



Risk Management for Public Works

Risk Management User Manual

June 2005

**The Government of Hong Kong Special Administrative Region
Environment Transport and Works Bureau**

This manual has been prepared by Ove Arup & Partners Hong Kong Ltd

CONTENTS

	Page
EXECUTIVE SUMMARY	1
1. INTRODUCTION AND SCOPE	2
1.1 Introduction	2
1.2 Scope and Objective	2
1.3 Definitions	3
1.4 Benefits of Risk Management	4
2. RISK MANAGEMENT PROCESS OVERVIEW	5
2.1 Basis	5
2.2 Main Elements	5
3. ESTABLISH CONTEXT AND RISK PLANNING	8
3.1 Basis	8
3.2 Establish Context	8
3.3 Define Responsibilities and Resources	9
3.4 Develop Risk Criteria	9
3.5 Risk Management Plan	10
4. RISK IDENTIFICATION	11
4.1 Brainstorming	11
4.2 Prompt Lists and Check Lists	12
4.3 Interviews	13
5. RISK ANALYSIS	14
5.1 Basis	14
5.2 Types of Analysis	14
5.3 Preliminary Analysis	15
5.4 Existing Control Measures	15
5.5 Consequence and Probability Tables	15
5.6 Consequences	15
5.7 Probability	16
5.8 Level of Risk	16
5.9 Quantitative Analysis	19
6. RISK EVALUATION	20
6.1 Basis	20
6.2 Evaluation	20
7. RISK TREATMENT	22
7.1 Basis	22
7.2 Risk Treatment Options	22
7.3 Risk Treatment Process	23
8. COMMUNICATION AND CONSULTATION	28
8.1 Stakeholder Identification	28
8.2 Communication and Consultation Plan	29
8.3 Benefits of Communication and Consultation	29
9. MONITORING AND REVIEW	30
9.1 Purpose	30
9.2 Measurement of Risk Management Performance	30

10.	RECORDING THE RISK MANAGEMENT PROCESS	32
10.1	Basis	32
10.2	Risk Management Plan	33
10.3	Risk Register	33
10.4	Risk Treatment Action Plan	33
11.	IMPLEMENTING EFFECTIVE RISK MANAGEMENT	37
11.1	Policy	37
11.2	Responsibilities and Authority	37
11.3	Success Factors	38
11.4	Timing Considerations	38
11.5	Aligning Risk Management to Project Phases	40
11.6	Risk Management Reviews	43
11.7	Preparation for Dedicated Risk Management Reviews	46

APPENDICES

APPENDIX A

Sample Prompt Lists and Check Lists

APPENDIX B

Outline of Some Selected Quantitative Methods of Risk Analysis

APPENDIX C

Sample Risk Management Documentation

APPENDIX D

Example Project Risks and Treatment Options

EXECUTIVE SUMMARY

- Projects within the Public Works Program are conducted within an environment of uncertainty, where complete and perfect information relating to a project is never available until the project is complete. In this context, how can decisions be made in relation to project activities that may not actually take place for weeks, months or even years into the future, and the project team be confident that the project imperatives will be achieved?
- Part of the answer is the considered application of **Systematic Risk Management (SRM)** to projects. SRM provides a valuable platform for achieving greater certainty in the delivery of projects.
- The SRM process is illustrated below. It comprises a considered, systematic risk planning, identification, analysis, evaluation and treatment process, which is supported by appropriate monitoring, review and recording of the identified risks, together with effective communication and consultation with stakeholders and project participants.
- This Manual provides guidance for the proactive use of Risk Management as a systematic management tool to support decision-making on projects in the Public Works Program, and provides specific details of the application of the risk management process and associated tools and techniques to provide project teams with:



THE SYSTEMATIC RISK MANAGEMENT PROCESS

- The means to identify project risks
- The means to measure and assess the level of risk exposure
- The means to prioritise risks for treatment, and identify treatment options
- The means to communicate risk information
- The means to continuously improve the effectiveness of the project risk management process.

• The Manual outlines the adoption of three risk management reporting formats to assist in the recording of the risk management process, these being the Project Risk Management Plan, Project Risk Register and Risk Treatment Actions Plans. These are discussed in Section 10.

- This Manual is primarily targeted at those who are responsible for the actual implementation of the risk management process on particular projects. However, the guidelines on risk management process presented in this Manual will also be of significant relevance and interest to all personnel (Departmental and Contracted Stakeholders) who will be involved in the management of risk during the course of a project from Project Definition to Commissioning and Handover.

1. INTRODUCTION AND SCOPE

1.1 Introduction

Systematic Risk Management (SRM) is a key process for effective project delivery. This User Manual provides a guide for the application of systematic risk management on capital works projects in the Public Works Programme. In this regard it should be noted that TCW No. 6/2005 requires that systematic risk management be applied to all projects in the Public Works Programme.

Specifically the User Manual provides:

- A background to the subject of project risk management.
- Details of the elements of a generic process that is recommended for application on projects within the Public Works Programme.
- Practical guidance on the implementation of the risk management process.
- Outlines some of the management tools that can be utilised to implement the process.

1.2 Scope and Objective

Works Departments are responsible for a range of diverse projects within the Public Works Programme. All involve some degree of risk.

Failure to manage the risk can have diverse and serious implications to project outcomes, including:

- Exceeding project budgets
- Programme delays
- Failure to achieve required functional requirements
- Failure to achieve the required quality requirements
- Damage to the environment
- Forfeiting the health and safety of personnel involved in the project
- Exposure to litigation
- Damage to the reputation of Government Departments

Within the context of the above, there is clearly a need to manage the risk that is present when undertaking projects. This can be achieved through proactive and systematic project risk management.

Risk management can help Works Departments improve their performance in a number of ways. It can lead to better delivery of projects, more efficient use of resources and enhanced project management.

Citizens and businesses can suffer significant and real adverse economic and other impacts if public services are inadequate or are inefficiently delivered. Further, the reputation of Departments can suffer where services fail to meet stated commitments or satisfy public expectations. Assessing the risk of such circumstances arising can help Departments to put in place appropriate measures to allow proactive rather than reactive management of risk.

Therefore this User Manual provides Departmental employees with guidance to achieve:

- A more rigorous basis for decision-making

- Better identification of threats and also opportunities
- Proactive rather than reactive management
- More effective allocation and utilisation of resources
- Improved stakeholder confidence and trust
- Improved compliance with Government policy

1.3 Definitions

There are many definitions of what **Risk** is:

- The chance of something happening that will have an impact upon objectives (AS/NZS4360: 2004 - Risk Management).
- Combination of probability of an event and its consequence (ISO/IEC Guide 73: 2002 – Risk Management Vocabulary – Guidelines for Use in Standards).
- The combination of the probability of an event occurring and its consequence for project objectives (BS IEC 62198: 2001 Project Risk Management – Application Guidelines).
- Uncertainty inherent in plans and the possibility of something happening that can affect the prospects of achieving business or project goals (BS6079-3: 2000: Guide to the Management of Business Related Project Risk).
- The chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to health, property, the environment, or other things of value (CAN/CSA-Q850-97: Risk Management Guideline for Decision Makers).

These definitions and others tend to agree that, in a project context, a risk relates to the probability and consequence of an event, and the resultant influence on project objectives.

Whilst there is some variation in terminology across risk management standards globally, the variation is minor, and for the purposes of this User Manual, the definitions below have been adopted.

Consequence – outcome of an event

Control – a process, policy, device, practice or other action that acts to minimise negative risk

Event – occurrence of a particular set of circumstances

Hazard – a source of potential harm

Probability (Likelihood) – extent to which an event is likely to occur

Residual Risk – risk remaining after implementation of risk treatment

Risk Management – the culture, processes and structures that are directed towards managing adverse effects

Risk Management Process – the systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, mentoring and reviewing risk

Stakeholders – those people and organisations who may affect, be affected by, or perceive themselves to be affected by a decision, activity or risk.

Treatment – process of selection and implementation of measures to modify risk

1.4 Benefits of Risk Management

Management of risk is an integral part of good project management practice. Learning how to manage risk enables government employees to improve outcomes by identifying and analysing a wider range of issues and proving a systematic way to make informed decisions.

Thus by implementing a systematic project risk management process on Government projects, a number of consequential benefits can be realised. These include:

- Improved planning, performance and effectiveness
- Improved information for decision making
- Greater time and cost certainty
- Fewer surprises
- More efficient use of resources
- Enhanced quality of output
- Improved communication and stakeholder relationships
- Exploitation of opportunities
- Greater certainty in delivery, and the effective realisation of required project outcomes
- Objective comparison of project options
- Optimal placement of risk
- Prioritisation of team efforts
- More effective management of change
- Enhanced reputation

2. RISK MANAGEMENT PROCESS OVERVIEW

2.1 Basis

There are many methodologies that can be adopted to manage project risk. Although the methodologies may differ in their detail and the particular techniques that they employ, they all must be capable of providing the following:

- The means to identify project risks
- The means to measure and assess the level of risk exposure
- The means to prioritise risks for treatment
- The means to identify treatment options
- The means to communicate risk information
- The means to continuously improve the project risk management process.

2.2 Main Elements

The main elements of the risk management process, as shown in Figure 1, are outlined below.

2.2.1 Establish Context and Risk Planning

Establish the external, internal and risk management context in which the rest of the process will take place. Criteria against which risk will be evaluated should also be established and the structure of the analysis defined.

As with any other project management activity, project risk management should be conducted methodically and the intent and structure of the risk management process specified within a Risk Management Plan. The Risk Management Plan will include the contextual elements mentioned above together with clear statements on arrangement of activities including:

- Responsibilities for implementing the risk management process
- Resource requirements for administering the process
- Proposed timing of key risk management activities

An outline of the suggested contents of a Risk Management Plan is presented in Section 10 of this Manual, and an example is presented in Appendix C.

2.2.2 Risk Identification

Risk identification is the process of determining the individual risks that are present and relevant to the project. The aim being to identify where, when, why and how events could prevent, degrade or delay the achievement of objectives. Risk identification is undertaken throughout the project implementation process. The end result of this sub process is a record of events that may affect the achievement of project objectives in some way.

2.2.3 Risk Analysis

Risk analysis is the process of measuring the relative level of risk exposure that the identified risks pose to the project.

The level of risk exposure can be considered as a product of the probability of the risk event occurring and the consequence to the project if it does occur. It can be measured by qualitative means (assigning particular risks to predetermined risk descriptors that denote the relative level of exposure in descriptive terms) or by quantitative means (estimating the

particular probability and impact values and utilising various numerical and mathematical techniques to determine a notional exposure figure).

2.2.4 Risk Evaluation

Comparison of estimated levels of risk against pre-established criteria will allow the prioritisation of risks for treatment and the identification of risks that require active management and those that are considered as acceptable and do not require active treatment.

