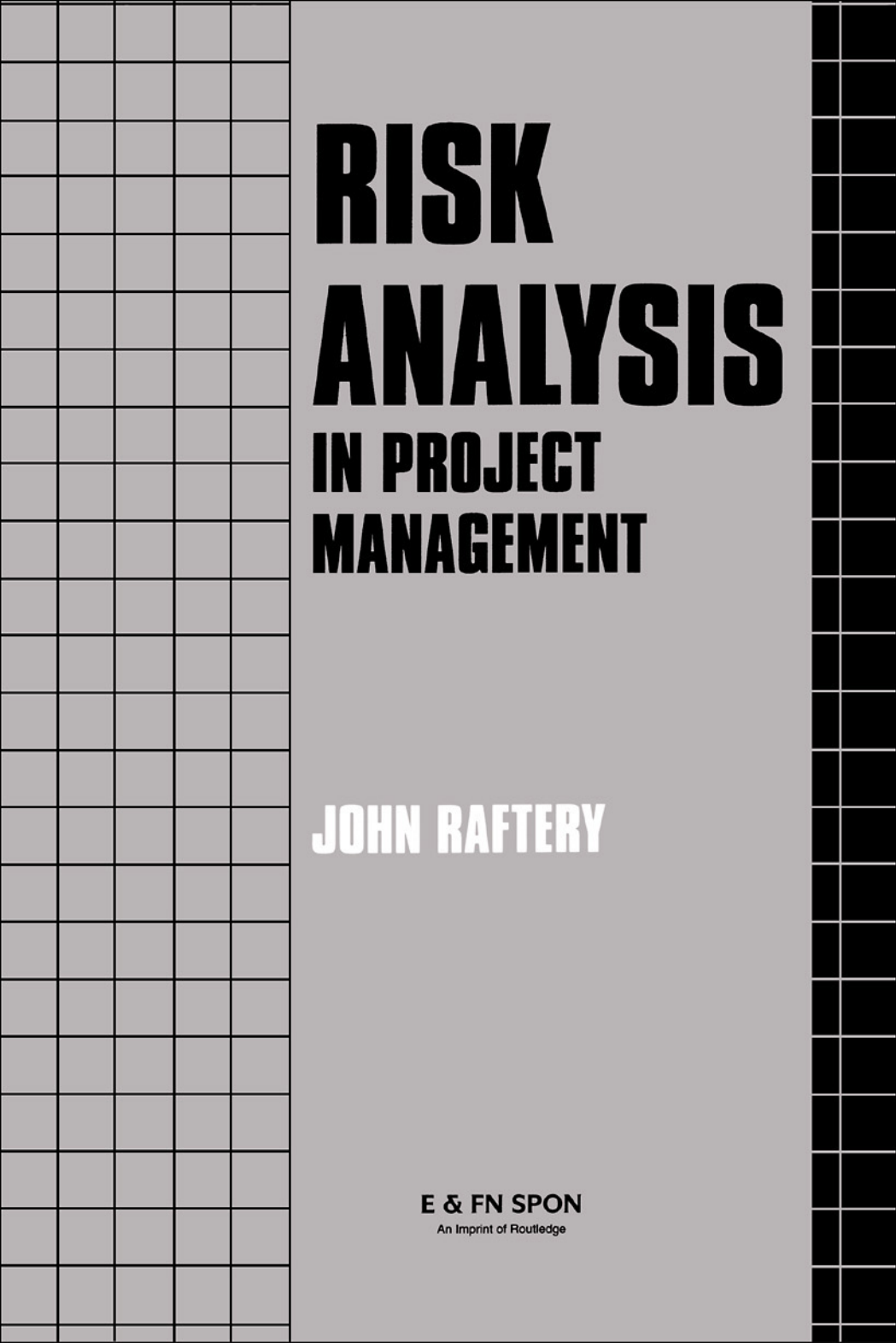




RISK ANALYSIS IN PROJECT MANAGEMENT

JOHN RAFTERY

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FEARGHUS AND TOM

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PREFACE

The principal objective of this book is to demystify the subject of risk analysis. The focus of the book is on the **analysis** rather than the **management** of risk. This is a practical text which minimizes jargon, mathematics and academic references. The text contains descriptions of the nature of risk and risk attitude, and psychological aspects of forecasting construction price and time. Techniques of analysis are described together with an assessment of their strengths and weaknesses. Case studies and worked examples are presented to show how they may be used in practice to carry out sophisticated risk appraisal on a range of projects covering building and major civil engineering and infrastructure work. The worked examples demonstrate how risk may be dealt with by construction clients and contractors. The emphasis of the book is not on model or checklist approaches to risk analysis; the book provides an opportunity for professionals to learn how to think systematically about project risks and to develop a maturity of judgement regarding project risk analysis. There is no intention here to replace judgement with analysis; the opposite is the case. Risk analysis enables decision makers to improve the quality of their judgements by providing more realistic information on which to base decisions.

The text is based on a series of risk analysis presentations and workshops over the past ten years to international construction clients, consultants and contractors in Europe, Scandinavia and South East Asia. Most of the examples are based on real projects.

