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A systematic approach to risk management for construction

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Abstract

Systematic risk management is expecting the unexpected – it is a tool which helps control risks in construction projects. Its objective is to introduce a simple, practical method of identifying, assessing, monitoring and managing risk in an informed and structured way. It provides guidance for implementing a risk control strategy that is appropriate to control construction projects at all levels. This paper will review systematic management approaches to risk. It discusses the allocation of risk and suggests that risk needs to be identified and managed early in the procurement process. In addition, a case study of a small project that was affected by difficult economic circumstances is included to demonstrate the effectiveness of systematic risk management.

Keyword(s): Risk management; Construction industry.

The construction industry is one of the most dynamic, risky, and challenging businesses. However, the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. This is influenced greatly by variations in weather, productivity of labour and plant, and quality of material. All too often, risks are either ignored, or dealt with in a completely arbitrary way: simply adding 10 per cent contingency onto the estimated cost of a project is typical. In a business as complex as construction, such an approach is often inadequate, resulting in expensive delays, litigation, and even bankruptcy (Hayes et al., 1986).

Risk management is an important part of the decision-making process of all construction companies. Risk and uncertainty can potentially have damaging consequences for some construction projects. Risk can affect productivity, performance, quality, and the budget of a project. Risk can not be eliminated, but it can be minimised, transferred or retained (Burchett, 1999).

Systematic approach to risk management

Risk management is not a new concept. Traditionally it has been applied instinctively, with risks remaining implicit and managed by judgement, informed by experience. The systematic approach makes the risks clear, formally describing them and making them easier to manage. In other words, systematic risk management is a management tool, which requires practical experience and training in the use of the techniques. According to Godfrey (1996), systematic risk management helps to:

- identify, assess, and rank risks, making the risks explicit;
- focus on the major risks of the project;
• make informed decision on the provision for adversity, e.g. mitigation measures;
• minimise potential damage should the worst happen;
• control the uncertain aspects of construction projects;
• clarify and formalise the company’s role and the roles of others in the risk management process;
• identify the opportunities to enhance project performance.

Although all uncertainty cannot be removed, systematic risk management improves the chances of the project being completed on time, within budget, to the required quality, and with proper provision for safety and environmental issues.

What is risk?

“Risk” is defined as the chance of an adverse event depending on the circumstances (Macquarie Dictionary). The impact of a risk can be measured as the likelihood of a specific unwanted event and its unwanted consequences or loss: see equation 1 where:

- \( R_I \) = risk impact;
- \( L \) = likelihood; and
- \( C \) = consequence.

According to Hayes et al. (1986) risk and uncertainty are part of all construction work regardless of the size of the project. Other risk factors that carry risk include: complexity, speed of construction, location of the project, and familiarity with the work. When serious risks occur on projects the effects can be very damaging. In extreme cases, time and cost overruns turn a potentially profitable project into a loss-making venture.

Hayes’ research showed that cost and time targets are often missed due to unforeseen events that even an experienced project manager cannot anticipate. These events are known in advance, but their extent could often not be quantified. For example, industrial disputes, delayed decisions, or changed ground conditions may all be anticipated, but their likelihood and impact are hard to predict with any precision as no two construction projects are the same; this makes it important to identify risk sources for each project (Hayes et al., 1986; Godfrey, 1996). Hayes recommended that it may be useful to group risks according to simple measures of their probability and likely impact, by focusing on what is important and the action which controls risk.

However, the outcome can always be unexpected, as costs may be less than anticipated, the weather may be kind, revenues may exceed expectation. Therefore, risks can sometimes be viewed as beneficial as long as they are allowed for. Indeed, it is the role of a construction manager to manage risk on behalf of the building client, and in return derive income or profit from the project.

Measurement of risk

The likelihood, or the probability, of an adverse event, is usually expressed in terms of the number of such events expected to occur in a year (Godfrey, 1996). The consequence of an adverse event, sometimes called damage, is often expressed in
monetary terms. In the case of fatalities or serious delays, it is more appropriate to use other measures, like days lost, or experience modification rating.