2.2.5 Risk Treatment

Risk treatment firstly considers the options for treatment. This involves the identification of cost-effective strategies and actions plans for the management of identified risks. The cost benefit of those options and the level of risk that will be present once that treatment has been undertaken are then considered. With this information, specific treatment options can be selected for implementation, monitored and reviewed for effectiveness.

2.2.6 Communicate and Consult

The project risk management process does not take place in isolation from other project and organisational activities. Communication of risk information and consultation with project participants and stakeholders should be a proactive activity that continues throughout the duration of the project.

2.2.7 Record, Monitor and Review

The status of all identified risks is recorded in the Project Risk Register. The Risk Register is the prime document for recording risk management activity. It records all details of the risk, the assessed risk exposure, the treatment activities that have been identified, which party is undertaking the treatment and their current progress. An outline of the suggested contents of a Risk Register is presented in Section 10 of this Manual, and an example is presented in Appendix C.

Risk management is a dynamic process. As such monitoring and review a key activities, which are sometimes overlooked. Risk exposures for projects can arise at any time and will wax and wane with the project cycle. Consequently the importance of the identified risks will change, and new risks will emerge, as the project proceeds.

Therefore, although the Risk Register that we will produce will represent an understanding by the Project Team of the significant risks associated with a particular project at a particular point in time; it should never be viewed as a ‘one-off’ exercise.

It is essential to project success that the risk management process is kept relevant and alive throughout the duration of the project. Risks (consequence and probability) and the effectiveness of control measures need to be monitored, as they will change with time. Additionally, as the project proceeds through planning, design, procurement and construction phases, new (or previously overlooked) risks will emerge. As such, ongoing review of the process and monitoring is essential to ensure that risks and the management plan remain relevant and effective.

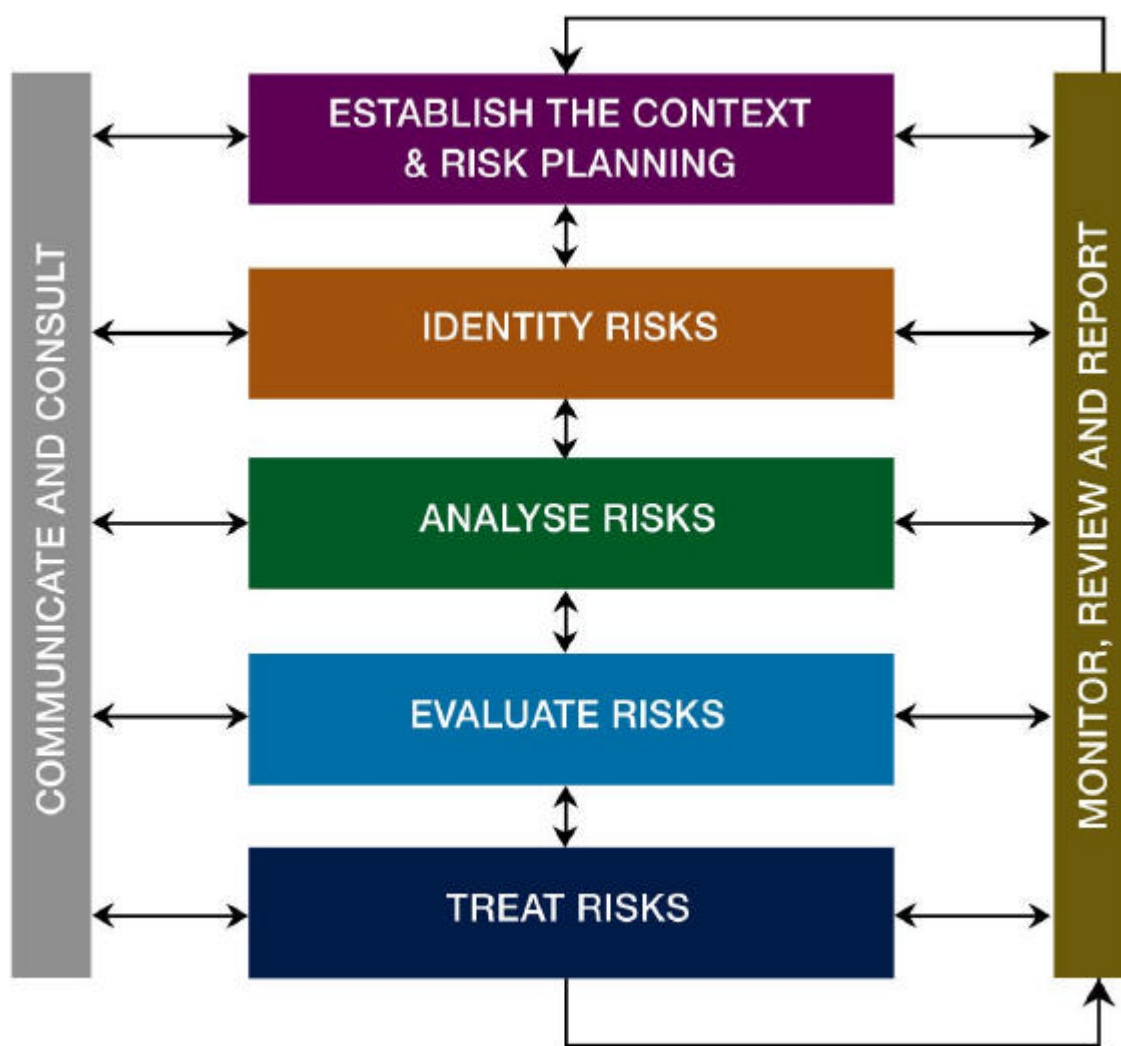


FIGURE 1 – SYSTEMATIC RISK MANAGEMENT PROCESS

3. ESTABLISH CONTEXT AND RISK PLANNING



3.1 Basis

Within this first stage of the risk management process the basic parameters within which risks must be managed are established and the scope set for the rest of the risk management process.

The activities that would typically be conducted in this initiation stage include:

- Determine objectives of the risk management process within the context project objectives and stakeholder environment
- Identify responsibilities and resource requirements
- Identification of a set of criteria against which the risks will be measured
- Prepare Risk Management Plan

3.2 Establish Context

When developing a risk management strategy, it is first necessary to consider and define the entity that will be the focus and beneficiary of risk management activity. It is not sufficient to state that the project is to be assessed for risk exposure. Projects are exposed to risk, but it is the organisations that undertake projects that ultimately suffer the ramifications when risk events occur.

It is the objective of project risk management to reduce the risk exposure faced by organisations.

The organisation at risk, in all likelihood will be the Works Department undertaking the particular project, but may extend to include other Departments or organisations if the project so dictates.

Therefore this step defines the organisational and stakeholder environment in which the project exists. Key elements of this include:

- Determination of project organisational structure, including any external stakeholders
- Determination of organisation-wide goals and objectives that will influence project

- Definition of project objectives and constraints
- Identifying proposed project implementation strategy

The overall intent in this stage is to clearly define the basic parameters within which the risks are to be managed. To achieve this it will be necessary to seek input from project participants and stakeholders. Specifically this would involve a combination of face-to-face interviews, discussions at Project Steering Committee meetings, individual written responses to a feedback questionnaire and review of project and organisational documentation.

The form of information sought from any interviews or questionnaires would need to be tailored for each specific project, but would be focussed on articulating the priorities and objectives for the project. This is critical in order to clearly establish a focus and framework for the rest of the risk management process. Additionally, feedback would be sought across a number of other areas that might include (but not be limited to) the following:

- ***Dominating Ideas*** - At this point in the project what idea or ideas are dominating your thinking? What is the underlying idea or ideas that control your thinking?
- ***Essential Factors*** - What factors, items, tasks, inputs or components are essential to, or are inherent, in the project. Going forward, what factors will be essential to success of the project?
- ***Assumptions*** - Identify any assumptions made in the development of this project. What behaviours do you and the team assume at this present stage in the project? Should we challenge or accept each of these assumptions?
- ***Boundaries*** - Identify the boundaries in which you perceive that you and the team are working within. Do we really have to work within these boundaries?
- ***Avoidance Factors*** - What do we have to keep away from? What things are we trying to avoid?

This reflection and appraisal will provide essential context, which will be referenced in developing the Risk Management Plan.

3.3 Define Responsibilities and Resources

There must be a clear definition of where responsibilities to the risk management process lie. This must be established at an early stage as responsibilities held by those outside the particular Works Department will often require to be incorporated in Contracts or Agreements.

Responsibility for implementing the risk management process on a project should be identified, as should the resource requirements for administering the process. The resource requirement and how those resources are to be procured will be dependant on the scale and complexity of the particular project and the availability of appropriately skilled and experienced individuals. The individual responsible for the implementation of the risk management process is referred to as a Risk Manager for the purposes of this document.

Further, in order for risk management to be successful, organisations or individuals who hold risk, (and therefore have a responsibility to manage it), should be familiar with the risk management process that is described in this document. This may require the provision of training.

3.4 Develop Risk Criteria

Early consideration of the criteria against which the level of risk will be assessed will influence the methods used to analyse risk. It is therefore important that appropriate criteria be considered at the outset of the process.

Important criteria, which should be considered, are:

- The kinds of consequences that will be considered
- How probability will be defined
- How it is determined whether the risk level is such that further treatment activities are required

Criteria may be affected by the perceptions of stakeholders and by legal or regulatory requirements.

It is not essential that all facets of the criteria be defined at this stage. It is however appropriate for the major items to be acknowledged. Further consideration of criteria forms part of the Risk Analysis function, and is discussed further in Section 5 of this Manual.

3.5 Risk Management Plan

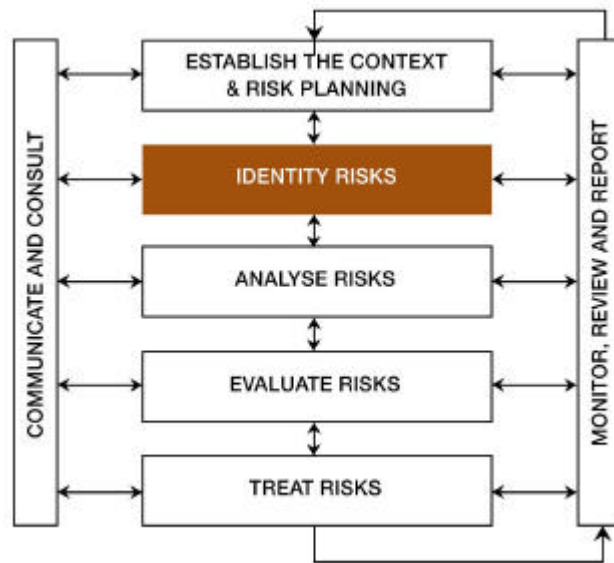
All the information that has been generated during the risk planning stage serves the purpose of defining how risk management will be undertaken during the execution of the project. It should be collated into a single document, this being the Risk Management Plan.

