PART I

An Introduction to Risk Assessment – Its Uses, Processes, Approaches, Benefits and Challenges

CHAPTER 1

The Context and Uses of Risk Assessment

This chapter provides a general discussion about the uses of risk assessment. We start by describing some simple examples; these demonstrate that risk assessment is a natural process that is conducted by most people in day-to-day situations, albeit informally and often implicitly. We also present some prominent examples of risk management failures in business-related contexts. We then describe some contextual challenges in decision-making processes, including that of achieving an appropriate balance between rational considerations and intuition, as well as the presence of biases. In the latter part of the chapter, we present key drivers of the need for structured, explicit and formal approaches to risk assessment in some contexts, and present the main uses and objectives of such activities.

1.1 RISK ASSESSMENT EXAMPLES

This section presents some simple examples of the use of risk assessment in everyday situations. From these, we aim to draw some general conclusions, including that the conducting of risk assessment is quite natural to most of us (and not something unusual, in principle). Indeed, in situations that are fairly simple or that are encountered frequently, the process is usually implicit; our plans automatically incorporate some element of risk mitigation and contingency planning based on experience, without us being particularly aware of it. For situations faced less frequently (or where the situation does not closely fit a recognised pattern), the process is generally slightly more explicit.

We also aim to show that a risk assessment process – whether explicit or implicit – may result in modifications to original (base case) plans in several possible ways:

- It may result in no change to the underlying plan or project, but simply to the adaptation of targets or of objectives to make them more realistic or achievable, such as the addition of contingency, whether it be extra time, resources or budget.
- It may lead to moderate changes to the initial plan or project, by leading one to look for measures to respond to risks, such as mitigation or exploitation measures.

- It could result in more fundamental changes to the project, such as the requirement for it to be re-scoped or changed in a major way, or for completely new structural or contextual possibilities to be developed.

We also show that the results of the process often depend on personal judgement, rather than robust analysis and criteria. In particular, we typically make a number of judgements in ways that are neither explicit nor formalised, and these depend on our experiences, personal situations, preferences and biases. Although, in personal situations, we often have discretion as to which decision option or mitigation measure to implement, and the consequences are borne directly by us, in some cases, consultation and agreement with others may nevertheless be required.

1.1.1 Everyday Examples of Risk Management

The following describes some simple examples, each of which aims to demonstrate some of the above points.

When planning to cross a road, in normal circumstances, one first looks each way. This can be considered as risk mitigation behaviour that has been instilled in us since a young age, and has become a natural reflex: it is clear that the benefits of looking are significant when compared to the cost of doing so; the small investment in time and effort is easily outweighed by the reduction in the risk of having an accident. However, when the circumstances are a little different to normal (e.g. the road is particularly busy, or the traffic signals are broken), one tends to naturally take extra precautions: one may look more carefully than usual, or walk more cautiously. Under more unusual circumstances (e.g. if considering crossing a very busy multi-lane highway), one would tend to try to identify risks explicitly, and to reflect even more carefully on possible risk mitigation measures: if it had been foreseen in advance that one may face such a situation, one may already have put on sports shoes or a coloured reflecting jacket before setting out on the journey. If such precautions had not been taken, and time were available, one may return home in order to change into the appropriate shoes and jacket. One may even wish to be able to build a bridge, if only time and money would allow! However, if all of the possible mitigation approaches are judged insufficient, impractical, too costly or too time-consuming, one would consider whether to abandon the plan to cross, and thus to have to develop completely new options or to revise one's objectives and targets.

When planning a major business trip, one could simply book an air ticket for the dates concerned. On the other hand, one would often naturally consider (the risk) that the dates of the trip may need to be changed, and take this into account in some way. In particular, one may consider a range of possible options, each with different costs, benefits and risks:

- Buy (now) a non-flexible ticket: This would generally be the cheapest option but also would result in the whole investment being lost if the trip were rescheduled. As a variation, one may be able to buy trip-cancellation insurance (thus increasing the cost slightly): indeed, there may be a range of such insurance types available, at different prices, with different levels of reimbursement, and different general terms and conditions.
- Buy (now) a fully-flexible ticket: This would generally be a more expensive option than purchasing a non-flexible ticket, but at least trip-cancellation insurance would not be required, and the cost would have been fixed.

- Delay the purchase of the ticket until the dates are fixed with more certainty; at that future point, make a final decision as to whether to buy a fixed-date ticket at that point or to purchase one that is flexible, and possibly also with trip-cancellation insurance.
- One could think of an even wider set of decision options of a more structural nature that are fundamentally different to the originally planned actions, and which nevertheless aim to achieve the desired objectives; for example, one may conduct a series of video conferences coupled with electronic document sharing, instead of having an in-person meeting.

When planning a major building or renovation project (for example, of an old apartment that one has just bought), one may estimate a base budget for the works and then add some contingency to cover "unexpected" issues: these could include that materials or labour costs may be higher than expected, or that asbestos would be discovered in currently hidden (or inaccessible) wall or ceiling cavities, or that supporting structures would not be as solid as expected, and so on. This process would result in a revised figure that may be sufficient to cover the total project costs even when several of the risks materialise. If this revised budget is covered by available funds, one would presumably proceed with the project as originally conceived. However, if this revised budget exceeds the funds available, one may have to develop further decision options, such as:

- To continue the project as originally planned and "hope for the best" (whilst potentially looking for other possible mitigation measures, such as borrowing money from a family member if required, and taking in a lodger to repay the borrowings more quickly).
- To re-scope the project (e.g. use less expensive finishings).
- To restructure the project into phases (e.g. delay for several years the renovation of the spare bathroom until more funds are available).
- To cancel the project entirely.

When planning to travel from home to the airport, if one has already conducted such a journey many times, one would know from experience how much travel time to allow: this "base case" plan would implicitly already take into account to some extent that there may be unforeseen events that can materialise en route. In other words, the base plan would have some contingency (time) built in. On the other hand, where the journey is new (e.g. one has recently moved into the area), one may do some explicit research to estimate the base journey time, and then perhaps add some extra contingency time as well.

When planning a journey that will be undertaken with another person, each person's desired contingency time would typically be different to the other's: each will have different tolerances for risk, with both their perceived cost of excess waiting time (e.g. at the airport) and the implications to them of missing the plane being different.

Of course, in general, these informal processes can be very valuable; indeed they may often be sufficient to ensure than an adequate decision is taken. In other cases, they will be insufficient.

1.1.2 Prominent Risk Management Failures

Clearly, in both the public and private sectors there have been many projects in which significant unexpected delays or cost overruns occurred, most especially in the delivery of major

infrastructure, transportation and construction projects. An example (chosen only as it appeared in the general press around the time of the writing of this text) was the project to deliver a tramway in Edinburgh (Scotland), which was due to cost around £400 million when announced in 2003, but rose to around £800 million by the date of project completion in 2014.

In fact, it is probably fair to say that most failures (and many successes) of risk management in business contexts are not publicly observable, for many reasons, including:

- They are of a size that does not impact the aggregate business performance in a meaningful way (even if the amounts concerned may be substantial by the standards of ordinary individuals), and the losses are absorbed within a general budget.
- They are not openly discussed, and the failure is not objectively investigated (nor the results made public).
- It is challenging to demonstrate that risks that did materialise could and should have been mitigated earlier: in other words to distinguish the "benefits of hindsight" from what should reasonably have been known earlier in the process.