The true cost of risk can be much higher than is apparent. Much of it can be indirect and uninsured. It can be best illustrated by the figure below (Figure 1). The study carried out by the Health and Safety Executive (1993) shows that the uninsured cost of health and safety risk can be 11 times the direct costs on a construction site. The risk therefore, can be much more complex than appears at first sight.

Both Godfrey (1996) and Hayes et al. (1986) found that the greatest degree of uncertainty is encountered early in the life of a new project. Decisions taken during the earliest stages of a project can have a very large impact on its final cost, and duration. Change is an unavoidable feature of any major capital project, but its extent is frequently underestimated during these early phases.

**Opportunities, risk and value**

Risk and opportunity go hand in hand. For this reason, there is usually a commercial benefit, or “added value”, from the risk control measures taken. For example, a hoist is provided instead of a set of ladders to reduce the risk of people falling. The added value of this risk control measure may be that the hoist increases people’s mobility and as a result their productivity. Potential opportunities arising from risk control should be considered as it gives a greater picture of the likely outcomes.

**Ownership of risk – transfer and spreading of risk**

The risk inherent in every construction project can be assumed by another party. The principal guideline in determining whether a risk should be transferred is whether the receiving party has both the competence to fairly assess the risk and the expertise necessary to control or minimise it (Hartman, 1996). Hartman (1996) found that both parties must have a clear and similar understanding of the risk. Contracting parties who do not have a shared understanding of its accountability may mismanage the risk event by assuming the event or its consequences are not their responsibility.

The term “ownership of risk” has a variety of meanings (Godfrey, 1996), including:

- having a stake in the benefit or harm that may arise from the activity that leads to the risk;
- responsibility for the risk;
- accountability for the control of risk;
- financial responsibility for the whole or part of the harm arising from the risk should it materialise.

In a risk allocation survey by Roozbeh (1995), respondents were asked to place risk associated with construction into three categories: allocation of the risk to the contractor, allocation of risk to the owner, or a sharing of the risk. The risk allocation process of the respondents is shown in Table I and the level of importance of risk is shown in Table II.
A similar survey carried out by ASCE in 1979 showed that contractors were less willing to accept, or even share risk, preferring instead that owners accept responsibility for most construction risks. Responses to the two surveys showed marked differences in opinion regarding third-party delays, acts of God, indemnification, and actual quantities of work.

**The benefits of systematic risk management**

There are often high levels of uncertainty in construction projects. Any feasibility study necessarily contains many assumptions about the future. Systematic risk management helps you quantify that uncertainty. Confidence comes from certainty, but in the absence of such certainty, confidence can be increased by knowing where the risks are coming from, how extensive that uncertainty is, and what the potential consequences are (Bing, 1999).

Therefore, systematic risk management is deemed to have the following advantages:

- questioning of the assumptions that most affect the success of your project;
- concentrates attention on actions to best control risks; and
- assesses the cost benefit of such actions.

The application of risk management at the outset clarifies the objectives and helps refine the project brief. Risk management helps to recognise the importance of any constraints that may be set and to assess their impact on the project.

Systematic risk management allows the early detection of risks. Therefore, there is no need for contingency plans to cover almost every eventuality (Dawood, 1998). As a result, you can ensure that your limited resources are concentrated on the major risks to achieve maximum effect, i.e. the areas where the greatest saving can be achieved and/or where there is maximum risk exposure.

Lack of clarity in the recognition or acceptance of risk is a risk itself that will tend to magnify the overall cost of risk. The start of a project presents the greatest opportunity to avert disaster by providing for risk at minimum cost. A systematic approach which focuses on risk issues at an early stage is more likely to have high cost benefit and is therefore recommended from inception, through successive project phases, to completion and beyond.