The Risk Management Plan is therefore a definition of the systematic risk management that is to be applied to the project. As a Project Quality Plan defines how project quality will be addressed during the course of a project, the Risk Management Plan defines how risk will be addressed.

The Risk Management Plan is a project specific document that must be updated in response to changes in project circumstances and available project information. It essentially should include the current versions of the Project Risk Register and Risk Treatment Action Plans and remain up to date and relevant.

An outline of the suggested contents of a Risk Management Plan is presented in Section 10 of this Manual, and an example is presented in Appendix C.

4. RISK IDENTIFICATION



The basic intent in this stage is to generate a comprehensive list of possible sources of risks and events that might have an impact on the achievement of each of the objectives identified in the Context and Planning Stage.

Comprehensive identification using a well-structured systematic process is critical. Identification should include risks whether or not they are under the control of the Department.

Ideally a risk should be identified in the following terms:

Something happens leading to outcomes expressed in terms of impact on objectives

A number of the approaches commonly used for project risk identification are described below. These may be used in isolation or combination. The particular approach, or approaches, employed will depend on the risk management context.

4.1 Brainstorming

Team-based brainstorming is a popular means of identifying and gathering information on project risks, particularly as it builds commitment, considers different perspectives and incorporates differing experiences.

Brainstorming would normally take place in a facilitated workshop environment, which would ideally involve a representative range of project participants from the respective Department(s), project team and other stakeholders as appropriate.

To provide a focused prompt for consideration of risks, selected elements of the summarised pre-workshop context information may be displayed at the workshop. Typically, this will include the agreed project objectives. The brainstorming process can then be directed to address the following questions for each of the stated objectives:

- What are the risks to achieving this objective?
- What might happen that could decrease the effective achievement of this objective?
- What might happen that could make the achievement of the objectives more or less efficient?

- What might happen that could cause stakeholders to take action that may influence the achievement of objectives?

This approach allows the consideration of many risk scenarios, by asking the questions “What might happen?”; and “How could this arise?” This session should be carefully facilitated to be free flowing and non-evaluative.

All risks should be recorded; no matter how trivial or seemingly irrelevant they might at first appear. This documentation of all risks is a necessary part of the process of agreeing a set of the most important risk areas to be addressed in the next stage of the process. Highlighting and documenting lessons learnt from previous projects will go some way to managing their potential re-occurrence on the project in question.

One of the particular advantages of undertaking risk identification in facilitated workshop environment, is that the workshop participants will subsequently and collectively undertake the risk analysis and evaluation tasks and consider treatment options. This means that those who are ultimately assigned risk management actions have been involved with the identification, assessment and consideration of how to treat the particular risks. They therefore, have a much deeper understanding of the risk and how it relates to the project, than would otherwise be the case. They are also likely to have an understanding of why the risk needs to be treated than would be the case if the action were simply assigned to them without any prior knowledge or involvement.

The primary advantages and disadvantages of the workshop-based brainstorming approach are:

Advantages

- Aids communication and buy-in
- Utilises team experience
- Promotes original thought

Disadvantages

- Looses focus without strong facilitator
- Relatively high cost
- Not effective when project conflict exists

4.2 Prompt Lists and Check Lists

Each Works Department that undertakes projects within the Public Works Programme will tend to implement projects that are similar in nature. It follows therefore, that these projects are exposed to similar risks each time they are executed. To retain valuable risk knowledge gained from previous experience it is advisable to develop an understanding of where risks will typically be found.

Common means of establishing the generic sources of risk and identifying specific project risks are the development and use of prompt lists and checklists.

Prompt lists consist of a list of subject areas that, from previous project experience, are known to be areas from which risks originate. Prompt lists are normally developed for particular phases of the project or for particular types of risk. A prompt list facilitates the identification of project specific risks from generic risk sources. It is a valuable means of starting the risk identification process. Prompt lists may be developed by Works Departments to reflect the particular generic risk sources that are typically apparent on their projects.

Checklists are more precise than prompt lists. Instead of being an aide memoir of subject areas, checklists tend to be very specific. They will directly relate to a particular subject and as their name implies, checklists are a means to ensure that either particular eventualities have been considered or that particular activities have been undertaken. Typical formats for checklists include questionnaires and tick sheets.

Some suggested prompt lists and checklists are presented in Appendix A.

The primary advantages and disadvantages associated with using prompt lists and/or checklists are:

Advantages

- Retains previous project experience
- Covers all subject areas
- Thorough

Disadvantages

- Does not address project specific risks
- Limits original thought
- Does not consider ‘bigger picture’ risks

4.3 Interviews

A particularly useful means of gathering risk information on specific topics is to interview an expert in that particular field. Through discussion risks can be identified, assessed and potential treatment options prepared.

The advantage of this technique is that the risks are being addressed by someone who is more likely than any other, to be in full appreciation of the implications of risks and their treatment. If there were a particular project issue that was considered by the project team to be particularly risk-prone, interviewing experts on the subject would probably be the most useful means to gather risk information.

The primary advantages and disadvantages for use of interviews in risk identification are:

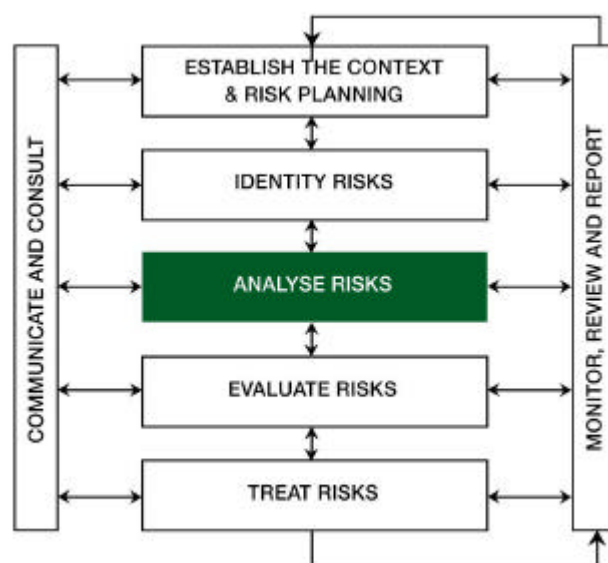
Advantages

- Easily implemented
- Not time consuming
- Clear and focused coverage of subject

Disadvantages

- Selection of appropriate expert is critical
- Does not consider ‘big picture’ risks
- Does not promote common understanding

5. RISK ANALYSIS



5.1 Basis

Risk analysis aims to establish an understanding of the level of risk and its nature. It provides an input to decisions on whether risks need to be treated and the most appropriate and cost effective risk treatment strategies. Risk analysis involves the consideration of sources of risk, their consequences and the probability that these consequences may occur. The level of risk is determined by combining consequence and probability.

Suitable scales for combining consequence and probability should be consistent with the criteria defined when establishing the context. Note however, that for risk analysis to be relevant, it is critical that important that any existing controls are taken into account.

5.2 Types of Analysis

Risk analysis can be undertaken to varying degrees of detail depending upon the risk, the purpose of the analysis, and the information, data and resources available. In broad terms analysis may be qualitative or quantitative, or a combination of these.

Qualitative analysis uses words to describe the magnitude of potential consequences and the probability that those consequences will occur. These scales can be adapted or adjusted to suit circumstances, and different descriptions may be used for different risks.

Quantitative analysis uses numerical values (rather than the descriptive scales used in qualitative analysis) for both consequences and probability.

The choice of analysis method will be influenced by the context, objectives and available resources. In practice qualitative analysis is often used first to obtain general indication of the level of risk and to reveal the major risk issues. Later it may be appropriate to undertake more specific or quantitative analysis on the major risk issues.

The following sections focus primarily on the qualitative form of analysis. Guidance on the use of quantitative analysis methods can be found in Section 5.9 and Appendix B of this Manual.

5.3 Preliminary Analysis

Following completion of risk identification, an initial analysis and prioritisation of the identified risks can be conducted. This preliminary analysis will allow similar risks to be combined and/or low impact risks excluded from detailed study. Excluded risks should be recorded in the risk register for future reference.

5.4 Existing Control Measures

Before the magnitude of the consequences of a risk event, and the likelihood of the event are assessed, it is first necessary to consider existing processes, systems, practices and measures that are already in place (or are already planned to be implemented as part of the project) that will minimise a negative risk.

These existing processes, devices or practices that act to minimise risks, are collectively called **Existing Control Measures**.

This step should be a deliberate (and facilitated) consideration of the particular context in which a particular risk exists. Otherwise it is likely that the assessed level of risk posed by a particular event will likely derive a more pessimistic view of level of risk than might actually be the case.

Existing Control Measures are typically activities, processes and systems that would be normally implemented on a project as part of business as usual activities or as outcomes of previous risk treatment activities, and include:

- current routine Departmental management systems
- planned project specific procedures and systems and controls
- project controls that professional consultants are expected to provide (eg, activities related to quality assurance).

Unfortunately sometimes the value of this step in the analysis process is overlooked,. However the clear articulation and documentation of the Existing Control Measures should be seen as a basic and essential, part of successfully implementing a considered approach to each risk.

5.5 Consequence and Probability Tables

Consequence and probability tables are used to provide definitions for rating scales so there is a common understanding of their meaning. The tables generated or used for a particular project should be consistent with the specific objectives and context of the risk management activity.

By combining consequence and probability, a resultant **Level of Risk** will be derived from the respective **Scale Values**. It is important to appreciate that:

- An event may have multiple consequences and affect different objectives
- The priority of risks resulting from this assessment, is comparative only; i.e. it is not a measure of actual risk levels.
- The combination of consequence and likelihood, is linked such that the probability of the event is considered in light of the assessed level of consequence.

5.6 Consequences

Table 1 shows a sample qualitative consequence table that might be used for an infrastructure capital works project. For consequence tables such as this where differing types of

consequences are shown together, or where the same descriptor is used for the level, then equivalence between each consequence will be inferred. If this is not true, then separate tables and descriptors will need to be developed and be used. Where equivalence is intended, then great care needs to be taken to ensure this is defensible and, where appropriate, agreed with stakeholders.

5.7 Probability

Scales will need to be developed to meet the circumstances of the specific project risk management study. Table 2 provides a sample probability scale. For project risk management it is important that the scale be relevant to a defined period of time against which the absolute probability of an event may be related to given activities i.e. the scale must match the need.

5.8 Level of Risk

The way the level of risk is described will depend upon the type of analysis undertaken. For a qualitative approach as described in this document, level of risk is described in descriptive terms.

To derive the relative level of risk, it is important that the assessed level of probability be derived, based upon the realisation of the considered/assessed level of consequence i.e. the combination of level of consequence and level of probability is linked. Then, once the consequence and probability of each risk has been identified, it is then possible to make a relative assessment of the level of exposure that is presented by each risk. A risk analysis matrix can be used for this purpose. An example of this is given in Table 3, which illustrates the process and descriptors that may be used to combine a level of consequence with a level of probability to determine a level of risk. The number of risk level categories that should be used in a table like this should reflect the needs of the project, remembering that the purpose of such categorisation is to gain an understanding of the level of risk exposure that is present and to provide a means to prioritise the treatment of risk.