However, occasionally there have been major cases that have been of sufficient size and public importance that their causes have been investigated in detail; some of these are briefly discussed below:

- The Financial Crisis. The financial crisis of the early 21st century led to the creation of a Financial Crisis Enquiry Commission, whose role was to establish the causes of the crisis in the United States. Although its report, published in January 2012, runs to hundreds of pages, some key conclusions were:
  - "… this financial crisis was avoidable … the result of human action and inaction, not of Mother Nature or computer models gone haywire. The captains of finance and the public stewards of our financial system ignored warnings, and failed to question, understand, and manage evolving risks."
  - "Despite the view of many … that the crisis could not have been foreseen … there were warning signs. The tragedy was that they were ignored or discounted."
  - "Dramatic failures of corporate governance and risk management at many systemically important financial institutions were a key cause of this crisis …"
- The Deepwater Horizon Oil Spill. In April 2010, the Macondo oil well being drilled in the Gulf of Mexico suffered a severe blowout, costing the lives of 12 men, and resulting in the spillage of millions of barrels of crude oil. This disrupted the region's economy, damaged fisheries and habitats, and led to BP's having to pay large sums in compensation and damages. A commission was set up by President Obama to investigate the disaster, its causes and effects, and recommend the actions necessary to minimise such risks in the future. The Report to the President, issued in January 2012, runs into several hundred pages. Some key conclusions include:
  - "The loss … could have been prevented."
  - "The immediate causes … a series of identifiable mistakes … that reveal … systematic failures in risk management."
  - "None of [the] decisions … in Figure 4.10 [Examples of Decisions that Increased Risk at Macondo while Potentially Saving Time] appear to have been subject to a comprehensive and systematic risk-analysis, peer-review, or management of change process."

- *Columbia* Space Shuttle. On 1 February 2003, space shuttle *Columbia* broke up as it returned to Earth, killing the seven astronauts on board. The Accident Investigation Board reported in August 2003, and showed that a large piece of foam fell from the shuttle's external tank on re-entry, which breached the spacecraft wing. The report also noted that:
  - The problem … was well known and had caused damage on prior flights; management considered it an acceptable risk.
  - "… the accident was probably not an anomalous, random event, but rather likely rooted … in NASA's history and … culture."
  - "Cultural traits and organizational practices detrimental to safety were allowed to develop, including … a reliance on past success as a substitute for sound engineering … [and] … organizational barriers that prevented effective communication and stifled professional differences of opinion."

1.2 GENERAL CHALLENGES IN DECISION-MAKING PROCESSES

This section covers some of the general or contextual challenges in decision-making processes, including that of achieving an appropriate balance between rational considerations and intuition, as well as the possibility of the presence of a variety of biases.

1.2.1 Balancing Intuition with Rationality

Most decisions are made based on a combination of intuition and rational considerations, with varying degrees of balance between them.

Intuitive approaches are typically characterised, driven or dominated by:

- Gut feel, experience and biases.
- Rapid decision-making with a bias to reinforce initial conclusions and reject counter-narratives.
- Ignoring or discounting items that are complex or not understood well.
- Little (formalised) thinking about risks, uncertainties and unknowns.
- Little (formalised) decision processes or governance procedures.
- Lack of transparency into decision criteria and the importance placed on various items.
- Seeking input from only a small set of people, rather than from a diverse group.

At its best, intuitive decision-making can be powerful and effective, e.g. low investment nevertheless resulting in a good decision (generally). Indeed, justification for such approaches can be made using the framework of "pattern recognition"; that is, the decision-maker (typically subconsciously) views the particular situation being faced as being similar (or identical for decision purposes) to other situations that have been experienced many times before. Thus, such approaches are most appropriate where a particular type of situation is faced frequently, or where the consequences of a poor decision are not significant (or can be reversed), or in emergency situations where a very rapid decision is required. Examples include:

- Planning at what time to leave to travel to work in the morning, which may be based on many years of (non-documented) experience of using the same route.
- An experienced driver who is not overtly conscious of conditions on a road that he drives frequently, but is nevertheless making constant implicit decisions.

Of course, intuitive-driven approaches can have their more extreme forms: an article in *The New York Times* of 20 October 2013 ("When C.E.O.'s Embrace the Occult") reports the widespread use of fortune tellers by South Korean executives facing important decisions.

Rational approaches can be contrasted with intuitive ones, and are characterised by:

- Non-reliance on personal biases.
- Strong reliance on analysis, models and frameworks.
- Objective, holistic and considered thinking.
- Self-critical: ongoing attempts to look for flaws and possible improvements in the process and the analysis.
- Openness to independent review and discussion.
- Formalised processes and decision governance.
- Setting objectives and creating higher levels of transparency into explicit decision criteria.
- A desire to consider all factors that may be relevant, to incorporate alternative viewpoints, the needs of different stakeholders, and to achieve diverse input from various sources.
- Explicitly searching out more information, a wide variety of diverse inputs and the collection of data or expert judgement.
- Openness to use alternative tools and techniques where they may be appropriate.
- Willingness to invest more in time, processes, tools and communication.
- Exposing, challenging, overcoming or minimising biases that are often present in situations where insufficient reflection or analysis has taken place.
- (Usually) with some quantification and prioritisation.
- (Ideally) with an appropriate consideration of factors that may lead to goals being compromised (risks and uncertainties).

Many decisions are made based on a combination of intuition and rational considerations; clearly formalised risk assessment is concerned in principle with increasing the rational input into such processes.

Intuitive approaches may be less reliable for decisions concerned with major investment or with very long-term implications; it would seem logical that no management team could genuinely have already had very significant experience with large numbers of very similar or identical projects over their full life cycle.

On the other hand, it is probably fair to say that intuition is generally the dominant force in terms of how decisions are made in practice:

- A course of action that "feels" wrong to a decision-maker (but is apparently supported by rational analysis) is unlikely to be accepted. Similarly, a course of action that "feels right" to a decision-maker will rarely be rejected, even if the analysis would recommend doing so; rather, in each case, invariably one would search for factors that have been incorrectly assessed (or omitted) from the rational approach. These may include important decision criteria that were overlooked, or other items that a team conducting the analysis was not aware of, but which were relevant from a decision-maker's perspective.

- In most business situations, there will almost always be some characteristics that are common from one project to another (otherwise the company may be straying from its core competence), and hence intuitive processes have some role. As a result, even where the use of rational approaches would seem appropriate (e.g. major investments, expansion or restructuring projects), such approaches may not receive the priority and attention that they deserve.
- The rational approaches are more complex to implement, requiring higher levels of discipline, extra time and potentially other investments; intuitive processes require less effort, and match many people's inherent personal preference for verbal communication and rapid action. In this context, some well-known quotes come to mind: "Opinion is the medium between knowledge and ignorance" (Plato), and "Too often we enjoy the comfort of opinion without the discomfort of thought" (John F. Kennedy).
- However much rational analysis has been conducted, management judgement (or intuition) will typically still need to play an important role in many decisions: very few situations can be understood perfectly, with all factors or risks identified and correctly captured. For example, some qualitative factors may not have been represented in the common terms required for a quantitative model (i.e. typically in financial terms). In addition, and as a minimum, there will always be some "unknown unknowns" that decision-makers need to be mindful of.