The book is aimed at practitioners (architects, engineers, project managers, quantity and building surveyors) who need a quick, easy to assimilate introduction to the field and at students on a range of construction and property-related courses who may be taking options in risk management. A recent RICS report on the future of the quantity surveying (QS) profession has indicated risk analysis as one of the new high value-added services which QS firms will need to offer to their clients in order to survive and

prosper into the late 1990s. This is a practical text which aims to enable the reader to be brought quickly up to date on the subject. There is therefore sufficient material for the construction professional to feel confident about undertaking systematic risk analysis; and sufficient also to enable the reader to decide when it is necessary to call for specialist advice.

ACKNOWLEDGEMENTS

For such a short book, I owe many debts. I worked closely on some of the ideas with Dr Stephen Mak, now at Hong Kong Polytechnic. Stephen coded the software that was used on some of the cases described in Chapters 5 and 6, and drafted the questions used in the personal bias section of Chapter 3. Randy Yu, my colleague at Greenwich, wrote up the case study of the Thames Bridge based on my amendments to one of our consultancies and also supplied me with the Goh Kee Contracting Company example used in Chapter 6. My colleague Professor David Wills supplied the material for Figure 1.7. I am grateful to my consultancy clients, who wish to remain anonymous, in Finland, South East Asia, Washington and London. In the same context I have relied on the support of Jenny Lynch, who runs our consultancy office, and Sue Lee, who produced the artwork for the diagrams. Tim DeLap helped with the St Alfege's project which I ran on our Master's programme in 1989. Maxine Davis supplied the figures in Tables 5.1–5.3. Others who have helped directly or indirectly include John Limpert now in North Carolina, Derek Drew and David Picken in Hong Kong, Frank Grogan and Jim Foley in London, Anders Ekman and Seppo Nilsson in Helsinki and Professor Bo-Christer Bjork now at the Royal Institute of Technology in Stockholm. I received detailed comments, criticisms and suggestions on an earlier draft of the text from Kieran Raftery and from my colleague Dr Hilary Davies. All of these people were responsible for improvements to this work. There is still room for improvement, and for any errors or inaccuracies blame me, not them.

John Raftery
Greenwich, September 1993

CHAPTER 1

RISKS AND UNCERTAINTIES IN PROJECTS

1.1 THE PURPOSE OF THIS BOOK

1.2 RISK AND UNCERTAINTY: DEFINITIONS

1.3 RISK EXPOSURE AND RISK ATTITUDE

1.4 RISK IN PROJECTS

1.4.1 Project heterogeneity

1.4.2 Budgeting and tender price forecasting

1.4.3 Project-based sources of risk

1.4.4 External risks

1.5 AN OVERVIEW OF RISK MANAGEMENT

1.5.1 Risk identification

1.5.2 Risk analysis

1.5.3 Risk response

1.6 RISK ANALYSIS: ADVANTAGES AND LIMITATIONS

1.7 SUMMARY

This is not a speculative game at all. Our objective is not to avoid risk but to recognise it, price it and sell it.

Tony Ryan, chairman of Guinness Peat Aviation Ltd,
quoted in the *Observer*, 14 June 1992, p. 49

1.1 THE PURPOSE OF THIS BOOK

Someone once said ‘Most books, on most subjects are too long’. Here is a short book on risk analysis. The primary objective of this book is to demystify risk analysis in construction. The text is intended to be a concise, practical introduction to systematic methods of dealing with risk in construction projects. There is enough material to equip the reader to carry out competent and thorough analyses of project risk. The book is intended to be a practical source of reference on the **techniques** of risk analysis used in construction economics and project management. Mathematics, jargon and excessive theoretical detail are all avoided, as far as possible. No prior knowledge of mathematics is assumed (Chapter 2 contains a very simple introduction to some basic notions of probability). The focus of the book is on the **analysis** rather than the **management** of risk. At the core of the book several techniques are introduced. Their strengths and weaknesses are examined to see how they may be used in practice to carry out risk appraisals of various aspects of construction projects and capital investment decisions. Certain techniques are necessary, but not sufficient, for competent risk analysis. Projects are managed by people. People enter data, assumptions and judgements into equations for the purpose of analysis. People’s assumptions and perceptions may be inaccurate and inconsistent, but are often powerfully accurate and consistent.

This book does not encourage a mechanistic approach. It sets out to encourage independent thought and maturity of judgement about projects. The worked examples cover building, civil engineering and infrastructure work and illustrate how risks may be dealt with by construction clients (and their consultants) and contractors.

Many books and papers on the economics of construction,

estimating and forecasting contain ritual declarations of the 'uniqueness' of construction:

- Each project is different.
- There are special problems in construction.
- The future cannot be forecast.
- Construction is a high-risk business.

These pleas are sometimes accompanied by suggestions that, in construction, 'different' rules (covering payment and service delivery) should apply. Personally, I do not agree with most of this. Of course, many industries have their own special characteristics, but few are so special that they cannot be understood by an outsider. Viewing the industry in this way (in terms of its special difficulties) seems to be rather negative and unhelpful. In fact, viewed systematically, there are many features common to a wide range of construction projects. Most projects will have a start date and a finish date. Most projects will be designed and built by teams of people and firms drawn together for that particular project. Most projects will have a design and a construction phase which may, or may not, overlap. Most projects will require contractors to marshal labour, equipment, materials and components to a specific site. Many physical elements of construction will recur across projects. For example, all bridges need a deck and a supporting structure. All buildings need substructures, cladding and services. Although each project may appear to be physically different, construction projects in general exhibit lower levels of complex technical innovation when compared, say, with aerospace, defence or computer software projects.