Systematic risk management encourages the company to itemise and quantify risks and to consider risk containment and risk reduction policies. Instead of relying on a single value project cost estimate, the distribution of risk is analysed and appropriate project costs allowed for. This makes the estimating process realistic because it recognises the uncertainties that exist.

**How to apply risk management**

Bajaj (1997) reported that if a risk is not identified it cannot be controlled, transferred or otherwise managed. Therefore risk identification is a necessary first step before risks can be analysed and an appropriate response determined. Risk management is not a
one-off activity, instead it should be applied continuously throughout the life of the project. According to Jaafari and Anderson (1995) risk management can be viewed in three stages:

1. (1) risk identification;
2. (2) risk analysis; and
3. (3) risk response.

**Risk identification**

Williams (1995) found that the identification of each risk is an essential first step in risk management and is possibly the most difficult. The identification of each source of risk and the components allows the risk item to be separated from others. Consideration of each influencing factor will simplify the analysis and management of the risk (Bajaj, 1997). In risk identification, the key question to ask is:

What are the discrete features of the project (risk sources) which might cause such failure? (Godfrey, 1996).

The realism of risk estimates increases as the project proceeds. However, the major decisions should be made early in the life of the project, as contingency steps need to be put into place to counter the risk. So despite the difficulties, a realistic estimate of the final cost and duration of the total project is required as early as possible.

There is a second, but equally important, reason for the early identification of risk and uncertainty, it focuses the attention of project management on the strategies for the control and allocation of risk, e.g. through the choice of a contract strategy. It will also highlight those areas where further design, development work, or clarification is most needed.

**Risk analysis**

Williams (1995) defined the quantification of risk as the magnitude and frequency or time frame of each event. Each event may be a single incident or an aggregation of incidents. There are a number of analysis techniques that may be used as aids to quantify risks.

Techniques which may be used in the evaluation of risk include: code optimisation (which is based on subjective estimation), sensitivity analysis, probabilistic analysis Monte Carlo simulation (Songer, 1997), and kinetic tree analysis (which allows the estimated probability of each alternative to be recorded and the probability of a sequence of events to be determined) (Mendenhall *et al.*, 1986).

Risk analysis sets out to quantify the effects of the major risks that have been identified. In some cases the analysis of the impact of the risks extends to judging the probability of occurrence of each risk. According to Hayes *et al.* (1986), only on a few project and contracts is risk considered in a consistent and logical manner; much assessment is too subjective. Commercial pressures were often used by clients, contractors, and consultants as the excuse for not applying analytical techniques. Hayes *et al.* state that
this cannot be justified in the light of the potential benefits of risk management, when there are many techniques that can be simply applied to any project.

**Risk response**

The greater the uncertainty associated with a project the more deliberate the response must be. There are ways to respond to risk, some of which may be used in combination: to avoid it, reduce it, transfer it, or absorb it. The most efficient response to risk is to allocate the risk to the party that is in the best position to accept it.

This idea has long been part of the understanding of contract lawyers. The contract that the tender is awarded on becomes the instrument that defines the duties and responsibilities of each party. This means that invariably the owner allocates risks to one of the other contracting parties. Contractors, upon receiving a bid request, evaluate the cost of building the project, and will, consciously or not, add contingencies for risks. Very often, contingency premiums are added to the cost “intuitively”, because too often there is no formal risk analysis, so there can be no scientific premium calculation.

Risk contingencies are a result of past experiences concealed or hidden within the bid process. They then submit their bid with the hope of winning the work. Contingencies protect the contractor’s interests in the event of a risk occurrence. Clearly, risk management has major benefits for any enterprise, but these are more than just ways of helping to get projects completed on time and to budget, for example it can:

- enable decision making to be more systematic and less subjective;
- allow the robustness of projects to specific uncertainties to be compared;
- make the relative importance of each risk immediately apparent;
- give an improved understanding of the project through identifying the risks and thinking through response scenarios;
- have a powerful impact on management by forcing a realisation that there is a range of possible outcomes for a project.

