CHAPTER 1

WHY AND WHAT IS RISK MANAGEMENT?

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> The pessimist sees difficulty in every opportunity. The optimist sees the opportunity in every difficulty.
>
> —*Winston Churchill*

INTRODUCTION

Risk is something that we deal with in our daily lives. For the most part, we assess it on an unconscious level, usually out of habit. Will I get hit by a car if I cross the street? Will I burn my hand if I take a pan out of the oven without a hot pad? Will I get sunburned today if I don't put on lotion? If you are reading this paragraph now, it is probably safe to assume that you are pretty good at dealing with these mundane risks. Most of us are. This type of risk analysis is intuitive and is built upon years of experience, intuition, and instinct. Generally speaking, the decision making involved is pretty straightforward and seldom do we devote much time to our analysis. It seems that when we face risks personally, they are generally easier to deal with and we arrive at answers rather quickly.

In contrast, when risks are removed from us, they seem to take on additional complexity. This is especially true when considering decisions related to the development and delivery of construction projects. There are countless risks that such projects can encounter at any point of its lifecycle. What if the geotechnical information is wrong and the foundation collapses? What if the price of steel skyrockets two years from now when construction starts? What if it drops? What if the project's environmental document is held up in review and delays the construction bid date? To be certain, the answers to these problems are not always clear. To make matters even murkier, should such events occur, they are likely to spawn a host of other uncertainties. Thinking along these lines is at best challenging and at worst completely overwhelming.

Nassim Nicholas Taleb, one of the most articulate, and arguably the most brilliant, contemporary scholars who writes on the subject of uncertainty, has popularized the term ''Black Swan,'' which he wrote about in a book bearing the same title. A ''Black Swan,'' as defined by Taleb, possesses the following attributes:

> First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable. I stop and summarize the triplet: rarity, extreme impact, and retrospective (though not prospective) predictability. A small number of Black Swans explain almost everything in our world, from the success of ideas and religions, to the dynamics of historical events, to elements of our own personal lives.[1]

To be sure, this book is not focused on managing Black Swan events. However, it would be disingenuous, to say the least, that the contents of this book will enable the reader to avoid, or even manage Black Swans. Therefore, before we go any further, let us acknowledge that there is, and will always be, some degree of uncertainty in all endeavors that extend into the future that lay beyond our perception, whether they are Black Swans or of the more prosaic variety.

We must approach the concept of uncertainty with total honesty if we are to approach it at all. The truth is that it's impossible to predict the future, regardless of the sophistication of the analytical techniques we apply and the expertise of the personnel we bring to bear.

At this point, it is useful to think about the ways in which we should think about the analysis of risk and how this information should be integrated into the decision-making process. Let us call one approach ''risk-based'' and the other ''risk-informed'' decision making.

Risk-based decision making is predicated on making decisions solely on the numerical results of a risk assessment. This approach relies on quantitative data to make predictions. Although such an approach is seemingly stochastic in nature, it is in fact deterministic, because it must make the assumption that the analysis that generated the quantitative data is all inclusive, which, as discussed in the previous paragraphs, is not possible.

In contrast, risk-informed decision making is based on synthesizing the quantitative data gained from risk analysis, along with other factors such as the anticipated benefits, functional performance, and political considerations, to name a few. This approach relies on using quantitative data to develop insights that will lead to improved decision making in the face of uncertainty. The quantitative data derived from risk analysis is not the sole basis for making decisions, but is critical information that must be considered within the context of the project and with a full appreciation of its limitations.

In summary, this book is about helping project owners, managers, and design professionals improve project value within the framework of risk-informed decision making. The processes and techniques presented in this book will assist readers to better understand and manage risk by developing insights into the nature and composition of project risks. Specifically, much of this book focuses on the process of comprehensive risk assessment. The approach to risk assessment that will be presented herein is referred to as risk-based estimating (RBE), which provides a method of quantifying project uncertainty, including risk events, and expressing its potential range of impact to a project's cost and schedule.

WHAT IS AN ESTIMATE?

What exactly is an estimate? This is an important question to ask, and the answer may surprise some. The American Heritage Dictionary defines an estimate (i.e., noun form) as follows:

1. The act of evaluating or appraising.
2. A tentative evaluation or rough calculation, as of worth, quantity, or size.
3. A statement of the approximate cost of work to be done, such as a building project or car repairs.
4. A judgment based on one's impressions; an opinion.

Key words to note in these definitions include: tentative, rough, approximate, judgment, opinion. In other words, an estimate is not a precise number, but rather, an approximate judgment of what the actual costs or time will be. In fact, it is not uncommon for professional construction cost estimators to refer to an estimate as ''an opinion of cost.'' This definition may indeed be in keeping with your understanding of what an estimate is; however, it would seem that this is not how most of us actually think about estimates in real life.

