	E
<b>0</b>	-1000	-1000	-1000	-1000	-1000
<b>1</b>	300	500	-300	200	-300
<b>2</b>	400	400	300	300	200
<b>3</b>	400	400	400	300	300
<b>4</b>	400	400	400	300	300
<b>5</b>			400		300

**NPV**                      292                      480                      (64)                      (55)                      (391)

**Prob.**                      0.55                      0.10                      0.15                      0.10                      0.10

<b>Expected NPV =</b>	<b>154</b>
-----------------------	------------



**Figure 1. Risk management life cycle**

### ***THE LADY OR THE TIGER***

Three young men could open either door they pleased. If they opened the one, there came out of it a hungry tiger, the fiercest and most cruel that could be procured, which would immediately tear them to pieces. But, if they opened the other door, there came forth a lady; the most suitable to her years and station that His Majesty could select from among his fair subjects. So I leave it to you, which door to open?

The first man refused to take the chance. He lived safe and died chaste.

The second man hired risk management consultants. He collected all available data on lady and tiger populations. He brought in sophisticated technology to listen for growling and detect the faintest whiff of perfume. He completed check lists. He developed a utility function and assessed his risk attitude. Finally, sensing that in a few more years he would be in no condition to enjoy the lady anyway, he opened the optimal door. And was eaten by a low probability tiger.

The third man took a course in tiger training. He opened a door at random and was eaten by the lady.

*(Taken from W C Clark - Witches, Floods and Wonder Drugs:  
Historical Perspectives on Risk Management.)*

*Thank you  
for your kind attention.*