**Case study**

As indicated previously, both Godfrey and Hayes *et al.* found that the greatest degree of uncertainty about the future is encountered early in the life of a new project. However, the ability to predict future events will always remain a very difficult task. In research undertaken by Jaafari and Anderson (1995), the authors analyzed the use of risk analysis from a developer’s point of view. The research investigated a post-mortem analysis of the development of an office building in Sydney, Australia.

The aim of the paper was not only to demonstrate the usefulness of the risk analysis technique, but also to highlight the dangers associated with using incomplete assumptions in risk analysis models in order to legitimise a certain view about the market outlook and other economic trends.

The intention of the paper was to deliver a simple message demonstrating that sensitivity analysis alone does not protect against taking the wrong path, unless it is part of a comprehensive risk analysis process. In systematic risk analysis, the nature of
scenarios and the conclusions that are derived from the study are fundamental
determinants to a prudent decision on the project.

The case study related to an office building that was developed as a speculative project
by a large holding company in a satellite business district near Sydney. Because of the
commercial sensitivity of the project, the actual name was not identified in the research.
However, the information in Table III was supplied to give an impression of the size and
nature of the building.

In addition, the building was to be commenced in 1988 and the following information
was provided:

- Total planned project duration was taken as 24 months from the acquisition of
  land to the sale of the building.
- Construction was planned to commence in the seventh month and was planned
to be completed by the 18th month.
- The target period for leasing was taken from the end of construction through to
  the end of sale.
- The finance was based on borrowing 100 per cent of the investment at 14 per
  cent per annum.

Internal rate of return (IRR) was chosen as the measure of profitability of the
investment. The IRR takes into consideration not only projected costs, rental growth
and revenue streams but also fiscal matters such as taxation, capital gain, and future
capitalisation rate (yield). According to Jaafari and Anderson (1995) the true IRR
expected for the project should not be below the hurdle rate of 15 per cent per annum,
given the economic circumstances of the project in 1988.

The research showed that an extensive risk analysis process was undertaken for the
project. Many risks were identified and assigned to various parties to the contract.

It became obvious that the greatest numbers of risks were identified as design and
construction related (Table IV). As a result a design and construct contract was chosen.
In this case the time and cost risks of the project were assigned to a single contractor,
however, it soon became obvious that the risk of time overruns was one of the most
critical issues for the success of the project overall.

The holding cost of the land was critical because of the high cost of finance of the
project. Any risk that extended the time of the project had the effect of delaying the
income stream and increasing finance costs. This issue was not fully understood by the
developer.

It should be noted that the economic conditions during 1989 and 1990 were extremely
volatile, at the time it was very difficult to predict the timing of the peak of the boom
and the subsequent severe downturn that followed. Nevertheless, the sensitivity of the
project to time delays was important, and the likelihood of their occurrence was
significantly underestimated.
The most critical risk was the sale income of the building, this risk could have occurred due to many reasons, most of which reverted back to the developer. For instance, although the builder was signed up to a fixed time and cost contract, any delays due to industrial action (deemed to be outside the control of the builder) were ultimately borne by the developer. In addition, latent site conditions, design variations and inclement weather may in the end also delay the income stream of the project.

A number of risks were also retained by the owner which could have led to reducing the income stream, these included: low occupancy rates, delays in the issue of development and building approvals, and reduced market price for the building. Consequently, the above risks all put pressure on the assumptions about the timing of the income, and therefore viability of the project.

According to Jaafari and Anderson (1995) the building was completed in 1990 without any significant problems:

- the statutory authority granted the development approval in time;
- the final construction cost was only marginally over the contract sum; and
- there were no delays or no latent conditions.

The construction of the project was successful and the project report indicated that subcontractors were prepared to deliver their work to the satisfaction of the main contractor.