Of course, the specific details, specification and precise measurements of each project are unique. Plans, estimates and time schedules have to be made in advance with limited information. Judgements about the future have to be made and built in to plans and forecasts. However, focusing on risk in this way may lead to negative attitudes and to the desire not to embark on the project at all in order to avoid all the possible unpleasant consequences. Excessive concern with the negative aspects of risks may lead to overcautious and irrational decisions. In construction, as in life in general, it is necessary to strike a balance between rigid adherence to the status quo, avoiding all risks on the one

hand, and rash risk-seeking behaviour on the other. The growth and development of a business, an economy or an individual, require the exercise of judgement and the taking of decisions involving some uncertainty of outcome. To avoid all risks is to stagnate and ultimately to be overtaken by events and die. In business in general, and in construction projects in particular, the question is not whether to take risks but how to take reasonable risks. Our task is not to avoid risk but to recognize it, assess it and manage it.

Risk analysis needs to be carried out in the context of a systematic approach to the management of risk. The point of the analysis is to establish the extent of risk in order to do something about it. The primary focus of these chapters is on the analysis, not the management, of risk. However, neither can be examined in isolation. The purpose of this chapter is therefore to introduce some basic notions of risk, risk analysis and risk management.

1.2 RISK AND UNCERTAINTY: DEFINITIONS

The future is largely unknown. Most business decision making takes place on the basis of **expectations** about the future. Making a decision on the basis of assumptions, expectations, estimates and forecasts of future events involves taking risks. Risk is an abstract concept. It is difficult to define and, in most cases, impossible to measure with any precision. In the context of the management and economics of construction projects, a working definition of risk and uncertainty would be along the following lines:

Risk and uncertainty characterize situations where the **actual** outcome for a particular event or activity is likely to deviate from the estimate or forecast value.

Risk can travel in two directions: the outcome may be better or worse than originally expected. These are known as **upside** and **downside** risks. Risk and uncertainty will apply to the forecast price or time for the entire project and for any subcomponent, subcontract, operation or activity within it. Similarly, risk and uncertainty will be attached to assumptions about weather,

inflation, strikes and other external aspects of projects. Taking these latter points into account, risk has also been defined as:

Exposure to the possibility of economic and financial loss or gain, physical damage or injury, or delay as a consequence of the uncertainty associated with pursuing a particular course of action (Chapman, 1991).

Some people like to distinguish between **risk** and **uncertainty**. The distinction is usually that risk is taken to have quantifiable attributes, whereas uncertainty does not. Risk analysis and risk management had their origins in the insurance industry in the USA in the 1940s. Hence, a **risk** arose when it was possible to make a statistical assessment of the probability of occurrence of a particular event. Risks, therefore, tended to be **insurable**. Using this logic, the actual risk to be carried was quantified as follows:

$$\text{Risk} = \text{Probability of event} \times \text{Magnitude of loss/gain}$$

Uncertainty, on the other hand, was used to describe situations where it was not possible to attach a probability to the likelihood of occurrence of an event. Uncertainties tended not to be insurable. It is not possible, actuarially, to assess the level of premium required to cover something which is classed as an **uncertainty**. There is much doubt about the practical usefulness of this distinction, especially as the vast majority of business decisions are made without the benefit of statistical data and statistical calculations. Most business decisions are made on subjective judgements, sometimes backed up by appropriate quantitative analysis. The distinction does, however, have some conceptual value. After all, **uncertainty** attached to a high impact event represents a **greater unknown** than a quantified risk attached to the same event. However, the unknown may be shown to have been either more or less likely than the known risk. For the practical purposes of decision making in project management this distinction serves little useful purpose.

Let us explore this briefly with some practical, project-related examples.

Given that we know, from meteorological data gathered over a

period of years, the mean and standard deviation of the rainfall in, let us say, Moscow, in October, we can quantify, within measurable confidence limits, the probability that there will be more than five centimetres of rain next October with consequent effects on the water table for a specific site near Red Square. Thus, it is possible to calculate the probability that sheet-piling will be necessary. With this information we can proceed to make a risk-adjusted decision on whether to allow for this in a cost or time forecast. Uncertainty, on the other hand, is assumed in that approach to be not quantifiable. For example, consider the long-term planning for a major project such as a new, privately financed, rapid transport system. The viability of the project depends, among other things, on whether the excess of ticket revenue over capital, running and finance costs is sufficient to give a reasonable return given the very large risks involved. This particular model will need to be built *ex ante*, that is pre-design, pre-site acquisition, pre-statutory permission. The level of ticket revenue will be a function of the number of passengers carried, the price of the ticket and the extent, if any, of government subsidy to take account of other beneficial spillover effects such as reduction of congestion. The number of passengers carried will be a function of, among other things, the economic conditions prevailing at the time and the cost and relative convenience of other forms of transport. Unlike the case of the meteorological records above, there will be no organized statistical database for most of these variables. Yet, in the classic definition of risk, it is likely that the **actual** will deviate from the **expected**. Those who differentiate would regard these variables as **uncertain**. While not exactly non-quantifiable, the latter group is certainly considerably **less** quantifiable than the expected rainfall of the earlier example. Note that in all cases we are concerned with making good decisions before the event, on the basis of limited information. Therefore, we are concerned with **opinions**, **professional judgements** or **degrees of belief** about the events.