Thus, ideally a robust and objective rational analysis would help to develop and inform a decision-maker's intuition (especially in the earlier stages of a decision process), and also to support and reinforce it (in later stages). Where there is a mismatch between the intuition of a particular decision-maker and the results of a rational analysis, in the first instance, one may look for areas where the rational analysis is incomplete or based on incorrect assumptions: there could be factors that are important to a decision-maker that an analytic-driven team is not aware of; ideally these would be incorporated as far as possible in revised and more robust rational analysis. On the other hand, there may be cases where even once such factors are included, the rational and intuitive approaches diverge in their recommendations. This may lead one to be able to show that the original intuition was incorrect and also to the drivers of this; of course, generally in such cases, there may be extra rounds of communication that are required with a decision-maker to explain the relevant issues. In other words, genuinely rational and objective analysis should be aligned with intuition, and may serve to modify understanding and generate further intuition in parallel.

1.2.2 The Presence of Biases

The importance of intuitive decision-making, coupled with the presence of potential biases, will create yet more challenges to the implementation of rational and disciplined approaches to risk assessment. Biases may be thought of as those that are:

- Motivational or political. These are where one has some incentive to deliberately bias a process, a set of results or assumptions used.
- Cognitive. These are biases that are inherent to the human psyche, and often believed to have arisen for evolutionary reasons.
- Structural. These are situations where a particular type of approach inherently creates biases in the results, as a result of the methodology and tools used.

Motivational or political biases are common in many real-life decision situations, often resulting in optimistic scenarios being presented as a base case, or risks being ignored, for many reasons:

- The benefits and cost may not have unequal or asymmetric impacts on different entities or people. For example, project implementation may allow (or require) one department to expand significantly, but may require another to be restructured.
- "Ignorance is bliss." In some cases, there can be a lack of a willingness to even consider the existence of risks. There are certainly contexts in which this reluctance may be justified (in terms of serving a general good): this would most typically apply where the fundamental stability of a system depends on the confidence of others and credibility of actions, and especially where any lack of confidence can become detrimental or self-fulfilling. In such cases, the admission that certain risks are present can be taboo or not helpful. For example:
  - A banking regulator may be reluctant to disclose which institutions are most at risk from bankruptcy in the event of a severe economic downturn. The loss of confidence that may result could produce a run on the bank, in a self-fulfilling cycle (in which depositors withdraw their money due to perceived weakness, which then does weaken the institution in reality, and also may have a knock-on effect at other institutions).
  - A central bank (such as the European Central Bank) may be unwilling to publicly admit that certain risks even exist (for example, the risk of a currency break-up, or of one country leaving the eurozone).
  - Generally, some potential credit (or refinancing) events may be self-fulfilling. For example, a rumour (even if initially false) that a company has insufficient short-term funds to pay its suppliers may lead to an unwillingness on the part of banks to lend to that company, thus potentially turning the rumour into reality.
  - A pilot needing to conduct an emergency landing of an aeroplane will no doubt try to reassure the passengers and crew that this is a well-rehearsed procedure, and not focus on the risks of doing so. Any panic within the passengers could ultimately be detrimental and hinder the preparations for evacuation of the aircraft, for example.
- Accountability and incentives. In some cases, there may be a benefit (or perceived benefit) to a specific party of underestimating or ignoring risks. For example:
  - In negotiations (whether about contracts, mergers and acquisitions or with suppliers), the general increased information and transparency that is associated with admitting specific risks exist could be detrimental (to the party doing so).
  - Many publicly quoted companies are required to make a disclosure of risks in their filing with stock market regulators. Generally, companies are reluctant to provide the information in any more detail than is mandated, in order not to be perceived as having a business that is more risky than competitors; a first-mover in such disclosure may end up with a consequential drop in share price. Therefore, such disclosures most typically are made at a very high level, are rather legalistic in nature and generally do not allow external analysts to truly understand or model risks in the business in practice.
- "Don't worry, be happy" (or "We are too busy to (definitely) spend time considering things that may never happen!" or "You are always so pessimistic!"). In a similar way to the "ignorance is bliss" concept, since identified risks are only potential, and may never happen, there is often an incentive to deny that such risks exist, or that they are not material, or to insist that they can be dealt with on an *ad hoc* basis as they arise. In particular, due to implementation time and other factors, it is often the case that accountability is only

considered at much later points in time (perhaps several years); by which time the truly accountable person has generally moved to a different role, been promoted, or retired. In addition, defenders of such positions will be able to construct arguments that the adverse events could not have been foreseen, or were someone else's responsibility, or were due to non-controllable factors in the external environment, and so on. Thus, it is often perceived as being more beneficial to deny the existence of a problem, or claim that any issues would in any case be resolvable as they arise. For example:

- A senior manager or politician may insist that a project is still on track despite some indications to the contrary, although the reality of the poor outcome is only likely to be finally seen in several years or decades.
- A manager might not admit that there is a chance of longer-term targets being missed or objectives not being met (until such things happen).
- A project manager might not want to accept that there is a risk of a project being delivered late, or over budget, or not achieving its objectives (until the events that provoke it actually occur).
- Management might not want to state that due to a deterioration in business conditions there is a risk that employees will be made redundant (until it actually happens).
- A service company bidding for a contract against an established competitor may claim that they can provide a far superior level of service at a lower cost (implicitly ignoring the risks that this might not be achievable). Once the business has been secured, then "unexpected" items start to occur, by which time it is too late to reverse the contract award. Unless the negotiated contracts have clear service-level agreements and penalty clause elements that are adequate to compensate for non-delivery on promises, such deliberate "low balling" tactics by potential suppliers may be rational; on the other hand, if one bids low and is contractually obliged to keep to that figure, then a range of significant difficulties could arise, so that such tactics may not be sensible.
- Often clauses may exist in contracts that would only apply in exceptional circumstances (such as if consequential damages may be sued for if a party to the contract delivers a performance that is materially below expectations). During contract negotiations, one or other party to the contract may insist that the clause should stay in the contract, whilst maintaining that it would never be enforced, because such circumstances could not happen.

Specific examples that relate to some of the above points (and occurred during the time at which this book was in the early stages of its writing) could be observed in relation to the 2012 Olympic Games in London:

- The Games were delivered for an expenditure of approximately £9bn. The original cost estimate submitted to the International Olympic Committee was around £2bn, at a time when London and Paris were in competition to host the games. Shortly after the games were awarded to London in July 2005, the budget estimate was revised to closer to £10bn, resulting (after the Games) in many media reports stating that they were "delivered within budget". Some of the budget changes were stated as being due to heightened security needs following a major terrorist attack that occurred in London shortly after the bid was awarded (killing over 50 people). Of course, one can debate such reasons in the context of the above points. For example, the potential terrorist threat was already quite clear following the Madrid train bombings of 11 March 2004 (which killed nearly 200 people),

the invasion of Iraq in 2003, and the attacks in the United States of 11 September 2001, to name a few examples; security had also been a highly visible concern during the 2004 Athens Olympics. An external observer may hypothesise that perhaps a combination of factors each played a role to some extent, including the potential that the original bid was biased downwards, or that the original cost budget had been estimated highly inaccurately. In any case, one can see the difficulty associated with assigning definitive responsibility in retrospect, and hence the challenge in ensuring that appropriate decisions are taken in the first place.