The purpose of the risk analysis phase is to gain an understanding of level of risk to make decisions about future actions and define priorities. Section 6 discusses the risk evaluation criteria which provide a means by which decisions can be made.

Note:

Tables 1, 2 and 3 are presented only as examples. It is not suggested that these tables would necessarily be appropriate for all projects within the Public Works Program. Instead it is necessary to develop consequence and likelihood criteria, and an associated risk analysis matrix that are pertinent / specific to the Department or project in question.

Descriptor	Insignificant	Minor	Moderate	Major	Catastrophic
Financial (Costs & Revenue)	Negligible financial consequence (< 1% of budget or revenue)	Minor financial consequence (1 to 5% of budget or revenue)	Moderate financial consequence (5 to 10% of budget or revenue)	Major financial consequence (10 to 25% of budget or revenue)	Huge financial consequence (>25% of budget or revenue)
Programme	Little or no delay	Short delay (increases duration by >2.5%)	Significant delay (increases duration by >10%)	Major delay (increases duration by >25%)	Project halted or huge delay (increases duration by >100%)
Safety	No injuries	First aid treatment / out-patients	A number of injuries / hospitalisation	Extensive injuries / hospitalisation / long-term treatment	Fatality / significant irreversible effects to a number of persons
PR / Profile	Some complaints but project, client, stakeholder reputation intact	Adverse local publicity or media attention	Attention from media and/or significant concern by local community / criticism by NGOs	Significant adverse regional and State media coverage / community and NGO outcry	Serious adverse international and/or national coverage / community and NGO outrage
Relationships	Stakeholders irritated but no formal complaints	Resolved at working level	Resolved at senior management level	Legal recourse or Departmental Head intervention	Government level intervention
Build Quality	Cosmetic repairs / rectification	Minor repairs / rectification	Major repairs / rectification - including structural	Substantial re-build	Total replacement
Operational Impacts	Negligible impact / no significant impact on personnel	Minor change to operations / some inconvenience to personnel	Requires a change in operations, work routines and schedules	Major disruption to operations, work routines and practices - additional resources may be required	Operations not possible or facility closed / impact on the well-being of personnel
Environment	No effects or effects which are below levels of perception, within normal bounds of variation or within the margin of forecasting error.	These effects may be raised as local issues but are unlikely to be of importance in the decision making process. However, they are of relevance in enhancing the subsequent design of the project and consideration of mitigation measures.	Important considerations at a local level but are not likely to be key decision making issues. Mitigation measures and detailed design may ameliorate some of the consequences upon the affected communities or interests.	Important considerations at a local or regional scale. Mitigation measures and detailed design work are unlikely to remove all of the effects upon the affected communities or interests.	Associated with sites and features of national or state importance. Typically mitigation measures are unlikely to remove such effects.
Property / Assets	Negligible damage to or loss of assets	Minor damage to or loss of assets - some repairs may be required	Moderate to high damage to or loss of assets - requires specialist / contract equipment to repair or replace	Significant / permanent damage to assets and/or infrastructure	Widespread, substantial / permanent damage to assets and/or infrastructure
Social / Cultural Heritage	Negligible social or cultural impacts	Minor medium term social impacts on local population, mostly repairable with appropriate management/remediation	On-going social issues / permanent damage to structures or items of cultural significance	On-going, serious social impacts / significant damage to structures or items of cultural significance	Widespread, on-going, significant serious, irreversible social impacts
Legal	Some minor non-compliances and breaches of regulation	Minor legal issues, non-compliances and breaches of regulation with option for legal recourse	Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fines possible	Major breach of regulation / major litigation	Significant prosecution and fines / very serious litigation including class actions
Systems, Information and Data	Negligible loss of or damage to IT and communications - no loss of data	Minor loss of or damage to IT and communications - some data retrieval may be required	Moderate to high loss / damage to IT and communications - some data may be permanently lost & workarounds may be required	Major loss / damage to IT and communications - data permanently lost, significant catch-up, business continuity plans required to be implemented	Extensive loss / damage to IT and communications assets and infrastructure - data permanently lost, widespread disruption to business

TABLE 1 – EXAMPLE CONSEQUENCE CRITERIA

Descriptor	Description of Frequency
Rare	May occur only in exceptional circumstances - can be assumed not to occur during period of the project (or life of the facility)
Unlikely	Event is unlikely to occur, but it is possible during period of the project (or life of the facility)
Possible	Event could occur during period of the project (or life of the facility)
Likely	Event likely to occur once or more during period of the project (or life of the facility)
Frequent / Almost Certain	Event occurs many times during period of the project (or life of the facility)

TABLE 2 – EXAMPLE PROBABILITY (LIKELIHOOD) CRITERIA

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Probability (Likelihood)	Rare	Low	Low	Low	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	High
	Possible	Low	Medium	Medium	High	High
	Likely	Medium	Medium	High	High	Very High
	Frequent	Medium	High	High	Very High	Extreme

TABLE 3 – EXAMPLE RISK ANALYSIS MATRIX

5.9 Quantitative Analysis

The above sections outline a qualitative method of analysis that can be used effectively for project risk management. As stated previously, quantitative analysis methods can also be adopted, in order to realise further powerful benefits, including:

- Refined contingency setting and monitoring of contingency draw-down
- Insurance benefits

Some of the quantitative methods of risk analysis that can be used for projects include:

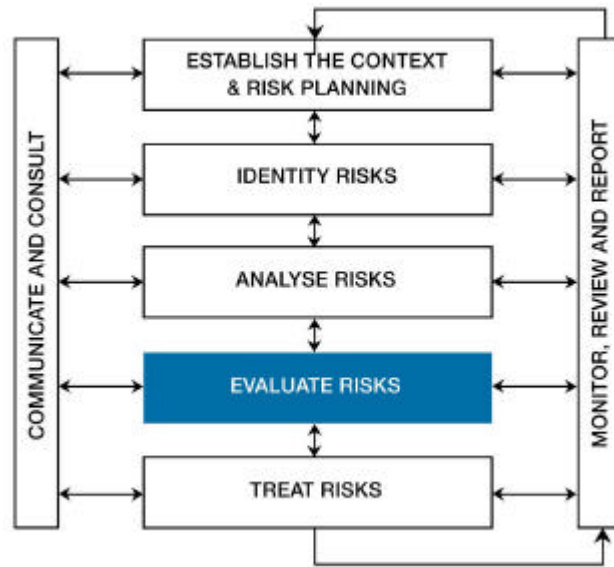
- Expected Value (EV)
- Simulation
- Sensitivity Analysis
- Decision Trees

In the construction project context, the most common methods are Simulation and Expected Value.

The Estimating using Risk Analysis (ERA) approach as described in Works Branch Technical Circular No. 22/93 is based on the Expected Value method. Various methods of quantitative risk analysis are discussed briefly in Appendix B. Discussion on the determination of insurance coverage is also given thereat.

It must be stressed that all methods of quantitative risk analysis rely on information from the qualitative SRM process. Any quantitative analysis must be based on a robust and ongoing qualitative risk management (SRM) process.

6. RISK EVALUATION



6.1 Basis

The purpose of risk evaluation is to make decisions. This is achieved by use of the understanding of risk obtained by analysis to make decisions about future actions. Decisions may include:

- Whether a risk needs treatment
- Whether an activity should be undertaken
- Priorities for treatment

Risk evaluation involves comparing the levels of risk found during the analysis process with risk criteria established when the context was considered.

6.2 Evaluation

All projects have inherent risks. Departments who undertake projects must accept that their Department will be exposed to risks throughout the project implementation process. However, no Department has limitless resources to manage risk. It is therefore necessary to define priorities. Rather than trying to avoid as much risk as possible, which is typically not a cost effective approach, it is preferable to define what level of risk is acceptable and what level of risk is not. Qualitative risk analysis enables priorities to be established and treatment options to be based upon level of risk.

Evaluation criteria will need to be developed to meet the circumstances of the specific Department and project. Table 4 provides a sample set of Evaluation Criteria. As can be seen the criteria are effectively a means by which decisions can be made, specifically:

- Where specific management action (treatment) is required
- The relative priorities for management action
- Whether a risk can be accepted

The sample criteria presented in Table 4 should be considered as a useful guide, and are likely to be suitable for the majority of projects in the Public works Programme. However, it is

always the responsibility of the respective Project Manager to verify the applicability of such criteria for a particular project.

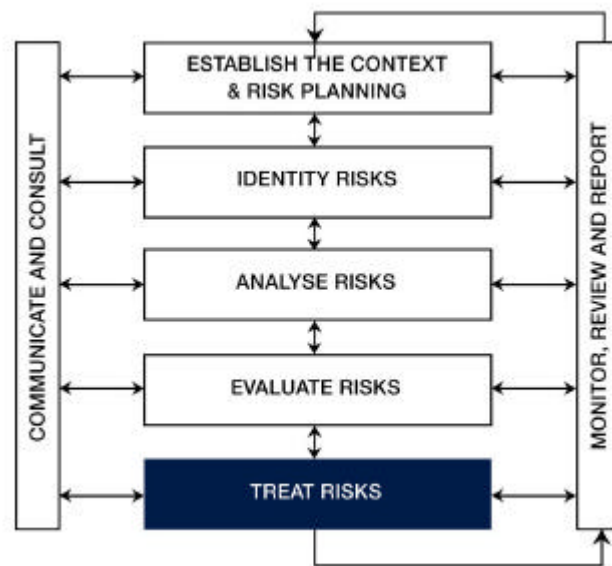
At a fundamental level, risks will either be acceptable or unacceptable. Those that are acceptable require no specific risk treatment, however, they should be monitored and reviewed to ensure that they remain acceptable. Activity during a project's implementation can and often does influence the acceptability of particular risks.

In making decisions in relation to acceptability of a risk, it should also be remembered that there will normally be Existing Control Measures (refer Section 5.4) that would likely already have some mitigating influence on the risk. In many cases measures to deal with a risk, particularly generic risks, will be found elsewhere in the project implementation documentation. If risks can be treated by existing procedures, it should be noted in the Risk Register. The actual implementation of those procedures should also be monitored as part of the risk management process.

Level of Risk	Recommended Level of Management Attention
Extreme	IMMEDIATE senior management attention needed, action plans must be developed, with clear assignment of individual responsibilities and timeframes.
Very High	Senior management attention needed, action plans must be developed, with clear assignment of individual responsibilities and timeframes.
High	
Medium	Risk requires specific ongoing monitoring and review, to ensure level of risk does not increase. Otherwise manage by routine procedures.
Low	Risk can be accepted or ignored. Manage by routine procedures, however unlikely to need specific application of resources.