Thus, for those who make the distinction, the only difference between risk and uncertainty is not one of substance, it is one of **degree** (of personal knowledge about the future event). For this reason it seems preferable not to differentiate between risk and uncertainty. No cost estimating, forecasting or project management situation comes to mind where such a distinction

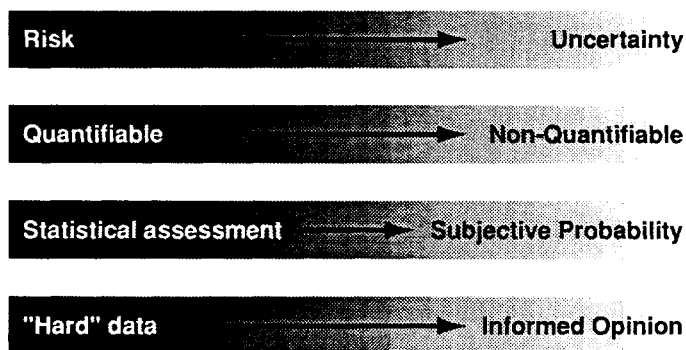


Figure 1.1 The risk—uncertainty continuum

would serve any useful purpose. In this text the terms are used interchangeably. There may be a strong or a weak degree of belief in an event. This degree of belief may be largely, or not at all, quantifiable. There will nearly always be an **informed** opinion of some kind about the variable in question.

Risk and uncertainty may, therefore, be viewed as at either end of the continuum. This is illustrated schematically in Figure 1.1. Risk is at the more assessable end of the continuum: there may even be some statistical data from which to produce an evaluation of the likelihood and size of the potential risk. Uncertainty is at the less assessable end: there will be no ‘data’; the decision maker will need to rely on informed opinion. It is possible, though, to attach, loosely, some numbers to subjective opinions. As long as the numbers are a fair representation of that person’s opinion, they are useful. A well-informed decision is one which makes use of all available relevant information, both objective and subjective.

1.3 RISK EXPOSURE AND RISK ATTITUDE

Few, if any, business decisions are statistically repeatable. Few have full statistical support in the form of detailed historical data relevant to the current decision. Most decisions of this type are

matters of judgement, sometimes supported by data. Risk analysis attempts to enhance the value of these judgements by enabling decision makers to make use of the full extent of their knowledge and experience through formal consideration of risk and uncertainty.

For most business decisions there are four main categories of risk, as follows:

High probability-high impact
Low probability-high impact
High probability-low impact
Low probability-low impact

The impacts may be positive or negative, upside or downside. The least important type of risk is the low probability-low impact risk. However, even this type of risk needs to be assessed in order to determine whether it has the potential to push non-critical operations into the critical path. Hence, in a formal risk analysis all risks should be considered at the outset. It is quite possible that after an initial analysis the low impact risks of both low and high probability may be eliminated as inconsequential. Using one of the definitions given above, the **exposure** to risk would be given by the probability of the event multiplied by the extent of the potential loss/gain.

It is commonly perceived that economic progress cannot take place without the taking of risks. People are frequently categorized as risk neutral, risk seeking or risk averse. Successful business people are perceived as risk seekers. Risk has about it an aura of achievement. Those who have successfully dealt with risky situations are held in high regard. These assumptions are contradicted by scientific studies of the attitudes of business people. Empirical studies have shown that it is often the case that business decision makers are highly risk averse. In fact they spend a lot of time and effort minimizing the risks that they do take. Similarly, professional gamblers are regarded as risk takers. In fact, successful professional gamblers are also very risk averse. They spend large amounts of effort calculating and minimizing their risk. Attitudes to risk are discussed in detail in Chapter 4.

1.4 RISK IN PROJECTS

1.4.1 Project heterogeneity

The construction industry generally has a bad reputation for its work. The industry has a reputation for time and cost overruns. This may be summed up in the commonly held perception that the industry tends to deliver expensive buildings late. Examples may be quoted from many countries. Is this reputation deserved? This section examines the environment and conditions for cost, price and time forecasting and project management in the context of the construction industry.