- A private company had been contracted by the UK government to provide the security staff for the Games; this required the recruitment and training of large numbers of staff. Despite apparently having provided repeated reassurances that the recruitment process for the staff was on track for many months, at the last minute (in the weeks and days before the Games) it was announced that there was a significant shortfall in the required staff, so that several thousand soldiers from the UK Armed Forces were required to step in. An external observer may hypothesise that the private company (implicitly by its actions) did not perceive a net benefit to accepting or communicating the existence of the risk of non-delivery until the problem became essentially unsolvable by normal means.

Cognitive biases are those that are often regarded as resulting from human beings' evolutionary instinct to classify situations into previously observed patterns, which provides a mechanism to make rapid decisions (mostly correctly) in complex or important situations. These include:

- Optimism. The trait of optimism is regarded by many experts as being an important human survival instinct, and generally inherent in many individual and group processes.
- Bias to action. Management rewards (both explicit and implicit) are often based on the ability to solve problems that arise; much rarer is to create rewards around lack of action, or for the taking of preventive measures. The bias to action rather than prevention (in many management cultures) can lead to lack of consideration of risks, which are, after all, only potential and not yet tangibly present.
- Influence and overconfidence. This refers to a belief that we have the ability to influence events that are actually beyond our control (i.e. that are essentially random). This can lead to an overestimation of one's ability to predict the future and explain the past, or to an insufficient consideration of the consequences and side effects. A poor outcome will be blamed on bad luck, whereas a favourable one will be attributed to skill:
  - A simple example would be when one shakes dice extra hard to try to achieve certain numbers.
  - People may make rapid decisions about apparently familiar situations, whereas in fact some aspect may be new and pose significant risks.
  - Arguably, humans are reasonable at assessing the effects of, and managing, individual risks, but much less effective at assessing the effects and combinations when there are multiple risks or interdependencies between them, or where the behaviour of a system (or model) output is of a non-linear nature as its input values are altered.
- Anchoring and confirmation. This means that the first piece of information given to someone (however misleading) tends to serve as a reference point, with future attitudes biased to that point. New information becomes selectively filtered to tend to try to reinforce

the anchor and is ignored or misinterpreted if the information does not match the pre-existing anchor. One may also surmise that many educational systems (especially in the earlier and middle years) emphasise the development of students' ability to create a hypothesis and then defend this with logic and facts, with at best only a secondary focus on developing an enquiring mind that asks why an analysis or hypothesis may be wrong. The bias of confirmation describes that there is typically more focus on finding data that confirm a view than in finding data to disprove or question it.

- Framing. This means the making of a different decision based on the same information, depending on how the situation is presented. Typically, there is a different behaviour when faced with a gain versus when faced with a loss (one is more often risk seeking when trying to avoid losses, and risk averse when concerned with possible gains):
  - A consumer is generally more likely to purchase an item that is reduced in price from $500 to $400 (that is, to "save" $100), than to purchase the same item if it had always been listed at $400.
  - An investor may decide to retain (rather than sell) some shares after a large fall in their value, hoping that the share price will recover. However, when given a separate choice as to whether to buy additional such shares, the investor would often not do so.
  - Faced with a decision whether to continue or abandon a risky project (after some significant investment has already been made), a different decision may result depending on whether the choice is presented as: "Let's continue to invest, with the possibility of having no payback" (which is more likely to result in the project being rejected) or "We must avoid getting into a situation where the original investment was wasted" (which is more likely to result in a decision to continue).
  - Framing effects also apply in relation to the units that are used to present a problem. For example, due to a tendency to think or negotiate in round terms, a different result may be achieved if one changes the currency or units of analysis (say from $ to £ or €, or from absolute numbers to percentages).
- Incompleteness. Historical data are inherently incomplete, as they reflect only one possible outcome of a range of possibilities that could have occurred. The consequence is that (having not observed the complete set of possible outcomes) one assumes that variability (or risk) is lower than it really is. A special case of this (sampling error) is survivorship bias (i.e. "winners" are observed but "losers" are not). For example:
  - For stock indices, where poorly performing stocks are removed from the index to be replaced by stocks that have performed well, the performance of the index is overstated compared to the true performance (which should use the original basket of stocks that made up the index, some of which may now be worthless).
  - Similarly, truly catastrophic events that could have wiped out humanity have not yet occurred. In general, there can be a failure to consider the possible extremes or situations that have never occurred (but could do so in reality), specifically those associated with low probability, large impact events. Having said that (as discussed in Chapter 2) the consideration and inclusion in analysis of truly rare events (especially those that are, in principle, present in any project context, such as an asteroid destroying life on the planet) are probably in general not relevant to include in project and business risk assessments, or for management decision-making.
- Group think. A well-functioning group should, in principle, be able to use its diversity of skills and experience to create a better outcome than most individuals would be able to. However, very often, the combination of dominant characters, hierarchical structures, an

unwillingness to create conflict, or a lack of incentive to dissent or raise objections, can instead lead to poorer outcomes than if decisions had been left to a reasonably competent individual. The fact that individual failure is often punished, whereas collective failure is typically not, provides a major incentive for individuals to "go with the pack" or resort to "safety in numbers" (some argue this provides part of the explanation for "bubbles" and over-/underpricing in financial markets, even over quite long time periods).

Structural biases are where particular types of approach inherently create bias in the results, independently of psychological or motivational factors. An important example is a static model populated with most likely values that will, in general, not show the most likely value of the true output range (the "fallacy of the most likely", as discussed in Chapter 4). Key driving factors for this include non-symmetric distributions of uncertainty, non-linear model logic or the presence of underlying event risks that are excluded from a base assumption. The existence of such biases is an especially important reason to use risk modelling; paraphrasing the words of Einstein, "a problem cannot be solved within the framework that created it", and indeed the use of probabilistic risk techniques is a key tool to overcoming some of these limitations.

1.3 KEY DRIVERS OF THE NEED FOR FORMALISED RISK ASSESSMENT IN BUSINESS CONTEXTS

Generally, risk assessment will be useful where there is a significant level of investment (i.e. non-reversible commitments in money, time, resources or reputation), and where there is inherent uncertainty (as there usually is in any future situation). More specifically, the key drivers of the need for formalised risk assessment in business contexts include:

- The complexity of typical projects.
- The size and scale of the decisions, in terms of financial and other resource commitments.
- To provide support to the procedures required to identify and authorise mitigation actions, or to change project structures, and to assign responsibilities for executing the required measures.
- Corporate governance requirements, both in a formal sense relating to specific guidelines or regulations, and in the sense of optimising executive management and decision-making, i.e. to make decisions that are the best ones that can be made, are not just adequate, and create some competitive advantage.
- The frequent need to support decisions with quantified analysis.
- The need to be able to reflect risk tolerances in decision-making and in business portfolio design, and to be able to compare projects of different risk profiles.

These are discussed individually below.

1.3.1 Complexity

Clearly, as projects become more complex, the potential increases as informal or intuitive risk assessment processes become inadequate, with risks overlooked or underestimated. On the other hand, in some cases, an intuitive awareness that one may be underestimating risks

may – in the absence of a more formalised process – be overcompensated by planning with excessive contingency or pessimism; this can also be detrimental (discussed further in Chapters 4 and 5).