TABLE 4 – EXAMPLE RISK EVALUATION CRITERIA

7. RISK TREATMENT



7.1 Basis

Arising from risk evaluation there will be a list of risks requiring treatment. Risk treatment involves identifying a range of options for treating these risks, assessing the likely effectiveness of those options, preparing treatment plans and implementing them.

7.2 Risk Treatment Options

Possible treatment options (over and above Existing Control Measures) include:

- avoiding the risk entirely
- transferring or sharing the risk
- reducing the probability and/or the consequences of the risk
- accepting or retaining the risk

7.2.1 Risk Avoidance

Avoidance of a particular risk can be achieved by:

- Deciding not to start or continue with the activity that gives rise to the risk
- Adopting alternate approaches or processes to effectively eliminate the risk in question

The objective of risk avoidance is to eliminate the uncertainty associated with the risk. Some of the specific means by which this can be achieved include:

- Clarifying requirements and objectives
- Improving communication
- Obtaining information
- Research or prototyping
- Acquiring expertise or knowledge

- Reducing project scope
- Adopting a familiar approach
- Using proven methods, tools, techniques, technology
- Building in design redundancy

7.2.2 Risk Transfer or Sharing

To transfer risk is to put in place measures where another party bears (or shares) the risk, preferably by mutual consent. The transfer of responsibility can be total or partial, in which partial risk transfer is referred to as risk sharing. Mechanisms for risk transfer include:

- Insurance arrangement
- Use of Contracts
- Organisational structures such as alliances and joint ventures to spread responsibility and liability

Within the construction industry there are many options for transferring risk to one degree or another through contracts. The particular contract used and its conditions, should always reflect the Works Departments desire and ability to retain, share or transfer particular risk elements.

7.2.3 Reduction of the Probability and/or the Consequences of a Risk

To reduce risk is to acknowledge that there is risk present, that risk avoidance is either not possible or not desired and that there is the capability within the project team to successfully influence either the probability that the risk will occur, its consequences should it occur, or both.

Project risk can be reduced by essentially three methods:

- Reducing the probability that the risk will occur by targeting the cause.
- Reducing the severity of the consequences by introducing contingency.
- Addressing commonly encountered causes of risk with generic responses

7.2.4 Accepting/Retaining the Risk

After risks have been reduced in some way or shared, there will be residual risks that are retained. Risks can also be retained by default e.g. where a considered decision has been made to accept a risk, based upon the risk evaluation process.

7.3 Risk Treatment Process

This section outlines the risk treatment process and the iterative nature of the development of treatment action plans.

7.3.1 Identify Risk Treatment Options

Risk treatment options can be identified whenever risk is being discussed. Common forums for identifying and considering the implications of risk treatment options include:

- Workshop – brainstorming
- Project meetings
- Proposals from risk owners

- Interviews / discussions

Lessons learnt

7.3.2 Consider Implications of Risk Treatment

If one were to consider the treatment of risk in isolation from all other project considerations, it could be argued that global best practice suggests that the selection of treatment strategies should be in accordance with the following hierarchy:

1. Firstly, if a risk can be managed effectively within the project team and it is within acceptability criteria, it should be accepted
2. Secondly, if a risk exceeds acceptability criteria, then it should be avoided.
3. Thirdly, if the risk cannot be avoided, measures should be implemented to reduce the probability that the risk will occur.
4. Fourthly, if a risk can neither be avoided nor its probability reduced, measures should be taken to reduce the consequence that it will have on the project objectives.
5. Finally, if none of the actions identified above is possible, then the risk should be transferred or shared.

It is however observed that for projects within the Public Works Program, Treatment Option 5 above (Risk Transfer or Sharing) is generally second in the hierarchy after Acceptance. It is recommended that the above hierarchy should be used as far as is reasonably practicable, whilst it is understood that there will normally be other project considerations that require to be taken into account in applying any hierarchy.

Selection of preferred risk treatments is typically a **cost-benefit decision**, with preference given to treatments that provide the **best all round benefit** to the project. In the majority of cases, the identification of which treatment provides the greatest benefit will be straightforward and will not require an in-depth analysis. Some of the specific issues that should might be considered in making decisions about treatment options, and respective priorities, are listed In Table 5 below.

Acceptability	Is the option likely to be accepted by relevant stakeholders?
Administrative efficiency	Is this option easy to implement or will it be neglected because of difficulty of administration or lack of expertise?
Capacity	Skills and experience of individuals
Compatibility	How compatible is the treatment with others that may be adopted?
Continuity of effects	Will the effects be continuous or only short term? Will the effects of this option be sustainable? At what cost?
Contacts	Contractual relationships and implications
Cost effectiveness	Is it cost-effective, could the same results be achieved at lower cost by other means?
Economic and social effects	What will be the economic and social impacts of this option?

Effects on the environment	What will be the environmental impacts of this option?
Equity	Are risks and benefits distributed fairly eg do those responsible for creating the risk pay for its reduction?
Individual freedom	Does the option deny any basic rights?
Jurisdictional authority	Does this level or organisation or government have the authority to apply this option? If not, can higher levels be encouraged to do so?
Leverage	Will the treatment options lead to additional benefits in other areas?
Objectives	Are organisational objectives advanced by this option?
Regulatory	Does the treatment (or lack of treatment) breach any regulatory requirements?
Political acceptability	Is it likely to be endorsed by the relevant government authority? Will it be acceptable to communities?
Risk creation	Will this treatment introduce new risks?
Timing	Will the beneficial effects be realised quickly?

TABLE 5 – DECISION MAKING CONSIDERATIONS

However, on occasions, the most beneficial treatment option may not be so clear and further consideration of the implications of various treatments is necessary. The first step to understanding the implications of the risk treatment is to fully appreciate the level of risk that would still be present once the proposed treatment has been carried out. This remaining level of risk is often referred to as the residual risk.

Secondary risk must also be established. Secondary risk is additional risk exposure that may result from undertaking treatment of the originally identified risk.

Another consideration is the cost of the risk treatment activity itself. Consequently, when developing treatment options, residual risk, secondary risks and treatment costs should be factors in the selection of a particular treatment option. A means of ensuring this is to calculate the following for each risk treatment option:

$$NVT = EVU - EVR - EVS - TC$$

Where:

NVT = Net value of treatment option being considered

EVU = Expected value of untreated risk

EVR = Expected value of residual risk

EVS = Expected value of secondary risks

TC = Cost of risk treatment

The net value calculation above can be employed to differentiate between two treatment options from a financial point of view, but it is time consuming to implement and the result of the net value calculation will not in itself dictate the decision to be made. There will be other issues, some of which can be measured, some of which cannot. Consequently, the actual decision on which treatment option to employ is a subjective judgement. The results of calculating the net value of treatments simply provide information that will contribute to the knowledge that tactical levels of management have on the risk in question and will aid decision-making.

7.3.3 Select Treatment Options & Prepare Risk Treatment Plans

Acceptable treatment options are then considered and suitable ones are selected for implementation. Normally, the selection of actual treatment options to be undertaken on the project will be made at the operational level.

Risk Treatment Action Plans are recommended as a formal means to instruct those charged with the responsibility to implement the risk management treatment related to the risk in question. They detail such issues as the actions that require to be undertaken, what resources are required, deliverables and due dates. They are the primary monitoring system for risk treatment activity and as such, require to be communicated to those responsible for project risk management monitoring, review and control. Their dissemination must conform to the risk communication procedures contained in the Risk Management Plan.

Further discussion of Risk Treatment Action Plans is presented in Section 10.4.

7.3.4 Responsibility for Risk Treatment

For each risk treatment, an individual should be nominated to have responsibility for that treatment.

When allocating responsibility for the treatment of specific risk items, the overriding premise that risk should be borne by those parties best able to control the risk should remain a key driver. Further consideration on the appropriateness of a particular individual to take responsibility for a risk treatment may include consideration of a number of additional factors:

- Who is responsible for the activity from which the risk arises
- Who can best control the probability of the risk occurring
- Who can reduce the consequences of the risk most effectively
- Who exercises the greatest level of authority over factors contributing to the risk

7.3.5 Implement Risk Treatment Action Plans

The implementation stage of the process is the actual risk treatment itself. It will require the use of project resources and may require additional resources to be mobilised or procured.

Outlined below is one possible procedure for ensuring that the treatment of risk is communicated to appropriate parties and that the treatment is monitored, reported and controlled.

Step one of the risk treatment process is the completion of a Risk Treatment Action Plans by the Risk Manager and distributed to the treatment owner. A template for a Risk Treatment Plan is presented in Figure 4 and an example is presented in Appendix C.

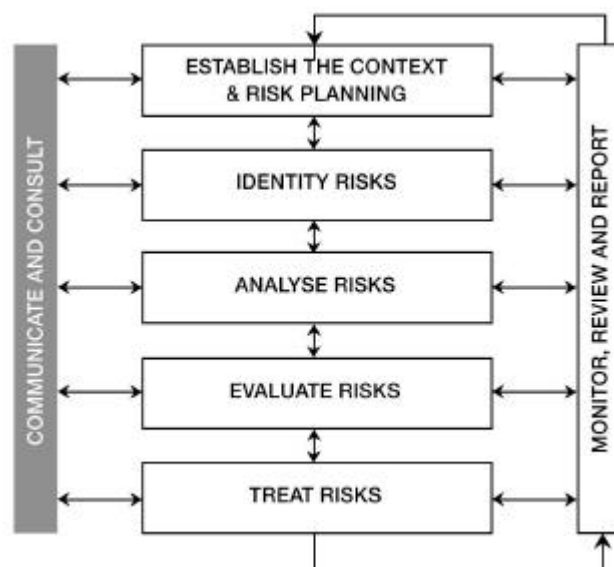
Risk Treatment Action Plans should be created for each of the identified risks that are deemed to require treatment as per the risk evaluation criteria. A Risk Treatment Action Plan should be created for each owner that has activities to carry out in relation to a risk.

Once the risk owners have received the Risk Treatment Action Plans, they should record the details of the treatment activities as they are undertaken and date them. Once they consider

that the required treatments have been completed, they should sign and date the Risk Treatment Plan and return it to the Risk Manager.

Once the Risk Manager receives the Risk Treatment Plan, he/she should update the Risk Register. Finally, at regular periods during the project, the risks that have been treated should be reviewed to ensure that they have had the desired affect in treating the identified risks. If this is not the case, further analysis and evaluation of the current level of risk would be appropriate.

8. COMMUNICATION AND CONSULTATION



Effective internal and external communication and consultation are integral to the risk management process. This is because risk management is not just a technical task but, rather, actions and decisions that take place in a social context. Dialogue with stakeholders should focus on consultation rather than a one-way flow of information from the decision makers to other stakeholders. Thus communication and consultation should be structured to allow all stakeholders to understand the basis on which decisions are made, their relevant roles and responsibilities, and why particular actions are required.