Most building and many civil engineering projects consist of a similar set of construction activities involving a variety of materials and specifications on different sites. Most completed buildings have the same set of elements such as substructure,

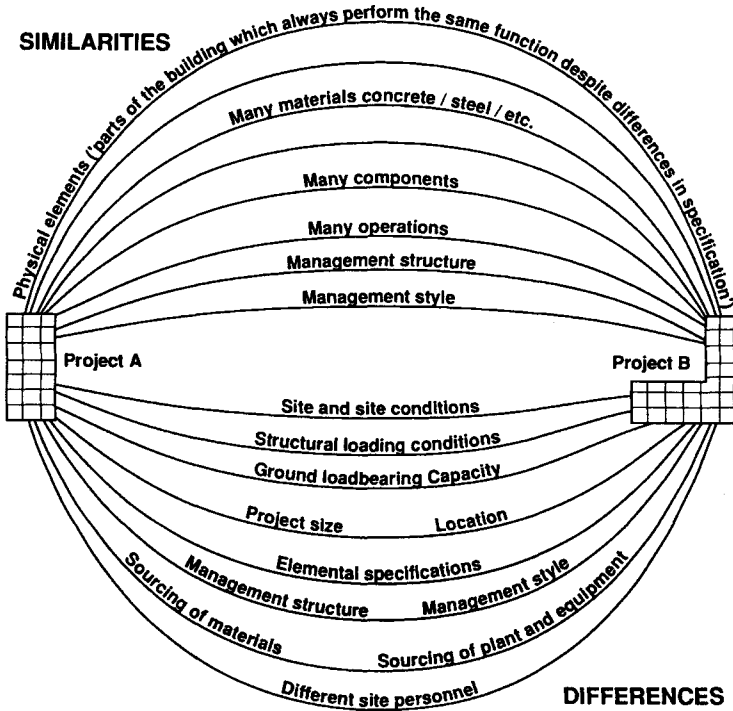


Figure 1.2 Project heterogeneity

frame, external walls, internal partitions, services and a roof. The result of this is that while it is a cliché and an overstatement to say that every project is unique, it is true that there are large differences between projects. Despite largely common activities and processes, each project is assembled and constructed on its own site with its own physical characteristics, subject to weather conditions depending on the season, with different material specifications and technical solutions to the problems of enclosing space. While a number of materials and components will be identical, many will not. Each project usually has a different labour force of operatives and managers. Hence, there will be differences in the management and interpersonal behaviour on each project simply because people are different. Similar arguments apply to civil engineering and infrastructure projects except that they are usually less homogeneous than building projects.

1.4.2 Budgeting and tender price forecasting

During the design process the client endeavours—usually with the assistance of professional advisers who may be in-house or external—to set a budget, to predict the tender price and to manage the design so that it meets budget. In forecasting the tender price the client's advisers are attempting to forecast the winning tender.

The winning tender will consist of an estimate of the contractor's costs and a mark-up. It is reasonable to expect that the mark-up will usually represent a smaller proportion of the total bid than the cost estimate. Hence, the tender price forecast is, largely, a forecast of the contractor's forecast of what the project is likely to cost. In other words, a forecast of a forecast. This is illustrated in Figure 1.3.

It is often said that during the bidding process the contractor is attempting to assess the correct market price for a project not yet built, to a design which is subject to revision, on a site about which there is little information and with a labour force not yet recruited.

Construction people sometimes suggest that under these conditions it is surprising that it is possible to produce a price at all. While that may be something of an overstatement it does

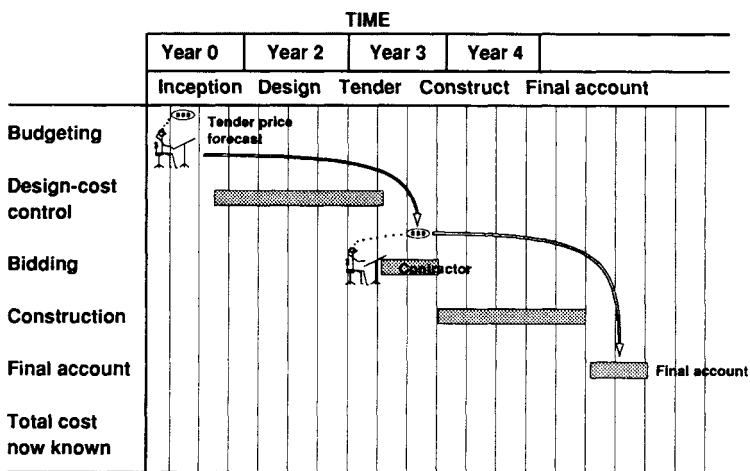


Figure 1.3 A forecast of a forecast

seem reasonable to suggest that such problems as these are infinitely (now there is an overstatement) more difficult at the earlier budget stage. The task of the client's quantity surveyor, for example, is to forecast the contractor's forecast without access to the contractor's data and with many more inherent uncertainties caused by not yet having a design or, perhaps, even a site. The budget decision is made at a much earlier point in the life of the project and so the forecast is being made over a much longer timescale.