The notion of complexity may take several forms:

- Technical complexity, or the level of specialist knowledge required. A business project will often involve issues of a technical nature that cannot be fully understood, dealt with or mitigated without the involvement of experts.
- Organisational complexity. The cross-functional nature of many business projects means that one must rely on inputs from a wide variety of people of different expertise. In some cases, there may also be third-party resources, contractors, partners or government departments involved.
- Interactions. Even where individual risks are identified and managed reasonably well using informal approaches, the possible effects of a large number of risks on the key aggregate metrics of project success (cost, time, quality, etc.) are hard to estimate by purely intuitive methods; this is even more the case when there are interdependencies between them, such as the knock-on effects on other project tasks if one particular activity is delayed. Such interactions can easily be overlooked, but – even where identified – their existence can make it more challenging to develop an understanding of the aggregate impacts of risks, and to correctly assess the value of various mitigation measures. Formal processes and the appropriate tools can help to address such issues in a more robust and transparent manner.
- Lack of previous experience with certain key elements. The more experience with similar situations one already has, the less is the level of complexity: if all elements of a project were essentially identical to those in many other already-implemented projects, then prior experience should be invaluable in designing projects and optimising their risk profile. On the other hand, where a project has non-standard components (e.g. in terms of technical, product, geographic, legal, regulatory, environment, team resources, or the requirement for the involvement for a wider than usual set of organisational departments), then there is a higher likelihood that it contains risks that may be overlooked or underestimated. Even where previous experience exists, an excessive reliance on it can have pitfalls because:
  - The time and place are different, and contextual circumstances are likely to have changed in some way.
  - The fact that risks did not materialise in earlier projects does not mean that they (the same or similar items) cannot happen in similar current projects.
  - It is easy to underestimate new factors that may be involved, unless proper consideration is given to trying to identify them. For example, a company may have successfully launched a new product in one European country and then finds that its launch in another country fails due to cultural, legal or local regulatory requirements that could have been anticipated and mitigated with a more formal assessment, including research and information gathering.

1.3.2 Scale

In practice, larger projects are typically more complex (or risky) than smaller ones, although this does not need to be the case, at least in theory. In addition, where a project is large (even if it is apparently "simple", such as the undertaking of a major construction project using a

prefabricated template), then the consequences of the materialisation of an unforeseen risk may be too large to be absorbed within the available budget, whereas similar risks in smaller projects could be absorbed without undue attention. In this sense, of course, the concept of scale is a relative one, depending on the context and organisation concerned.

1.3.3 Authority and Responsibility to Identify and Execute Risk-Response Measures

Measures to respond to risk can include changes to project scope, structures, deliverables, timelines, budgets, targets and objectives. In many personal situations, the individual concerned can make decisions related to such topics without reference to others. In contrast, in organisations and businesses (and in some personal situations) such actions would almost always require authorisation from others, typically from more senior management. In addition, project collaborators within the organisation, as well as third parties (external agencies, contractors, etc.), may also be impacted by any changes. Therefore, significant communication, negotiation and coordination are often required. Indeed, even fairly simple or common-sense risk measures may require significant analysis in order to prepare the groundwork for formal authorisation processes. The particular contexts in which this is mostly likely include:

- If the benefits of risk-response actions are "external" or highly asymmetric, such as where the costs of risk mitigation are borne by one department, but the benefits may accrue to another department or project.
- If changes are required to organisational processes, budgets, targets, timelines, quality or other performance indicators, or to contractual or other relationships with third parties.
- If the identification of risks may potentially expose issues of a political or motivational nature, for example if problems are uncovered that should have already been addressed within normal work, or if a lack of expertise capability or competence would be highlighted.

In such contexts, formalised risk assessment processes will support the activities of a project team by creating robustness in the analysis, in the assessment of the cost–benefit trade-offs, and will increase objectivity and transparency.

1.3.4 Corporate Governance Guidelines

There is an increasing requirement for decisions within businesses to be supported by formal governance processes, particularly in publicly-quoted (listed) companies, where management is ultimately responsible to shareholders, and not to themselves. One may think of governance issues in two categories:

- Mandated governance requirements and guidelines.
- Processes that enhance general organisational effectiveness and competitive advantage (see later).

A complete description of published governance guidelines is beyond the scope of this text: their focus is typically on structured frameworks and processes to manage risk (especially

operational risk) and less on the details of modelling issues and associated challenges. Here, we simply highlight a few examples from various contexts; the interested reader can no doubt easily find others by general internet or other searches:

- The UK Combined Code on Corporate Governance. This sets out standards of good practice in relation to Board leadership and effectiveness, remuneration, accountability and relations with shareholders. Certain listed companies are required to explain in their annual report and accounts how they have applied the Code. The Code includes the following (June 2010 edition):
  - "Every company should be headed by an effective Board, which is collectively responsible for the success of the company … The Board's role is to provide entrepreneurial leadership within a framework of prudent and effective controls which enables risk to be assessed and managed …"
  - "The Board should be supplied in a timely manner with information in the form and of a quality appropriate to enable it to discharge its duties. All directors should … regularly update and refresh their skills and knowledge."
  - "The Board is responsible for determining the nature and extent of the significant risks it is willing to take in achieving its strategic objectives. The Board should maintain sound risk management and internal control systems."
- The Corporate Governance Council of the Australian Stock Exchange publishes Corporate Governance Principles and Recommendations (or Principles), of which Principle 7 concerns recognising and managing risk. Selected sections (2nd edition, 2010) state:
  - "Risk management is the culture, processes and structures that are directed towards taking advantage of potential opportunities while managing potential adverse effects."
  - "Companies should establish policies for the oversight and management of material business risks and disclose a summary of those policies."
  - "The Board should require management to design and implement the risk management and internal control system to manage the company's material business risks and report to it on whether those risks are being managed effectively. The Board should disclose that management has reported … the effectiveness of the company's management of its material business risks."
- The Sarbanes–Oxley Act (2002) requires management to certify the accuracy of financial information of companies listed on US exchanges. The guidelines cover issues relating to risk assessment and internal controls, rather than management decision-making.
- A number of other organisations have provided guidelines, recommendations and standards relating to risk assessment and its methods. A few examples include:
  - The International Organization for Standardization (ISO) has published ISO 31000 Risk Management – Principles and Guidelines and 31010 Risk Management – Risk Assessment Techniques. The British Standards Institution (BSI) has published BS 31200:2012 Risk Management: Code of practice and guidance for the implementation of BS ISO 31000, and other works.
  - The Institute of Risk Management (IRM), the Association of Insurance and Risk Managers (AIRMIC), Alarm (the Public Risk Management Association) the Federation of European Risk Management Associates (FERMA) and the Committee of Sponsoring Organizations (COSO) each regularly publishes documents, such as COSO Enterprise Risk Management – Integrated Framework. Each provides guidance on risk

management processes and controls for management. The PRMIA (Professional Risk Managers' International Association) also publishes on a number of similar topics.

1.3.5 General Organisational Effectiveness and the Creation of Competitive Advantage

Of course, organisations will not succeed simply by following mandated guidelines: of utmost importance is the ability to create, identify and exploit opportunities that are aligned with strategy, create value and have some competitive differentiation. According to financial theory, in efficient markets, higher risks should be associated with higher returns only where such risks cannot be reduced economically efficiently or diversified away: the taking of risk *per se* is not rewarded. In contrast to many personal situations (for which the making of an "adequately good" decision is usually sufficient) organisations exposed to high levels of competition will need to perform to a superior standard, and to create opportunities, structure projects and make decisions that are (close to) the best possible ones available.