Involving others, or at least looking at things from another point of view, is an essential and crucial ingredient of an effective approach to risk management. Engagement with stakeholders makes risk management explicit and more soundly based, and adds value to an organisation. It is particularly important where stakeholders may:

- impact on the effectiveness of the proposed risk treatments
- be affected in risk incidents
- add value in the assessment of risk
- incur additional costs
- be constrained by future risk treatments

Further, sharing information and engaging with others can help embed risk management as a regular part of the Government business, so that it becomes part of business as usual.

8.1 Stakeholder Identification

Stakeholders are those who may affect, be affected by, or perceive themselves to be affected by a particular project or the risk management process. In other words, stakeholders are those people or groups who have a legitimate interest in the project.

There will be differences of opinion on who should be included as stakeholders but generally, in determining stakeholders, it is important to be as inclusive as possible.

It is important to identify stakeholders and to realise that the Department does not pick the stakeholders, they choose themselves. If a group is missed initially, it is likely they will emerge later and benefits of early consultation will have been missed.

8.2 Communication and Consultation Plan

The extent of the consultation and communication will depend on the situation. For example, risk management in the course of operational decision making necessarily entails a less formal communication process than strategic risk management at the level of an organisation overall. Also at the outset of the risk management process a Department might decide to concentrate initial attention on internal stakeholders and to engage with external stakeholders progressively in subsequent cycles as part of the iterative and dynamic approach to risk management.

The essential elements of a communication and consultation plan (whether a formal document or a checklist) would include:

- The **objectives** of the communication
- The **participants** who need to be included, for example:
 - Stakeholder groups and individuals
 - The project team
 - Specialists / experts
 - Project or Departmental public relations / communications team
- The **perspectives** of the participants that need to be taken into consideration
- The communication **methods** to be used
- The **evaluation** process to be used

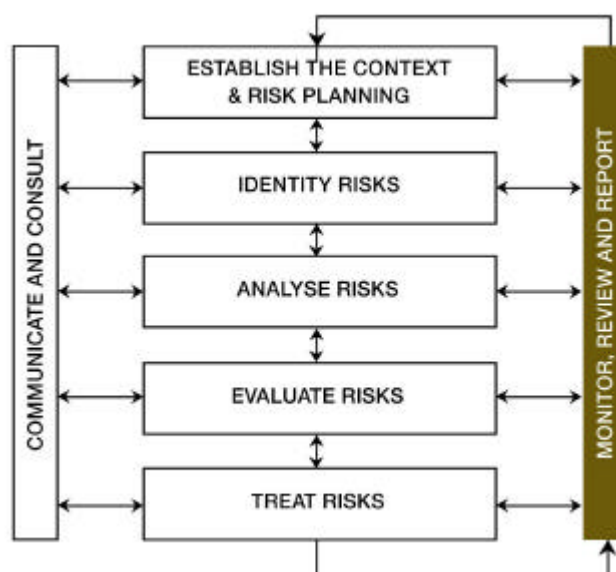
The method of communication and consultation will need to be varied throughout the risk management cycle.

8.3 Benefits of Communication and Consultation

For all projects, effective communication and consultation of the risk management objectives and activities and outcomes will greatly assist in the effective implementation of the risk management process. Specifically, it will facilitate:

- Building greater awareness and understanding about a particular issue/risk
- Learning from stakeholders, and also providing a means by which stakeholders can be advised of risks or risk treatments over which they have some influence or control
- Influencing the target audience or users
- Obtaining and communicating a better understanding of risk context and appropriate risk criteria, and also the effect of risk treatments
- Achieving an attitudinal or behavioural shift in relation to a project or particular aspect of a project matter

9. MONITORING AND REVIEW



9.1 Purpose

Risk management is a dynamic process. The importance of identified risks will change, and new risks will emerge, as a project proceeds. As such risk management should not be viewed as a ‘one-off’ exercise.

It is essential to project success that the risk management process is kept relevant and alive throughout the duration of the project. Risks (consequence and probability) and the effectiveness of control measures need to be monitored, as they will change with time. Additionally, as the project proceeds through the project life cycle from business case to commissioning, new (or previously overlooked) risks will emerge. As such, ongoing review of the process and monitoring is essential to ensure that risks and the management plan remain relevant and effective.

Departments should embrace “review” as an integral part of the overall risk management process. To keep the risk management process current, meaningful and relevant, mechanisms should be established to allow continuous feedback from the Project Team to the Risk Manager, and a formalised updating of the risk management plans and associated documentation, at set periods during a project.

Actual progress against risk treatment plans provides an important performance measure and should be incorporated into Departmental performance management.

Monitoring and review should also involve learning lessons from the risk management process, by reviewing events, the treatment plans and their outcomes.

9.2 Measurement of Risk Management Performance

Performance indicators are quantitative measures of the level of performance of a given item or activity. They need to be measurable and appropriate to individual Departmental or project needs and hold individuals accountable while forming the basis for continuing improvement.

The performance indicators should reflect the range of key project objectives defined when the context was established at the start of the process.

Performance indicators may monitor outcomes (for example, specific losses or gains) or processes (for example, consistent performance of risk treatments procedures).

Normally a blend of indicators is used but outcome performance indicators usually significantly lag the changes that give rise to them so in a dynamic environment process indicators are likely to be more useful.

Performance indicators should reflect the relative importance of risk management actions, with the greatest effort and focus applied to:

- The highest risks
- The most critical treatments or other processes
- Those treatments or processes with the greatest potential for improvements in efficiency

In choosing performance indicators it is important to check that:

- They are reasonably able to be measured
- They are efficient in terms of demands on time, effort and resource
- The measuring process / monitoring encourages or facilitates desirable behaviours and does not motivate undesirable behaviour (such as fabrication of data)
- Those involved understand the process and expected benefits and have the opportunity to input to the procedure
- The results are captured and reported in a form that will facilitate learning and improvement

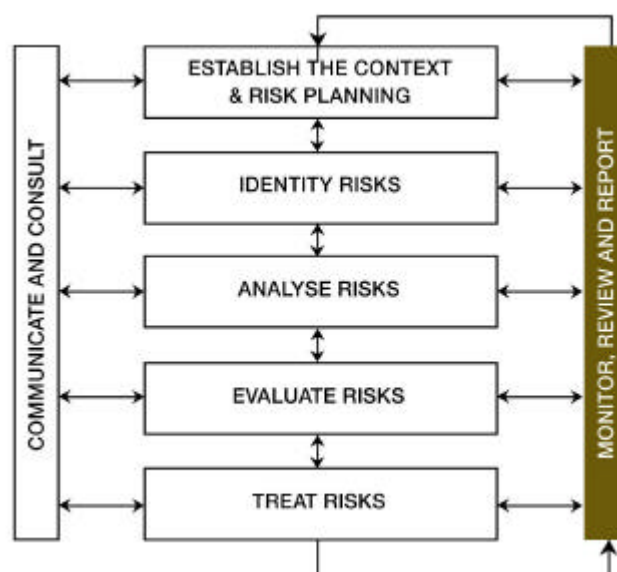
Some examples of useful risk management performance indicators are:

- Decline in total cost of risk
- Progress towards a specific organisational objective
- The extent to which recommendations for risk treatment are implemented

When considering which performance indicators may be appropriate for a particular project, the following items should be carefully considered:

- Effective measurement of performance requires resources. These should be identified and allocated as part of the development of the performance indicators.
- Some risk management activities may be difficult to measure. This does not make them less important but it may be necessary to use surrogate indicators. For example, resources devoted to risk management activities, may be a surrogate measure of commitment to risk management.
- Any variance between performance indicators measurement data and instinctive ‘feel’ is important and should be investigated. For example - if despite numerous risk assessments indicating low residual risk, Departmental management remain worried.
- While sudden deterioration in indicators will usually attract attention, progressive deterioration can be equally problematic and trends in performance indicators should be monitored and analysed.

10. RECORDING THE RISK MANAGEMENT PROCESS



10.1 Basis

Documenting each step of the risk management process is important:

- To demonstrate to stakeholders that the process has been conducted properly
- To provide evidence of systematic approach to risk identification and analysis
- To enable decisions of processes to be reviewed
- To provide a record of risks and to develop the Department's knowledge base
- To provide decision makers with a risk management plan for approval and subsequent implementation
- To provide an accountability mechanism and tool
- To facilitate continuing monitoring and review
- To provide an audit trail
- To share and communicate information

At each stage of the process, documentation should include:

- The objectives of the stage
- The information sources on which outcomes were based
- All assumptions made in the process
- Who was involved
- The decisions that were agreed

There is a range of media that can be used to record the risk management process. Three of the primary recommended recording media are:

- Project Risk Management Plan
- Project Risk Register

- Risk Treatment Plan

The suggested contents of these are discussed in the following sections.

10.2 Risk Management Plan

The **Project Risk Management Plan** provides a high-level view of the risk management process as applied to a specific project, and how it is embedded in project activities.

The Risk Management Plan may contain:

- A outline of the project objectives
- A statement of the project risk management strategy (which will necessarily need to be consistent with Departmental policy)
- Details of the scope and objectives of the risk management activities on the project, timing and analysis and evaluation criteria
- A description of the external and internal context arrangements for management and supervision of the risk management process
- Risk management roles, responsibilities and functions on the project
- Description of the reporting formats to be adopted on the project, this would necessarily include the project Risk Register

An example Risk Management Plan is presented in Appendix C.

10.3 Risk Register

The **Risk Register** provides the latest details on identified risks and their current status. Typically the register would provide the following information for each of the identified risk items:

- Unique risk identification number
- A description of the identified risk, its causes and consequences
- Details of existing control measures
- Analysis of consequence/and probability, given the controls
- Risk rating
- Suggested risk treatments
- Nominated person(s) responsible for specific risk treatments (where approved), and associated timeframes for implementation.
- Review arrangements

An example Risk Register is presented in Appendix C, and a suggested blank proforma is presented in Figure 3.

10.4 Risk Treatment Action Plan

The **Risk Treatment Action Plan** documents the new management actions and controls to be adopted. It would typically comprise the following information:

- The actions to be taken and the risks they address
- Who has responsibility for implementing the plan

- What resources are to be utilised
- The budget allocation
- The timetable for implementation
- Details of the mechanism and frequency of review with the status of the treatment plan

An example Risk Treatment Action Plan is presented in Appendix C, and a suggested blank proforma is presented in Figure 4.