There seems to be something magical about the act of printing a number, any number, on a piece of paper that somehow conveys to us that it is a fact, whether it really is or not. For example, when you go to the mechanic to get your car fixed you typically receive an estimate as to the cost of the repairs. You ''know'' that this is just the mechanic's best guess; however, in practice you tend to take it for granted that it is factual. When you return to pick up your car from the garage, you find that the price has increased significantly, and you tend to feel cheated. ''But that's not what the estimate said!'' you cry out in shock. ''Well, once I removed the carburetor to get to the transmission, I found out that the head gasket was leaking, which damaged the catalytic converter. I ended up having to replace that. I also noticed that the fan belt was shot and that you also needed an oil change. You really ought to take better care of your vehicle!'' says the mechanic, his overalls covered in grease. It is easy to see how a $200 repair turned into a $1,000 repair very quickly. We can only accurately estimate what we know. Uncertainty will always throw us for a loop and turn even the most careful estimate into a bad joke.

Executive management, politicians, and the public in general seem to suffer from a similar bias when it comes to dealing with cost estimates on construction projects. ''The deal was that the project was estimated to cost $10 million. Now you are telling me its $20 million! What happened!? Are you incompetent?'' Anyone who has ever prepared an estimate or received one can probably relate to this scenario.

It must be acknowledged that there is estimating uncertainty and then there is event uncertainty. These two elements are independent, but together comprise the risk profile of a project. We place a lot of weight on estimates, probably more than we should. And yet, it's really the only way we have of planning for future expenditures or timelines that are subject to uncertainty. Therefore, we must have a way to deal with uncertainty in our estimates that allows us to think stochastically rather than deterministically in a manner consistent with the framework of risk-informed decision making.

WHAT IS UNCERTAINTY?

Uncertainty is defined as the quality or state of being uncertain. That is to say, it is a state of not knowing. Within the context of this book, the term *uncertainty* refers to a lack of knowledge about current and future information and circumstances. Uncertainty poses a special set of problems to the management of projects as it can potentially affect outcomes for both the good and the bad.

WHAT IS RISK?

The definition of the term *risk* merits some discussion. It is often assumed that the word *risk* implies a negative outcome. For example, if someone said to me, ''That is a very risky assumption,'' I would take it to mean that she thinks that my assumption is likely to be wrong and, consequently, something bad will happen as a result. The fact of the matter is that risk represents an uncertain outcome. Risks may have either positive or negative outcomes. A negative risk is defined as a *threat* while a positive risk is defined as an *opportunity*. Therefore, something that is properly defined as *risky* does not necessarily mean that it is a bad thing, only that it is an uncertain thing.

This bias toward risks as being bad things often causes us to overlook potential opportunities. Just as threats can result in a catastrophic disaster, opportunities can result in spectacular windfalls. This is the reason for the opening quote for this book. Clearly, Churchill was very shrewd in his ability to perceive both threats and opportunities in employing his wartime strategies. Moreover, he seemed to have possessed the ability to see risks in a balanced way, that is, as both threats and opportunities. Successful risk management requires us to adopt a similar mindset. We must maintain an unbiased outlook and be neither pessimistic nor optimistic in our assessment of risk and be prepared to address both threats and opportunities as they arise.

WHAT IS RISK MANAGEMENT?

A project manager responsible for the delivery of a new office building identifies a permitting concern that could delay the approval of her project. A structural engineer is assessing the quality of the data of a geotechnical report that was performed and fears that the abutments of the bridge he is designing could experience differential settlement. A school district superintendent is concerned that the environmental document could be delayed by public comment. A general contractor fears that the recent volatility in the price of steel could turn a profitable project into a money loser.

All of these scenarios are everyday occurrences within the design and construction industry; however, the manner in which these risks are addressed will have a large impact on project outcomes. The practice of risk management can certainly play an important role in ensuring that the outcomes will be positive ones. However, a lack of risk management will likely result in increases to a project's cost and schedule.

Risk Management is one of the nine Project Management Knowledge Areas identified in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Fourth Edition*. The *PMBOK® Guide* is an excellent project management reference published by the Project Management Institute (PMI®).

To quote from the *PMBOK® Guide*, "Risk Management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project. The objectives of project risk management are to increase the probability and impact of positive events and decrease the probability and impact of negative events in the project."[2]

Another definition of risk management provided by the International Organization for Standardization (ISO)[3] identifies the following principles of risk management:

Risk management should:

- create value
- be an integral part of organizational processes
- be part of decision making
- explicitly address uncertainty
- be systematic and structured
- be based on the best available information
- be tailored
- take into account human factors
- be transparent and inclusive
- be dynamic, iterative, and responsive to change
- be capable of continual improvement and enhancement

WHY RISK MANAGEMENT?