However, in the early part of 1990 the property industry experienced one of the biggest economic downturns for some time. The building could not be sold and remained vacant for well over one year. This added significantly to finance costs and impacted on the success of the project. Although the authors did not know the actual costs, it is estimated that the project would never be able to pay for itself unless a fundamental return to boom conditions in the industry had taken place (such as a return to substantial appreciation of the sales prices).

The authors believe that with the aid of systematic risk management techniques, it would have been possible to foreshadow the situation and avoid investing in the project. Some risk scenarios clearly illustrated the vulnerability of the project to extended holding periods. Jaafari and Anderson (1995) showed that under all scenarios analysed there was very little chance (less than 30 per cent) of meeting the hurdle rate of 15 per cent IRR.

Given the five scenarios outlined and tested in Jaafari’s research, it is evident that the project was going to fail against at least two of them. Both of these analysed two major risks that were beyond the control of the developer, i.e. industrial disputes and slumps in the property market. According to Jaafari and Anderson (1995) the message from this research is quite clear. Had a proper risk analysis been performed at the time of project feasibility studies, it would have shown that the project would be highly vulnerable to delays, including the impact of poor market conditions.

In fairness to the developer, the buoyant market of the late 1980s indicated that buildings were selling quickly. However, a structural analysis of the market, including
investigation of the expected oversupply of stock, would have suggested that “the writing was on the wall” for a slump in the commercial property market. Consequently, prolonged holding periods should have been considered as a real possibility.

This research acknowledges that many developers are “risk seekers” who take on risks without understanding the full impact. This is not a new concept to the industry and has occurred many times before. However, the aim of this paper is to demonstrate that systematic risk management practices can be useful for analysing project success.

**Conclusion**

In the end, the burden of responsibility for identifying risks and dealing with them remains with the party that carries the risk. Risk management will not remove all risk from a project; its principal aim is to ensure that risks are managed in the most efficient manner. Project managers will recognise that the clients must always carry certain residual risks. This risk must be analysed in an organised and systematic way considering the full impact of time and cost.

Risk management is not intended to kill off worthwhile projects, nor to dampen levels of investment. It aims to ensure that only projects that are genuinely worthwhile are sanctioned. When applying risk management techniques, the attitude of the manager is important, steps should be taken to ensure that as much realism as possible is included in the analysis.

Risk management should be viewed as a positive process, and can be one of the most creative tasks of the project manager. Its aim is to generate realistic expectations and increase the control of the process. In addition, it can open the way to finding innovative solutions that may not have otherwise been considered.
<table>
<thead>
<tr>
<th>Risk allocation</th>
<th>Risk description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contractor</strong></td>
<td>Labour and equipment productivity</td>
</tr>
<tr>
<td></td>
<td>Quality of work</td>
</tr>
<tr>
<td></td>
<td>Labour, equipment, and material availability</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
</tr>
<tr>
<td></td>
<td>Defective material</td>
</tr>
<tr>
<td></td>
<td>Contractor competence</td>
</tr>
<tr>
<td></td>
<td>Inflation</td>
</tr>
<tr>
<td></td>
<td>Actual quantities of work</td>
</tr>
<tr>
<td></td>
<td>Labour disputes</td>
</tr>
<tr>
<td><strong>Owner</strong></td>
<td>Differing site conditions</td>
</tr>
<tr>
<td></td>
<td>Defective design</td>
</tr>
<tr>
<td></td>
<td>Site access/right of way permits and ordinances</td>
</tr>
<tr>
<td></td>
<td>Changes in government regulations</td>
</tr>
<tr>
<td></td>
<td>Delay payment on contract</td>
</tr>
<tr>
<td></td>
<td>Changes in work</td>
</tr>
<tr>
<td><strong>Shared</strong></td>
<td>Financial failure – any party</td>
</tr>
<tr>
<td></td>
<td>Change-order negotiations</td>
</tr>
<tr>
<td></td>
<td>Contract-delay resolution</td>
</tr>
<tr>
<td><strong>Undecided</strong></td>
<td>Acts of God</td>
</tr>
<tr>
<td></td>
<td>Third-party delays</td>
</tr>
<tr>
<td></td>
<td>Defensive engineering</td>
</tr>
</tbody>
</table>