Figure 3 - Example Risk Register Template

Risk ID	Identified Risk Item		Existing Control Measures (ECMs)		Initial Risk Analysis										Residual Risk Analysis			Close Out
	Risk Item	Consequences & Additional Comments / Notes	ECMs Already in Place	ECM Owner	Consequence of Risk <i>with ECMs</i>	Likelihood of Risk <i>with ECMs</i>	Risk Rating <i>with ECMs</i>	Treatment Strategy	Possible Treatments (Additional Risk Control Measures RCMs)	Approved for Implementation	Risk Treatment Action Plan Ref. No.	Treatment Owner	Timeframe for Implementation	Consequence of Risk <i>with additional RCMs</i>	Likelihood of Risk <i>with additional RCMs</i>	Risk Rating <i>with additional RCMs</i>	Comment/ Status	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11) <input checked="" type="checkbox"/> Approved	(12)	(13)	(14)	(15)	(16)	(17)	(18)	
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								
		♦	♦						♦	<input type="checkbox"/> Approved								

Notes:

(1) Unique identification number for each identified risk

(2) Full description of the risk and outcomes

(3) Description of the consequences of the risk on project objectives, together with any other additional details as appropriate

(4) Details of Existing Control Measures that will exert a positive influence the risk

(5) Person / party responsible for implementation of the Existing Control Measure

(6) Level of consequence derived from risk analysis criteria (taking into account the influence of any Existing Control Measures)

(7) Likelihood that the assessed level of consequence will occur. Level of likelihood derived from risk analysis criteria (taking into account the influence of any Existing Control Measures)

(8) Level of risk (risk rating) derived from the combination of adjudged level of consequence and the associated (linked) level of likelihood, using the risk analysis matrix

(9) The proposed treatment strategy e.g. avoid, mitigate by reducing likelihood, mitigate by reducing consequence, share, transfer, accept

(10) Full details of the proposed risk treatment activities (Additional Risk Control Measures)

(11) Confirmation of senior management approval for implementation of treatments (Additional Risk Control Measures)

(12) Reference No. for associated Risk Treatment Action Plan (where appropriate)

(13) Person / party responsible for implementation of the approved treatment (Additional Risk Control Measure)

(14) Timeframe / schedule for implementation of the approved treatment (Additional Risk Control Measure)

(15) Residual level of consequence derived from risk analysis criteria (taking into account the influence of any approved Additional Risk Control Measures and also the Existing Control Measures)

(16) Residual likelihood that the assessed level of consequence will occur. Level of likelihood derived from risk analysis criteria (taking into account the influence of any approved Additional Risk Control Measures and also the Existing Control Measures)

(17) Residual level of risk (residual risk rating) derived from the combination of adjudged level of residual consequence and the associated (linked) residual level of likelihood, using the risk analysis matrix

(18) Any comments on risk issues and report on current status should be entered here

FIGURE 4 – EXAMPLE RISK TREATMENT ACTION PLAN PROFORMA

Risk Treatment Action Plan		Treatment Plan No:
Project Name:		Risk ID No:
Approved and issued by: (Project Risk Manager)	Issued to for implementation by: (Risk Treatment Owner)	Date Issued:
<i>Full description of risk:</i>		
<i>Summary of likely impacts (consequences) and recommended response and impact:</i>		
<i>Specific details of agreed treatment actions (action plan):</i>		
<i>Approved resource requirements:</i>		
<i>Responsibility:</i>		
<i>Timing:</i>		
<i>Monitoring & reporting requirements:</i>		
Treatment completed by: (Risk Treatment Owner) Signature:..... Date:.....	Treatment close-out approved by: (Project Risk Manager) Signature:.....	Date of Completion:

11. IMPLEMENTING EFFECTIVE RISK MANAGEMENT

11.1 Policy

ETWB policy in relation to the application of SRM to the Public Works Projects is contained in ETWB Technical Circular (Works) No. 6/2005: Implementation of Systematic Risk Management in Public Works Projects.

11.2 Responsibilities and Authority

11.2.1 Management Commitment

The success of implementing effective risk management programmes at all levels is largely dependent upon the support and sponsorship of senior management both within Departments and Project Teams.

11.2.2 Risk Manager

It is recommended that risk management activity is co-ordinated by a designated officer who has been appointed specifically for this purpose. This person is referred to as the Risk Manager and on smaller or less complex projects he/she may also hold other project positions. It is expected that an officer of senior professional rank shall be appointed for this purpose for in-house projects. For consultant-managed projects, it is expected that specific professional staff equipped with expertise in this field shall be employed.

The Risk Manager should ensure that risk is considered by stakeholders and project participants who have an operational management role on the project or who provide a specific service. These stakeholders may include works departments, enabling/maintenance departments, appointed consultants, contractors and suppliers. The Risk Manager should ensure that risk is addressed in a manner that is consistent with the principles of this Circular and that it is properly recorded.

11.2.3 Project Team

All those within the project team have a duty to identify risks where they are present and to relate the details of those risks to the core team responsible for the implementation of the risk management process. The project team members also have a responsibility to undertake risk management activity where it is assigned to them by the core team or by the mechanisms detailed in the risk management plan.

Responsibilities in the construction industry are largely dictated by contracts. It is therefore necessary to identify what contribution to the project risk management process is required from those who will be responsible in some way to project delivery and to define that role in their respective contracts. Ideally, everyone involved in project delivery should be required to identify risks and communicate them to the appropriate parties.

The size and complexity of the project, the extent of the risk management strategy and the financial commitment of the client organisation to project risk management will largely dictate the resource requirements for undertaking these activities. One concept is critical however; there must be a single assigned party responsible for implementing the project risk management process at the project level. This might normally be the Project Manager. This is not to suggest that the Project Manager will conduct the risk management process in a ‘hands-on’ capacity. Instead the Project Manager may delegate the day-to-day implementation of the risk management process to an appropriately experienced Project Team member, or the Risk Manager. However, the Project Manager remains the person with responsibility and accountability to ensure that the risk management process is properly implemented and effective throughout the entire duration of the project.

11.2.4 Contracted Stakeholders

Many stakeholders will be in contract with the particular Works Department that is undertaking the project. Contracts by their nature, transfer prescribed elements of responsibility from one party to another and therefore much of the responsibility to manage the associated risks are typically also transferred. However, unless it is specifically stated in their contract, these stakeholders are under no obligation to conform to the risk management processes outlined in this document. It is therefore imperative that the requirements for stakeholders' risk reporting and risk management activity are defined prior to their appointment and that those requirements are included in their respective contracts.

Note: ETWB TCW No. 6/2005: Implementation of Systematic Risk Management in Public Works Projects provides some suggested sample clauses for incorporation into works contract documents and consultancy briefs to ensure that contracted stakeholders implement risk management practices in accordance with this Manual.

11.3 Success Factors

Risk is managed by the individuals who have a responsibility to control particular elements of the project. When project risk management, and as a result projects, fail, it is usually due to people issues rather than procedural issues.

To facilitate the implementation of a successful and systematic risk management process on projects, a number of underlying factors should be present. They include:

- Experienced and effective leadership of the risk management process.
- Senior management understanding and support.
- Effective communication of risk issues.
- Risk management policies that are clearly communicated to project participants.
- A defined risk management process, approved at senior level.
- The consistent application of risk management across all elements of the project.
- A risk management process that is closely linked to achievement of project objectives.
- Risks associated with working with other organisations are assessed and managed.
- Risks are actively monitored and regularly reviewed.

There is no single application of a risk management process that can be considered as the optimal solution for every project case. Large projects have differing needs to small projects, as complex projects have differing needs to more simplistic ones. The challenge of implementing an effective risk management strategy on a project is to ensure that the scale of risk management activity is matched to the project.

11.4 Timing Considerations

11.4.1 Continuous Process

It is critical for project success that risk management is applied throughout the project. One of the major causes of a failed risk management process is that it is considered to be either a single or a small number of isolated interventions during the early stages of the project.

It must be realised that risk management is a continuous and developing process that is integral to the implementation of the project itself. It will not normally be possible or cost effective to attempt to deal with all project risk near the commencement of a project. Projects by their very nature, contain uncertain future events that will impact the project during

its implementation. These impacts must be controlled and they must be controlled throughout the entire implementation of the project.

There is an obvious need to target particular types of risk exposures at particular stages during the project implementation process. However, the risk process should be managed in the knowledge that the optimum time to influence some risks that may arise later in a project, are actually in the current project stage.

11.4.2 Early Application

Time spent at the start to set a Risk Management approach will be a critical success factor. This is due to the reality that the ability to manage risk diminishes with time, as illustrated in Figure 5 below.

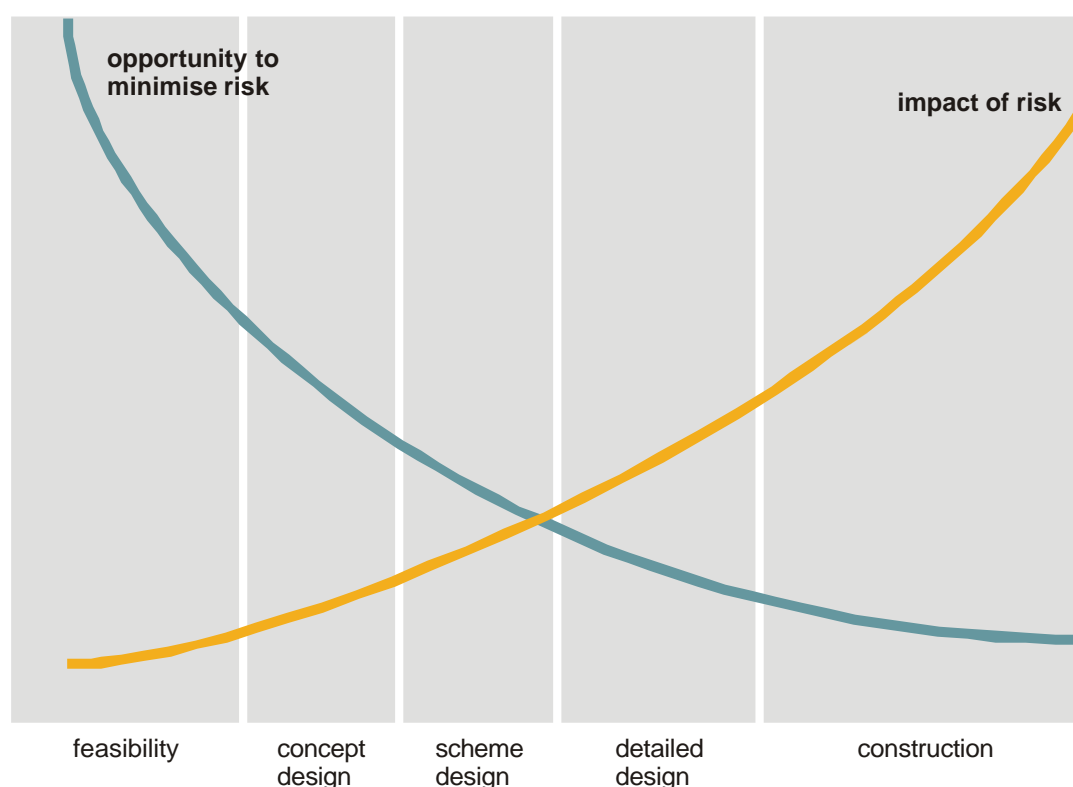


FIGURE 5 – OPPORTUNITY TO MINIMISE RISK VS TIME

Thus the best opportunity for a Works Department to cost-effectively manage risk on Public Works Projects is toward the beginning of projects, especially during the Feasibility and Preliminary Design stages. As a project progresses, a Works Department's ability to actively manage risk is reduced dramatically. The primary reason for this is that elements of the project become fixed eg. the scope of the project, the site boundary, design elements etc. Changes to these elements once they have been fixed, might normally result in unbudgeted expenditure and delay to the particular phase of the project.