Formalised risk assessment can support effectiveness in these areas in several ways:

- Supporting the consideration of a full range of decision options.
- Helping to ensure that the opportunities being considered are value-creative and structured optimally.
- Ensuring that decisions are supported by robust rational analysis and data, and are appropriately transparent.
- Ensuring more transparent trade-offs and appropriate risk tolerances in decision-making.
- Reducing biases in analysis and in decision-making.
- Ensuring that project execution risks are appropriately considered within decision evaluation processes, as well as within the detailed implementation projects.

1.3.6 Quantification Requirements

Businesses almost always require that important decisions are supported with fairly detailed quantitative analysis. Risk assessment can be used to support this in many ways:

- Reflecting the reality that the situation inherently contains risk and uncertainty.
- Providing a structured process to ensure that all relevant factors are included in the analysis and quantitative model.
- Understanding the range of possible outcomes, and generating an understanding of how likely a particular (e.g. "base") case is to be achieved, and what modifications are required (e.g. to targets, inclusion of contingencies, implementation of risk-response measures, or development of new structural options).
- Enhancing the ability to compare projects with different risk profiles, and to support the development of optimal business portfolios.
- Allowing risk tolerances to be made explicit, reflected in decision-making and to be done in a way that is aligned with organisational objectives (see below for further discussion).
- Increasing transparency, reducing biases and supporting the achievement of the appropriate balance between intuition and rationality in decision-making.

1.3.7 Reflecting Risk Tolerances in Decisions and in Business Design

Robust decision-making in business contexts requires a consideration of risk tolerances:

- Corporate governance. Shareholder demands for appropriate risk taking (to create rewards for equity investors by taking appropriate risk) need to be reflected in decision-making and in project selection: in theory (and practice), some companies should be more risk seeking than others, but it would seem difficult for a company to appropriately manage its risk profile without knowing and measuring (quantitatively) how much risk is being taken. Instead, very often, such processes remain intuitive, non-transparent and elusive, and are likely to be suboptimal.
- Consistency. Without a formal consideration of risk tolerances, a decision that would be authorised on one occasion may not be authorised on another. Thus, in one instance a project that is high risk/high reward may be favoured over a lower risk/lower reward one, whereas in similar circumstances on another occasion the reverse would be the case. This may be due to the presentation or framing of the decision, or to short-term inconsistencies and fluctuating optimism or pessimism that occur in day-to-day behaviours when formal processes are not put in place.
- Business portfolio optimisation. Most businesses can be considered as portfolios of components (e.g. customers, geographies, projects or products). As such, there is an optimisation aspect to the appropriate business design and strategic choices, with an optimal portfolio consisting of a combination of components with different profiles, so that some elements balance out against others.

Given these drivers, the application of a formalised risk analysis process in many business situations is likely to create significant benefits in terms of the quality of the final decision.

1.4 THE OBJECTIVES AND USES OF GENERAL RISK ASSESSMENT

Risk assessment processes and tools are already widely used in some business contexts. Typical applications include general planning and forecasting (e.g. revenue and capital expenditure, financing needs), cost estimation and contingency planning, project schedule uncertainty, portfolio structuring and optimisation, valuation of the flexibilities associated with being able to respond to uncertain outcomes or of gaining additional information (such as real option analysis), and general decision-making under uncertainty. Such applications apply to essentially any sector; key examples include oil, gas, energy, resources, construction, pharmaceuticals, insurance, reinsurance and finance.

Of course, formalised risk assessment is much more than simply "expecting the unexpected" by identifying possible risk factors in advance. Ultimately, the overall objective is to enhance organisational performance through superior project design, selection, decision-making and management. In particular, the essential role of risk assessment is to support the development and choice of the optimal context in which to operate (operating within the best structural context, and mitigating and responding to risks within it in the best way), and to support the evaluation of a final decision within that context by taking into account the residual

uncertainty and risk tolerances of the decision-maker. This may be achieved through more specific objectives, which are generally of several forms:

- Adapting and improving the design and structure of plans by managing, mitigating or exploiting uncertainties.
- Achieving optimal project structures and economically efficient risk mitigation.
- Enhancing decision-making concerning project evaluation, objectives and target setting, contingency planning and the reflection of risk tolerances within the decision-making processes.
- Managing project execution and implementation effectively.
- Constructing, selecting and optimising business portfolios.
- Supporting the creation of strategic options and corporate planning.

1.4.1 Adapt and Improve the Design and Structure of Plans and Projects

Perhaps the main role of risk assessment is to enhance a particular set of (original) plans to include risk mitigation, management or response measures:

- The identification of risks, and the generation of an understanding of their interactions, dependencies and likely significance, drives the identification and development of possible response actions.
- In this way, plans are improved, both reducing adverse risks and exploiting upsides (such as operational or strategic flexibilities), with such actions, and their effects, costs and benefits, being included in a revised plan.

Much benefit can often be achieved even when such processes are only of a qualitative nature, because key individual risks would nevertheless typically be identified, and some consideration of possible risk-response actions would be undertaken. However, quantitative approaches will provide a much larger set of benefits, as discussed later in the text.

1.4.2 Achieve Optimal Risk Mitigation within Revised Plans

When considering the structure of a project or plan, there are generally many possible risk-response measures available. Some risk items are more controllable (or exploitable) than others, and the cost of doing so will be different for each. For example, the variation in oil prices may be essentially uncontrollable (there may be possibilities to hedge or engage in forward contracts in the short term, but in the medium term the impact on a business is typically largely uncontrollable).

In general, one may prioritise and implement measures in some order driven by a cost–benefit analysis of each one, and after implementing some of them, one would arrive at a point where the use of further measures is not economically efficient. For example, the risk of having an accident when crossing the road is rapidly reduced when low-cost measures are implemented (such as looking each way, or perhaps wearing running shoes or reflective clothing) but in many cases it would not be economically efficient, or practical, to eliminate the risk entirely (by having a bridge built): the marginal risk reduction that would be achieved

by such a measure cannot be justified by the marginal cost increase that would be needed to implement it.

There may also be interaction between any such measures, so that there may be some measures that would make (economic) sense in isolation, but would not make sense within the wider context of a set of measures. Indeed, whether a particular measure makes sense may depend on which other measures are implemented first.

Further, in practice, risk-response actions may also affect multiple metrics (or line items in a model), so that the making of the appropriate trade-off between them may be non-trivial.

Thus, although the choice of measures to implement could be considered as a quantitative optimisation problem, the use of such approaches in these contexts is usually limited by practical considerations; a mixture of judgement, pragmatic considerations and some basic quantitative analysis is usually sufficient to find a mix of measures that is (close to) optimal.

1.4.3 Evaluate Projects, Set Targets and Reflect Risk Tolerances in Decision-Making

Once the "risk-optimised" structure has been found, there is still generally residual risk; some risks will not be economically effective to eliminate, even where doing so would be possible. One is still exposed to potentially adverse outcomes, so that the ultimate outcome may not be satisfactory (of course, the chance of a satisfactory outcome should increase as a result of the risk assessment activities).

Nevertheless, it is still of fundamental relevance to understand the extent of residual (or non-controllable) risk that remains after all worthwhile measures (or decisions) have been implemented: the range of possible outcomes will help to establish whether to proceed or not with a particular decision, or to inform the process of modifying targets and setting contingencies. For example, before a decision is made, one may typically wish to know the average outcome, as well as the best or worst 10% of cases for key metrics (such as sales, cost, cash flow). Risk tolerances therefore come into play when the final decision is being made: one person may reject a decision that has a 10% chance of a significantly bad outcome (even if all other outcomes would be highly favourable), whereas another person may choose to proceed, in order to generally benefit from the mostly positive outcomes.