In addition to all of this there is some dispute about what is actually being forecast. Is it the lowest tender? What if the lowest tender is a mistake? Perhaps we are trying to forecast the average of all the tenders received. This average will be influenced by errors made by bidders at the top and bottom end of the range and by cover prices at the top end of the range. Additionally, the actual price for constructing the project will not be known until the project is complete and all accounts have been agreed, if not settled. The range of possible targets is illustrated in Figure 1.4. It is probably safe to assume that, in most cases, the lowest tender is not an error. Where the lowest tender is an error, this will be clear to the quantity surveying team who may recommend further investigation and possibly the acceptance of another tender. Therefore, what we are trying to forecast is the accepted tender. This accepted tender represents the winning contractor's estimate

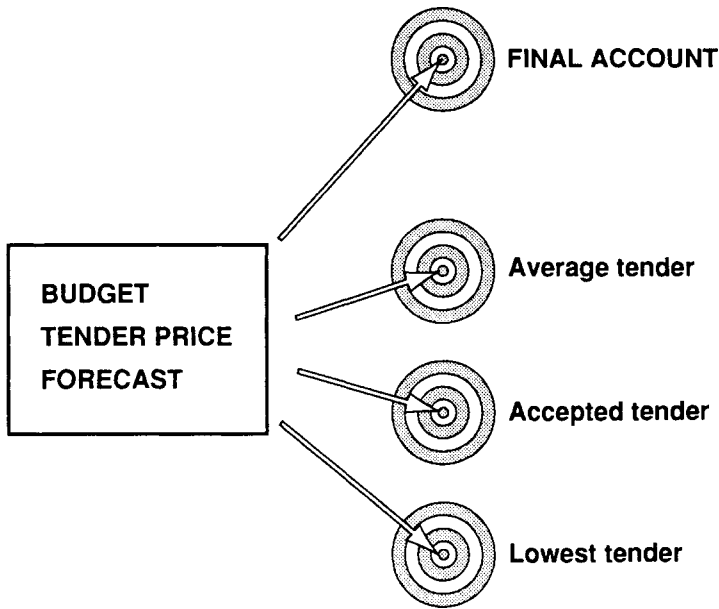


Figure 1.4 Range of available targets for budget forecasts

of the market price for constructing the project. This estimate may or may not eventually be shown to be a correct estimate of the actual outturn cost of the project to the contractor. Clearly, if the contractor's estimate proves to have been optimistic, then the achieved profit margin will reduce. The converse is also the case. This is too simplistic a view, of course, as it assumes that other things are equal. Specifically, it assumes that there will have been no variations or design changes and that the contractor has taken no control action to reduce costs during the course of the project. The nature of construction is such that no matter how well designed the project, it will usually require some fine adjustments. Some inflation, or perhaps a change of mind on some detail from the client. Changes of this sort can be minimized by appropriate contractual arrangements. But it is unrealistic to expect that the precise details of the project as constructed will be exactly as they were envisaged at the budget or tender stage, except in rare cases. This highlights one of the differences between forecasting and budgeting in construction and business forecasting. Business forecasting is concerned with forecasting

- ☐ Precise ground conditions of site
- ☐ Substructure design
- ☐ Detailed superstructure design
- ☐ Timing of project
- ☐ Type of contract arrangements
- ☐ Inflation (medium term: two to five years)
- ☐ Construction market conditions (anticipated)

Figure 1.5 Risks and uncertainties affecting construction budgeting decisions

phenomena that may subsequently be measured, such as sales, inflation and share price. In construction, on the other hand, the forecast is mostly concerned with estimates. Some specific risks and uncertainties affecting construction budgeting decisions are suggested in Figure 1.5.

In budgeting and forecasting for construction projects, as in many other fields, it is sometimes necessary to remember that we have a tendency to believe that the more precise a statement is, the more accurate it is. We are all familiar with the illusion of precision given when the answer to a problem is given on a

- | | |
|--------------|--|
| Technical | – Adequacy of site investigation |
| | – Availability of materials and components |
| | – Adequacy of design and design information |
| Logistical | – Sourcing materials, plant and labour |
| Construction | – Productivity |
| | – Weather |
| | – Adequacy of contractor's own construction plan |
| | – Adequacy of resource scheduling |
| | – Industrial relations |
| Financial | – Escalation/inflation (short term) |
| | – Payment schedule |

Figure 1.6 Risks and uncertainties affecting the contractor's estimate

- | | |
|------------------------------|--|
| 1. Cost of materials | – discounts, different suppliers, speed of payment, vertical integration |
| 2. Labour productivity | – skill, standard of workmanship |
| 3. Labour costs | – wages, overtime, good staff |
| 4. Wastage | – materials, labour, theft |
| 5. Plant | – amount, type, own/hire |
| 6. Site techniques | – different sequence of operations |
| 7. Allowance for fixed price | – future increased costs |
| 8. Effect of design team | |
| 9. Deliberate distortion | – front loading and cash flow, anticipating variations |
| 10. Overheads | |
| 11. Profit | |

Figure 1.7 Same project, different contractor

computer printout to six decimal places. In construction budgeting, judgements have to be made between being roughly accurate or being precisely wrong.

Moving through time to the point where the majority of the design work is done and tender documentation has been produced, there will still remain many areas where judgements about risk and uncertainty will need to be made by the contractor in order to prepare an estimate. Some of these are illustrated in Figure 1.6.

It follows, then, that there will be good reasons for differences in estimates produced by different contractors for the same project. These are summarized in Figure 1.7.

1.4.3 Project-based sources of risk

For any given project the major sources of risk are: size, complexity, novelty, speed of design and construction and location. There is an abundance of empirical evidence on project cost and time overruns which indicates that initial forecasts are far too optimistic and that project risks are not being dealt with adequately.