**Source:** Roozbeh (1995)
Table II Level of importance of risk

<table>
<thead>
<tr>
<th>Importance</th>
<th>Risk allocation</th>
<th>Risk description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most important</td>
<td>Contractor</td>
<td>Safety</td>
</tr>
<tr>
<td></td>
<td>Contractor</td>
<td>Quality of work</td>
</tr>
<tr>
<td></td>
<td>Contractor</td>
<td>Labour and equipment productivity</td>
</tr>
<tr>
<td></td>
<td>Owner</td>
<td>Defective design</td>
</tr>
<tr>
<td></td>
<td>Owner</td>
<td>Construction competence/delayed payment</td>
</tr>
<tr>
<td>Least important</td>
<td>Owner</td>
<td>Changes in government regulations</td>
</tr>
<tr>
<td></td>
<td>Owner</td>
<td>Site access/right of way permits and ordinances/inflation</td>
</tr>
<tr>
<td></td>
<td>Undecided</td>
<td>Acts of God</td>
</tr>
<tr>
<td></td>
<td>Undecided</td>
<td>Defensive engineering</td>
</tr>
</tbody>
</table>


Table III Size of the building

<table>
<thead>
<tr>
<th>Office space</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground floor ( (m^2) )</td>
<td>715</td>
</tr>
<tr>
<td>Level one ( (m^2) )</td>
<td>885</td>
</tr>
<tr>
<td>Level two ( (m^2) )</td>
<td>1,059</td>
</tr>
<tr>
<td>Level three ( (m^2) )</td>
<td>993</td>
</tr>
<tr>
<td>Total ( (m^2) )</td>
<td>3,652</td>
</tr>
<tr>
<td>Car parking spaces ( (n) )</td>
<td>73</td>
</tr>
</tbody>
</table>

Source: Jaafari and Anderson (1995)
Table IV Risks identified in case study

<table>
<thead>
<tr>
<th>Planning risks</th>
<th>Design and construction risks</th>
<th>Site-related risks</th>
<th>Market risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development approval</td>
<td>Quality of brief</td>
<td>Accessibility</td>
<td>Rental income</td>
</tr>
<tr>
<td>Building approval</td>
<td>Designer</td>
<td>Contaminated soil</td>
<td>Occupancy rate</td>
</tr>
<tr>
<td>LG contributions</td>
<td>Consultants’ fees</td>
<td>Site flooding</td>
<td>Sale of building</td>
</tr>
<tr>
<td></td>
<td>Design changes</td>
<td>Soil conditions</td>
<td>Yield</td>
</tr>
<tr>
<td></td>
<td>Contracts and flaws</td>
<td></td>
<td>Interest rates</td>
</tr>
<tr>
<td></td>
<td>Contractor performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subcontractor performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Latent conditions</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Inclement weather</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Industrial disputes</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Defective materials and workmanship</td>
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<td></td>
<td>Expediting</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Materials shortages</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment and facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor quality control</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Poor performance control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neighbours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Jaafari and Anderson (1995)

Table IV Risks identified in case study

INSURED COSTS
Employer’s liability
Third party liability
Corporate liability
Property damage

UNINSURED COSTS
Product and material damage
Plant and building damage
Tool and equipment damage
Legal costs
Expenditure on emergency supplies
Clearing site
Production delays
Overtime work and temporary labour
Investigation time
Supervisors time & Clerical effort
Fines
Loss of expertise/experience

Source: The Health and Safety Executive (1993)

Figure 1 The Health and Safety Executive “Iceberg” 1993
References