1.4.4 Manage Projects Effectively

Risk assessment also has a key role to play in project management and execution. For example, one may wish to analyse potential risks relating to the schedule, potential delays, specific cost items or on-specification delivery. To some extent, such activities are a continuation of those that may have been initiated at project design and conception: risk considerations relating to project execution should ideally be reflected in the earlier stages of conception and basic design; projects that are expected to be more complex to execute than others should be evaluated less favourably.

However, in practice it is not possible to fully take into account all project execution risks at the earlier stages of project conception:

- Very often, following authorisation, a much more detailed planning procedure is undertaken prior to (or as part of) the implementation: items such as detailed technical planning, obtaining quotes from several suppliers for all outsourced items, conducting contractor

negotiations, planning internal resources and making resource trade-off decisions can really only be conducted once decisions to proceed have been finally made.
- In the time period between the authorisation and the implementation of a decision, the external environment may have altered (such as a change in regulations issued by the government, or other risk events materialize, which alter the best possible future course of action). There may often be some change to the scope, or other changes that may have occurred.
- The project may inherently contain phases (or decision gates), where future activities within the project may need to be adapted as the project proceeds; examples include exploration, appraisal and development projects in the oil, gas and resource sectors, as well as in pharmaceutical development.

1.4.5 Construct, Select and Optimise Business and Project Portfolios

Most businesses are portfolios of activities or other elements in some way. For example, sales revenues are the sum of those of different product lines, regions, business units, customers, geographies, projects or assets. In general, the constituent components typically have different characteristics in terms of their implications for key business metrics, such as growth rates, capital investment requirements, project delivery timeframe, cost, cash flow, return on capital, etc. (as well as for their associated risks):

- Mature projects (or products that may be generating a fairly dependable stream of revenues or cash flow) may require little ongoing investment or development activity.
- Projects currently in the implementation phase may require significant amounts of cash investment: whilst not yet producing revenues, these may nevertheless be of medium risk, in the sense that future revenues and cash flow may be uncertain, subject to uncontrollable factors, or to overruns in capital expenditure, or to implementation delays.
- Projects in research or early-stage development may currently require fairly small investments, but their success or failure (and associated timeframe) may be crucial to the medium-term performance or to the long-term survival of the business; in that sense, these projects may be considered highly risky.
- There may also be existing joint ventures, potential acquisition possibilities, and so on; each will have its own specific risk profile for key metrics.

In addition, there will be some issues that are important at a corporate (or aggregate) level, even though such issues may be less relevant at the level of individual projects. For example:

- Generally, issues concerning corporate cash flow, financing, debt and equity structures, treasury and tax have to be dealt with at the corporate level, even though the aggregate corporate position is driven by individual projects.
- Although individual projects within a set of investment projects may appear to make sense on a stand-alone basis (for example, each may have a highly positive net present value, resulting from some initial investment and then a series of positive cash flows), in aggregate, the investment requirements for the full set of projects may be too high to allow them all to be implemented simultaneously. There could also be non-financial

constraints to their simultaneous implementation, such as technical expertise or material resources.

- Holding a portfolio of "high risk/high return" projects may be acceptable, even if – when viewed in isolation – each individual project would likely be judged as too risky. For example, a project with a 30% chance of success (creating a net gain of $100m), and a 70% chance of failure (creating a net loss of $10m), will have a positive (weighted) average net gain of $23m (i.e. $0.3 \times 100 – 0.7 \times 10$). On a stand-alone basis, one may wish to avoid the possibility of a $10m loss; however, as part of a portfolio, the project may be acceptable:
  - As part of a mixed portfolio of stable cash-generative projects (whose cash flow could be used to cover the investment of the newer projects, or of any additional costs resulting from unexpected events), the single project may also be acceptable.
  - If the project were shared with partners, in order to reduce the effective investment and exposure to losses, one could still partly benefit from the average positive nature of the project whilst reducing the downside losses proportionally.
  - A large portfolio of similar but independent projects would be profitable not only on average, but also in almost all cases. For example, given 100 such projects, it is very likely that outcomes close to the average would be observed in most cases, i.e. close to 30 successes and 70 failures. Since the benefits of success easily outweigh the cost of failure, such a portfolio would be attractive in general, as success at the portfolio level is almost guaranteed (providing that there is financing available to cover early failures). Figure 1.1 shows the distribution of the number of successful projects, such as that in 77% of cases the number of successes is between 25 and 35 inclusive (the details of such analyses are discussed later in the text).

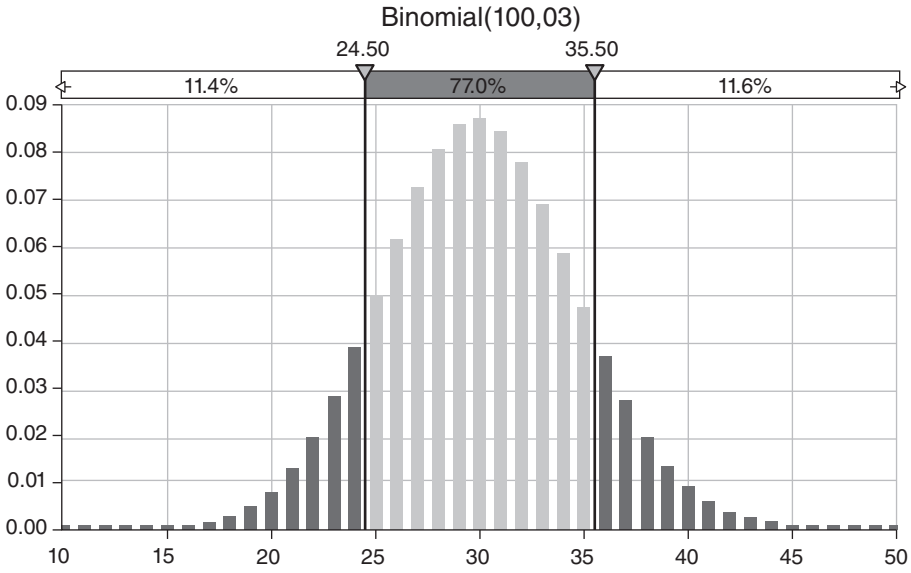

FIGURE 1.1 Number of Successful Projects out of 100, Each with Probability of Success Equal to 30%

Risk assessment (and uncertainty analysis) can have a number of applications in the construction, adaptation and optimisation of project portfolios, to help to ensure that business growth or other objectives are met:

- Identify, for any assumed portfolio, how likely it is that corporate objectives and targets would be achieved with that portfolio:
  - Identify whether new projects or different activities are required; this is related to the development of strategic options, which is covered separately below.
  - Understand the level of "natural diversification" within it: for example, where cash-producing projects can cover the financing of key investments, so that new calls to financing are not required at the corporate level.
  - Understand the level of residual uncertainty within the portfolio, to ensure it is appropriate and in line with risk tolerances. For example, equity investors generally expect that the business will take some level of risk, but one that is appropriate for its strategic positioning and which is in line with reasonable expectations for a business of that nature.
- Ensure that commonalities across portfolio elements are correctly evaluated:
  - Common risks could be related to technology, exchange rates, regulatory regimes, price levels, input costs, and so on. A risk that is common to all projects or business units may be important at the corporate level but may only appear to be of medium importance at the project or business unit level.
  - In general, dependencies between the portfolio elements need to be captured correctly in order to avoid either excess or insufficient diversification of the portfolio.
- Optimise project contingencies within a corporate context:
  - Individual project contingencies, when added up at the corporate level, could be significantly too high (or significantly too low), depending on the contingency level planned for each component (see Chapter 4).
  - The issue of balancing the amount of contingency to hold at the level of an individual item versus at an aggregate organisational level is perhaps one of the most challenging issues in practice, and has implications for organisation design (e.g. issues of centralisation and decentralisation), authorisation processes and project management.
- Have a framework to compare and evaluate projects with different risk profiles. For example:
  - It is clearly more risky to drill for oil in the sea bed of a new unexploited area, where the water is deep and complex engineering and technology is required, than to do so in shallow water using existing technologies: the first may be higher risk with potentially higher reward, and the latter may have lower risk with lower likely reward.
  - One decision could be preferable over another, depending on the context and criteria used: a higher risk option may sit well within a large portfolio of mature projects, where one may be aiming to use new projects to achieve growth objectives. A lower cost and lower risk option may be more appropriate if failure of a larger (potentially higher reward) project could lead to bankruptcy of the company, or if the company's (or its shareholders') risk profile or tolerance are such that it is not willing to take such risks for other reasons.
  - A risk assessment provides a framework to estimate the impact of each decision option and its possible outcomes, so that one can make a more informed and appropriate

judgement about which option is best (rather than perhaps relying mainly on gut feel, intuition or suboptimal simplifications).

As agents of shareholders, management should understand the corporate risk profile and behave in alignment with it: thus, residual risk exposure, shareholders' risk expectations and corporate risk tolerances should all be considered within the process of project evaluation, selection and portfolio construction. A project should be evaluated based not only on its individual merit, but also on its fit within the business portfolio, and on its contribution and effect on aggregate risk at the corporate level.

1.4.6 Support the Creation of Strategic Options and Corporate Planning

Generally speaking, the processes of strategy development and the creation of strategic options typically need to be addressed using open and creative approaches. The "changes of context" required to proactively conceive, generate or identify new structural or strategic options is typically of a different nature to the more reactive processes of risk assessment (in which generally the frame of consideration has been narrowed to some extent).

Nevertheless, risk assessment has some valuable uses in strategy development and corporate planning:

- To assess the range of possible outcomes (aggregate risk) in a portfolio of business projects.
- To set corporate and business unit targets and assess the likelihood of achieving them.
- To ensure, before selecting a final strategic option, that each has been risk optimised for its own context. For example, some options may have inherent flexibilities that are not present in others, and hence a fair comparison between the strategic options would need to properly take into account the value associated with these flexibilities (this is the topic of real options analysis, for which examples are provided later in the text).
- To assess the likelihood that current business and already-planned strategic initiatives will be sufficient (or not) to meet the company's objectives. This may identify whether further strategic, high-level or structural projects may be required to increase the likelihood of objectives being achieved.

As an example of the latter point, when using base case assumptions on project success rates, a base plan to grow revenues in the medium term through the development of new products may seem sufficient to meet the growth objectives. However, if the risk of failure or of potential delays in new product development processes is properly considered, then the base plan may, in fact, be shown to be inadequate in most cases. Thus, a company may be drawn to consider adding additional products to its portfolio, or adding new projects that are more likely to be able to be delivered in the shorter term, or to pursue acquisition, partnership or other opportunities. The consideration of such possibilities through quantitative modelling can, in fact, be fairly simple to implement at a high level (e.g. using summary figures for each key element of the portfolio, such as cash flow) whilst having major implications for the appropriate business structure and corporate planning activities.

As a specific numerical example, assuming that a company needs six successful projects to meet its business targets, where each has a 60% chance of success, then the initial plan may

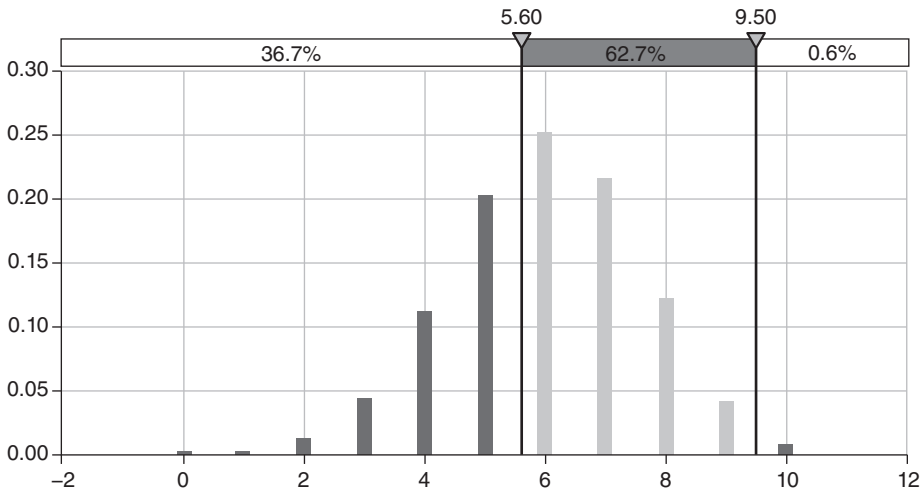

FIGURE 1.2 Number of Successful Projects out of 10, Each with Probability of Success Equal to 60%

be to conduct 10 projects (6/60%). This may appear to be a logical basis on which to base resource plans and make forecasts of future performance. However, such a portfolio would only be successful on average. Figure 1.2 shows the distribution of the number of successful projects; in particular, there is a 36.7% chance of five or fewer successes, i.e. that the targets would not be met.

If one wished instead for the chance of meeting the target (of six successes or more) to be 90% (10% chance of failure), then the number of projects would need to increase to around 13. This can be seen from the bottom table in Figure 1.3,which shows a sensitivity analysis of

	A	B	C	D
1				
2		**Initial Plan**		
3		No. Successes Required	6	
4		P(Success)	60%	
5		Estimated Number of Projects	10	=ROUNDUP(C3/C4,0)
6		Prob (Number of successes is less than required)	36.7%	=BINOMDIST(C$3-1,C5,C$4,1)
7				
8		**Revised Plan**		
9		Number of Projects	10	
10		Prob (Number of successes is less than required)	36.7%	=BINOMDIST(C$3-1,C9,C$4,1)
11		Prob (Number of successes is sufficient)	**63.3%**	=1-C10
12				
13		P(Six or More i.e. Success) Sensitivity Analysis to Number of Projects	**63.3%**	
14		10	63.3%	
15		11	75.3%	
16		12	84.2%	
17		13	90.2%	
18		14	94.2%	
19		15	96.6%	
20				

FIGURE 1.3 Number of Projects Required to have Six Successes, where Each has a 60% Probability of Success

the probability of having six or more successes depending on the number of projects engaged (once again, the detailed statistical concepts are covered later in the text).

The file Ch1.ProjectNumbers.xlsx contains the calculations in Figure 1.3, for the interested reader to explore further. Note that the assumption that each project would have the same probability of success may not be realistic in many practical cases; this provides one reason to use simulation methods to perform analogous calculations, as exact analytic solutions become harder to find in cases of unequal probabilities.