- ☐ **Size**
- ☐ **Complexity**
- ☐ **Novelty**
- ☐ **Intensity (speed of design and construction)**
- ☐ **Physical location**

Figure 1.8 Major sources of project risk

Consider a stereotypical project life cycle from inception through to commissioning and operating. At any given point the project participants have only expectations about the future. They do not, as it were, **know** what will happen next. They can only work on reasonable assumptions. Sources of project risk are summarized in Figure 1.8.

1.4.4 External risks

Change is an unavoidable feature of all large projects. The world of construction is one where timescales are relatively long, where there is time for variability. The longer the time scale is, the more likely it is that there will be some interference or outside event which affects the project. These are fertile conditions for things to go wrong. All of this together emphasizes the need for forecasts and plans to allow realistically for change. Categories of risk, internal and external, to projects are illustrated in Figure 1.9 and Table 1.1.

- ☐ **Inflation**
- ☐ **Market conditions**
- ☐ **Cost escalation on input resources**
- ☐ **Materials** } **availability**
- ☐ **Labour** }
- ☐ **Political uncertainty**
- ☐ **Weather**

Figure 1.9 Sources of risk external to the project

1.5 AN OVERVIEW OF RISK MANAGEMENT

Most commentators on construction risk start with a consideration of what is known as the **risk management cycle**. This is illustrated

Table 1.1 A list of major categories of sources of risk

SOURCE	EXAMPLE
Client/government/ regulatory agencies	Bureaucratic delays, changes in local regulations
Funding/fiscal	Changes in government funding policy, liaison between several funders
Definition of project	Change in project scope
Project organization	Authority of project manager, involvement of outside bodies
Design	Adequacy to meet need, realism of design programme
Local conditions	Local customs, weather windows
Permanent plant supply	Degree of novelty, damage/loss during transportation
Construction contractors	Experience, financial stability
Construction materials	Excessive wastage, reliability of quality
Construction labour	Industrial relations, multiracial labour force
Construction plant	Resale value, spares availability
Logistics	Remoteness, access to site
Estimating data	Relevance to specific project availability
Inflation	
Exchange rates	
<i>Force majeure</i>	

Source: Hayes et al. (1986), p. 12.

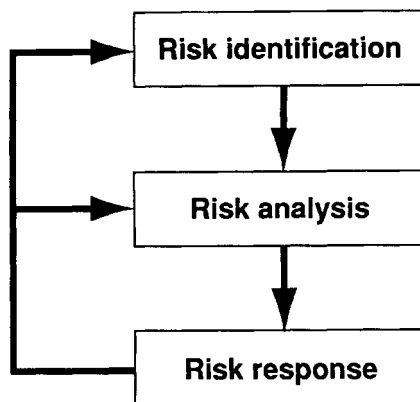


Figure 1.10 Risk management

in Figure 1.10. The cycle is useful insofar as it focuses the mind in a systematic way on the identification, analysis and response to risk. The whole purpose of risk analysis is to help the decision maker to consider a rational response to the degree of exposure to risk which is revealed by the identification and analysis stages.

1.5.1 Risk identification

The risk identification stage has received the least attention in the literature on risk. Many professionals who have accumulated some experience of carrying out risk analysis on capital projects find that the identification stage is the most time consuming. Identification of risks internal and external to the project requires that the analyst be systematic, experienced and creative. It is frequently the case that the best way to gain access to this range of personal qualities is by assembling an appropriate team. It is not realistic to expect 20/20 foresight. Construction professionals are required in law to exercise reasonable care and skill in carrying out their work. The identification of risks is about making the best use of the information and experience available at the time of making the decision. In practice I have found that it is useful to work closely with the project team and to consider explicitly at least three separate areas:

1. Risks internal to the project, by breaking the project down into major work packages.

2. Risks external to the project and emanating from the business and physical environment.
3. Consider the client, the project, the project team and the quality of the documentation from the perspectives of the various contractors in anticipation of sources of claims.

It may be necessary to consider the use of a formal technique for teasing out an exhaustive range of potential problems. Formal brainstorming is sometimes used in this context. A formal brainstorming session should have a set of clear rules and a timetable. A coordinator should be appointed, and it is essential that he or she has two qualities: the ability to chair meetings and a sense of humour. The first stage is the creative session where the coordinator elicits one idea at a time from individuals on potential risks or sources of risk. Individual team members are not restricted to their own knowledge domain. The rule of this stage is that no criticisms of ideas or people are allowed. Outlandish suggestions are encouraged. A list of suggestions is maintained on a flipchart or similar device. As the list contains no names, there is no way of associating any particular idea with any particular member of the team. Stage two of the session is quite different in character; it is the evaluation stage, when all the ideas are evaluated seriously and a final list is made. The list is the product of the team rather than the individual members.

Two other aspects of risk identification are worth mentioning here. First, if the team members are committed to the project and motivated towards achieving a successful outcome overall, then the whole process of risk analysis should be a positive experience. Someone once said (not about risk analysis), 'If it isn't fun then you probably aren't doing it right'. Second, it is sometimes argued that risk analysis encourages negative and cautious attitudes among the team or the project sponsors. If this is happening it needs to be taken seriously and examined closely to ascertain whether it is a realistic assessment of the problems associated with the project. At the same time the analyst needs to maintain some distance from the project in order to avoid 'falling in love' with it. This affliction will be dissected more fully in Chapter 8.