Research has shown that historically the majority of construction projects experience cost and/or schedule overruns. A cost overrun is defined as the difference between the low bid and the actual incurred costs at the time of construction completion.

A study focused on analyzing the costs of public works projects in Europe and North America found that the incidence and severity of cost overruns was significantly higher than indicated by the previous source.[4] This same study found that cost overruns were found in 86 percent of the 258 projects that were sampled. Further, actual costs were, on average, 28 percent higher than estimated costs. The authors of the study concluded that the following factors were the primary culprits in cost overruns:

- Lack of proper risk analysis in developing estimates
- Poorly defined scope at the time initial project budgets were developed
- Larger public projects are prone to intentional underestimation due to political pressure (In other words, there was a deliberate misrepresentation of project costs and/or schedule in order to further political agendas.)

Public projects, especially ''mega'' projects, seem to be especially vulnerable to unfavorable project outcomes resulting from poor risk management. Governments worldwide are making massive capital investments in large infrastructure projects as a means of providing badly needed services while providing a ''boost'' to flagging economies. In a recent article, *World Finance* reported:

> . . . governments may be throwing these vast sums down the drain if the harsh lessons from other mega infrastructure projects are not learnt. The Channel Tunnel cost double its original budget and only returned a profit 20 years after the project started. Denver's international airport saw its eventual cost triple from what had originally been planned, and Sydney's Opera House—as amazing as it might look—still holds the world record for worst project cost overrun at 1,400 percent over budget. Its construction started in 1959 before either drawings or funds were fully available and when it opened in 1973, 10 years later than the original planned completion date and scaled down considerably, the building had cost A$102m rather than the meager A$7m budgeted.[5]

Clearly, as construction technology becomes more sophisticated and the problems facing society become more complex, the need for prudent risk management will only grow.

THE LIMITATIONS OF RISK MANAGEMENT

To some, the term *risk management* may seem like an oxymoron. How can you manage the future? Further, how can you quantitatively model it? Similarly, why do risk management plans sometimes fail? These are valid questions that merit further discussion.

Taleb has argued that the use of probability distributions, which were first developed by the German mathematician Carl Freidrich Gauss (1777–1855), are inappropriate and were never designed for the purposes of modeling complex future events. The authors agree that there are indeed limitations in applying such statistical techniques in modeling risk; however, they are still useful, provided we acknowledge these limitations and ensure that those who make decisions based on them are made aware of them. The dangers of modeling risks using statistical methods are abundant. Perhaps a recent one that has had the largest impacts on the greatest number of people is the stock market crash of 2008.

Back in 2000, a very clever mathematician named David Li introduced the Gaussian copula function to the world of quantitative finance. The formula was initially conceived as a quick way of assessing the financial risk of investments. It essentially simplified what was otherwise an infinite set of financial interactions into a rudimentary correlation of market prices based on credit default swaps (CDSs). In fact, Li's equation was what fueled an explosion in the use of credit default swaps and collateralized debt obligations (CDOs), which were instrumental in the spectacular crash of 2008. The notional value of derivative instruments exploded from $920 billion to $62 trillion between 2001 and 2007. Ironically, the inventor of the Gaussian copula function repeatedly tried, unsuccessfully, to alert Wall Street financial houses of the limitations of the equation—but Wall Street wouldn't listen.[6]

The lesson to be learned here is that quantitative risk analysis will always be limited by the assumptions on which the calculations are based. Financial markets are far too complex to include all data, and any quantitative model is therefore only as good as the information and algorithms used, which can never match the real world. A model, whether it is a risk model or a model of an airplane, will always be an imperfect facsimile of reality to a certain extent.

The failures of risk management are not limited to the misuse of quantitative modeling techniques. Drawing upon another example, let us consider the recent economic and ecological disaster of the Deepwater Horizon oil spill of 2010 in the Gulf of Mexico.

This is an excellent example of an event that was "not supposed to happen." In fact, the insurance industry considered the probability of such an event occurring as zero.[7] The event was a true Black Swan. The probability of the explosion happening was considered to be statistically insignificant given the various safeguards and procedures that were in place to prevent such occurrences. Therefore, it was considered by those in the industry to be extremely unlikely, and essentially "off the curve."

The initial explosion killed 11 people and resulted in the release of 1.5 million to 2.5 million gallons of crude oil per day into the Gulf of Mexico for a period of 86 days, impacting vital fisheries and decimating tourism revenues in the Gulf.[8] Further, the long-term damage to the environment is unknown but assumed to be severe. The ramifications of this catastrophe will have far-reaching impacts on government energy and environmental policy and will undoubtedly shape individual attitudes and behavior about energy and the environment for years to come.