1.5.2 Risk analysis

As the techniques of analysis form the focus of the bulk of these chapters, we shall not dwell upon them here.

1.5.3 Risk response

The purpose of the identification and the analysis is to enable the decision maker to make a considered response **in advance** of the problem occurring. The general guiding principle of risk response is that the parties to the project should seek a collaborative and, insofar as is possible, mutually beneficial distribution of risk. The starting point for the distribution of risk is the contract. A dominant party unthinkingly offloading all the project risks to others is unlikely to enhance the chances of a successful outcome to the project. Responses to identified risk are usually listed as follows: retention, reduction, transfer, avoidance.

A number of factors should be taken into account when allocating risks among parties to the project. First, the best way to avoid all risk is not to proceed with the project. The benefits of the project must be judged to be worth the risks involved in undertaking it. Second, it seems sensible to place the risk under the responsibility of the party who has the best possibility of controlling it. Third, risks should be allocated where possible to the party for whom the risks are least onerous. Fourth, although it is reasonable to exact a premium for carrying a specific project risk, the party responsible should be left with some motivation to avoid and minimize risk consequences should unfortunate events occur.

Responding to anticipated risks by collaborating on the equitable distribution of risk should lead to long-term economies in the industry.

1.6 RISK ANALYSIS: ADVANTAGES AND LIMITATIONS

All forecasts about the future are uncertain. From first principles, it seems entirely unreasonable to disguise this fact in making the forecast. At the same time, decisions have to be made, budgets

have to be allocated and development potential maximized. Systematic analysis of risk exposure must, over time, lead to a more efficient allocation of resources. Even without producing quantitative results, the very discipline of breaking a project down into its sources of risk and systematically examining them ensures that the estimator develops a much more realistic feel for the project and its range of possible outcomes.

Virtually all writers and consultants on risk agree that there is no such thing as a software-only solution to the problem of risk management. Risk analysis software is neither **necessary** nor **sufficient** for risk management. Rigorous, comprehensive and competent risk analysis is primarily dependent on the attitude of mind of the appropriate decision makers and their advisers. Risk management will not remove all risks; it will enable explicit decisions to be made which will mitigate the potential effect of certain risks. Risk management will also assist in rational, **defensible** decisions regarding the allocation of risks among the parties to the project. Risk analysis is not a substitute for professional experience and judgement. On the contrary, it helps professionals to make use of the full extent of their experience and knowledge by liberating them from the necessity of making simplifying assumptions in order to produce deterministic plans and forecasts. Risk analysis is a supplement to, not a substitute for, professional judgement.

Fully documented risk studies of project estimates are helpful in subsequently 'defending' estimators' decisions. There is a useful distinction between good **luck** and good **management** (Chapman, 1991). For example, it may subsequently be necessary to defend a budget which had been set high initially in order to take account of a risk which, either through good management or good luck, did not in the event occur. Conversely, it may be necessary to support a subsequent request for additional project resources to cover an outcome which, although originally foreseen, was thought to be highly unlikely. Thus, one of the many uses of this form of analysis is in distinguishing **bad luck** from **bad management** and, of course, **good luck** from **good management**. Thus, in subsequent project *post mortems* it is possible to distinguish controllable from uncontrollable events. For a budget estimate, full documentation of the risk analysis need not

necessarily be more than a few sides of A4 paper. According to Chapman (1991) documentation is important in another respect: in situations where experienced professional staff move on to different posts, good documentation ensures that the firm will retain its 'corporate' knowledge of the risk analysis and also facilitate the induction of new staff.

Probabilistic forecasts increase the quality of information available to senior managers who have to take decisions about which projects shall receive funding. They also render it possible to consider contingencies, across portfolios of projects, in a meaningful way. There should be no doubt that the implementation of risk management procedures will lead, over time, to a more efficient use of resources.

In summary, many writers, consultants and users of risk management agree on the following benefits from the approach:

- There is an overall reduction in risk exposure;
- Pre-planning should lead to the use of pre-evaluated and prompt responses to any risks which do materialize;
- More explicit decision making on the project;
- Clearer definition of specific risks associated with particular projects;
- Full use is made of the skill and experience of project personnel;
- Good documentation ensures that corporate knowledge of project risks accumulates over time and does not remain with individuals;
- Situations where there is little, no or unreliable data are not ones where it is not possible to carry out the analysis, they are situations where the analysis is **more**, not less, important.

1.7 SUMMARY

This chapter is an introduction to the basic ideas of risk analysis and risk management and their application in the planning and appraisal of construction projects. The terms risk and uncertainty are clarified at the outset and a conceptual framework is presented which separates risk exposure from risk attitude. The specific problems of budgeting and tender price forecasting are then considered. Sources of risk both internal and external to the project are identified. An overview of the process of risk management then forms the background for the introduction of a number of techniques of risk analysis. The chapter concludes by considering the limitations and the advantages of risk analysis and risk management.

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