Sadly, as befits the pattern of Black Swans, the event is already being explained away as an anomaly or "fluke" rather than as a risk that is fundamental to the nature of offshore oil production.[9] This means that it is likely that history will repeat itself as time passes and our collective memories fade. Indeed, this event was not the first such oil spill of its kind in history.

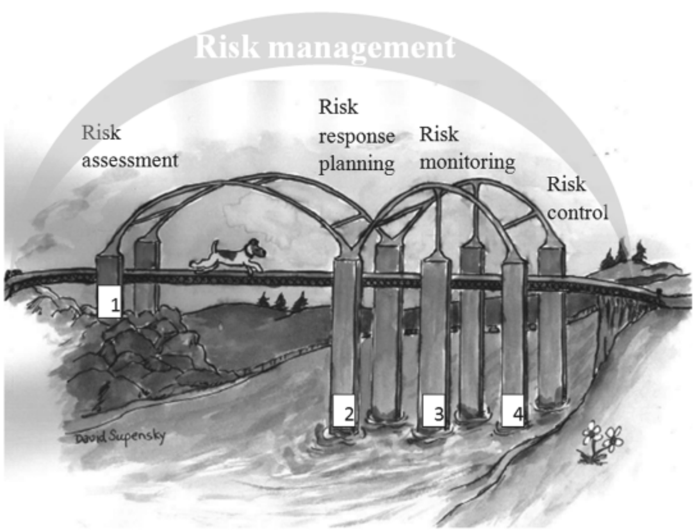
The Deepwater Horizon catastrophe should not have happened, and yet it did. It is likely that years will pass before all of the relevant factors that contributed to this disaster are brought to light. Nonetheless, this was a "known" risk and procedures had indeed been put into place to prevent it. The management of this risk failed as these preventative measures were not followed. Further, no contingency planning had been done, which meant that there was nothing to immediately fall back on when the blowout occurred. If there had, it is likely that the severity of the impact would have been far less. This is not only a failure of British Petroleum and the oil industry, but also a failure of federal regulatory agencies for not requiring such plans to be in place. So, in this case, we have a systemic failure of risk management from the standpoint of response planning and the monitoring and control of risk.

Risk management requires constant effort at every phase to maintain its efficacy. Even the most thorough and well-executed risk management plan is not infallible. We cannot predict the future, nor should we pretend to. However, if we approach the management of risk openly, honestly, and with great care and effort, we can minimize the effect of uncertainty on our projects.

OBJECTIVE OF THIS BOOK

The purpose of this book is to provide project managers, design professionals, estimators, schedulers, and contractors a systematic approach to manage project risk, specifically as they relate to cost and schedule.

An appropriate metaphor for this process is that of a bridge. Beneath the bridge flows a river of uncertainty. One side of the bridge is supported by the technique and application of risk assessment, which focuses on the identification and analysis of risks. The other side is supported by the remaining processes of risk management. The first span of the bridge is the risk-based estimate, which provides a means for us to get halfway across the bridge. The remaining span is supported by the piers of risk response planning, monitoring, and control, as illustrated on Cartoon 1.1. The point is that all of these actions are essential in order to manage project risk.



Cartoon 1.1 The Bridge of Risk Management

After reading this book and becoming fluent with the techniques and software applications that are presented, the reader should be able to:

- Understand that risk management is an essential component of project management that includes all of the necessary steps from risk identification through risk monitoring and control.
- Understand and use the process of integrated, quantitative cost and schedule risk analysis which we call the risk-based estimate (RBE).
- Avoid the common mistakes that users often make when risk-based estimating is employed.
- Understand and avoid the danger of professional sophistication as it applies to the risk-based estimate.
- Separate and define the two major components of risk-based estimates:
  - Base estimate
  - Risk events
- Develop a clear definition of base cost and schedule uncertainty by employing the probability box approach to consider:
  - Base variability
  - Market conditions
- Understand the different distributions and how they are best applied to risk-based estimates.
- Assess cost and schedule risks by considering:
  - Significant risks
  - The interrelationship of risk dependencies and correlations that form a project's ''risk mesh''
- Assess the statistical impact of risks and base uncertainties on a project in terms of schedule and cost using mathematical models, specifically the Monte Carlo method, by:
  - Employing the self-modeling risk-based estimate spreadsheet
  - Understanding the true effect of a project's risk mesh, which is composed of:
    - risk dependencies
    - risk correlations
    - schedule sequence of risk events
- Interpret the true meaning of the results of risk analysis in terms of:
  - The range and shape of estimated cost and schedule histograms and cumulative distribution functions
  - The candidates for risk response planning
- Develop risk management strategies to minimize threats and maximize opportunities.

- Develop detailed action plans to implement the risk response strategies.
- Monitor and control risks throughout the life of the project.
- Improve project outcomes by applying the theory and techniques presented herein in a timely and conscientious manner.

ENDNOTES

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