Secondly, during the project, responsibility for particular elements of the project may be transferred from the Works Department to Consultants, Suppliers and Contractors (Contracted Stakeholders). The transfer of responsibility also results in a transfer of risk. Once the risk has been transferred to another organisation, the ability of a Works Department to actively manage that risk is greatly reduced.

It therefore follows that a systematic risk management process should be established on a project as soon as reasonably practicable and maintained throughout the entire duration of the

project. It also follows that those who have risk transferred to them should also be required to actively manage risk and manage it in a manner that is consistent with the guidelines outlined in this User Manual.

11.5 Aligning Risk Management to Project Phases

As the project progresses there are three distinct objectives that a project must achieve.

- It must be demonstrated that the project is technically feasible. This objective is achieved by carrying out a Technical Feasibility Statement and/or a Feasibility Study, and the project receives Category C status.
- The second objective is to define what requires to be constructed. This objective is achieved by the production of a detailed design, tender and contract documentation and the approval of the PWSC paper.
- The third objective is to construct the works. This objective is achieved when the Contractor has fulfilled all his obligations under the Contract and the facility has been handed over to the operation and maintenance staff.

Therefore, in order to successfully manage risk, risk management activity must be aligned with these three objectives.

11.5.1 Project Definition and Technical Feasibility

The initial phases of a project developed from a Government policy-based, business or community need, to a stage where the project has been demonstrated to be technically feasible.

On receipt of a Project Definition Statement, a Works Director is required to prepare a Technical Feasibility Statement. The Technical Feasibility Statement is required to be completed within four months and without recourse to consultancy support¹.

When undertaking studies to include in the Technical Feasibility Statement, there is a requirement to define a project programme and prepare a capital cost estimate. There is also a need to consider the risks to which project programme and the capital cost estimate are exposed.

Risks to be addressed at this time would be project specific. However, they are likely to emanate from some of the sources listed below (note, this list is not exhaustive, and all risk areas should be considered as appropriate for the project in question):

- Political Risks – Proposed project does not serve stated Government policy directives
- Economic Risks – Inflation may lead to reduced patronage
- Environmental Risks – Accidental chemical spillage during plant operation.
- Procurement – Procurement strategy allocates responsibilities to inappropriate parties
- Project Control – Management controls are not suitable to the scale of the project.
- Financial/Legal – Business case is unsound
- Human – Public opposition to proposals

Appendix A provides some lists of possible sources of risk, and Appendix D provides examples of risks that may be encountered on projects and options for treating them.

¹ Financial Circular No.11/2001 – Requirement for Project Definition Statement and Technical Feasibility Statement for Capital Works Projects

11.5.2 Design

A project design undergoes a number of distinct phases of development after the preparation of the Technical Feasibility Statement and/or Feasibility Study:

- The design at feasibility stage is developed to a stage where the major design elements are fixed, being the preliminary design.
- The preliminary design is developed to a detailed design and the PWSC paper is drafted.
- The detailed design is finalised and tender and working drawings are produced.

Risks to be addressed at this time again would be project specific. However, they are likely to emanate from some of the sources listed below (note, this list is not exhaustive, and all risk areas should be considered as appropriate for the project in question):

- Economic Risks – Escalating project costs due to improving economy for example
- Political Risks – Government policy change (may affect budget availability)
- Environmental Risks – Designed noise protection proved to be inadequate during construction.
- Procurement – Local market has little or no experience of proposed construction techniques
- Project Control – Detailed design period too short to complete detailed design with available resources.
- Financial/Legal – Lease conditions cannot be agreed
- Human – Unfamiliarity with approvals process
- Natural – Wet season stops work in nullah
- Construction – Long lead items not purchased in sufficient time
- Design – End user requirements change after fixity of architectural layout drawings
- Operations and maintenance – Lifecycle costs not considered adequately.

The project will dictate the appropriate approach to risk management undertaken during this stage. Typically checklists, prompt lists and interviews would be used in a similar manner as during the project definition and project feasibility stage. Appendix A provides some prompt lists of possible sources of risk, and Appendix D provides examples of risks that may be encountered on projects and options for treating them.

However, since a certain amount of risk will have been transferred to or shared with consultants by this stage, and with it possibly also transfer or share responsibility for management of particular risks, there is a need to integrate consultants into the risk management process. Consequently the respective Department should specify that any risk management activities undertaken by any contracted consultant should be consistent with the guidelines outlined in this User Manual. For example the following approach may be specified:

- At the commencement of their services, the consultants should be required to produce their own Risk Management Plan to demonstrate how they intend to manage the risks that are within their control.
- During the course of the project, the consultants have the responsibility to implement appropriate risk management activities in accordance with this Manual, and consistent with the risk management practices adopted by the Works Department on the project.

- Record the results of their risk management activities on the project by means of updated versions of their Risk Management Plan, a Project Risk Register and associated Risk Treatment Action Plans. With the requirement that each of these documents are updated and distributed to the Works Department on an agreed review and reporting schedule.

11.5.3 Construction

By the time construction begins, a significant portion of the Works Department's risk has been managed or has been transferred to or shared with Contracted Stakeholders (Consultants or Works Contractors). It is expected that the specific risk treatment measures (or responsibilities) would be transferred to the Contractors via specific clauses in the Particular Specifications/Bill of Materials and/or other Special Conditions of Contract of the contract document (such as in the case of insurance).

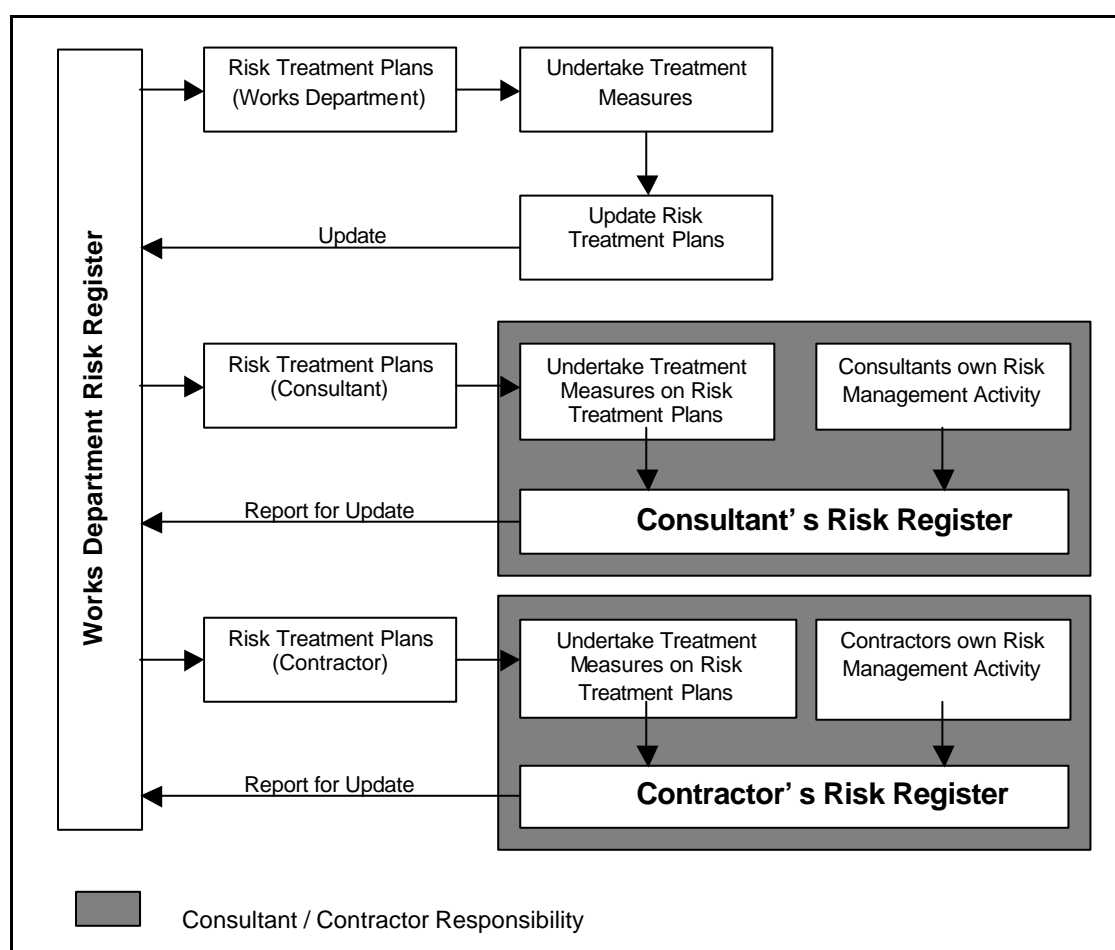
Therefore, during this stage, the Works Department's role may become monitoring and control orientated. However it is imperative that the respective Department should still retain an active risk management regime. The Departmental Project Manager remains the person with responsibility and accountability to ensure that the risk management process is properly implemented and effective throughout the entire duration of the project. For the purpose of systematic monitoring, the Contractors should be provided with the Risk Treatment Plans for those risks under their responsibility; and the Contractors should prepare their own risk register and undertake the risk treatment activity as required.

Risks to be addressed at this time again would be project specific. However, they are likely to emanate from some of the sources listed below (note, this list is not exhaustive, and all risk areas should be considered as appropriate for the project in question):

- Economic Risks – Declining Contractor profit margins (may lead to decreased quality)
- Environmental Risks – Excessive complaints about construction debris not being confined to site.
- Procurement – Multi-layered sub-contracting
- Project Control – Non-conformance with specification.
- Financial/Legal – Dispute over variations
- Human – High turnover of key staff
- Natural – Adjacent slope de-stabilised by construction work
- Safety – loss of life or injury on site
- Operational – site operations impacting upon day-to-day activities in adjacent areas
- Approvals – statutory approvals or third-party agreements not in place by required time, leading to programme delays

Appendix A provides some prompt lists of possible sources of risk, and Appendix D provides examples of risks that may be encountered on projects and options for treating them.

As described previously in relation to the design stage, since a certain amount of risk will have been transferred to or shared with Contracted Stakeholders (Consultants and Works Contractors), there is a need to integrate these contracted parties into the risk management overall process. Consequently the respective Department should specify that any risk management activities undertaken by any contracted organisation should be consistent with the guidelines outlined in this User Manual. Figure 6 illustrates one possible way in which this concept could be implemented. However, it must be remembered that the Departmental Project Manager remains the person with responsibility and accountability to ensure that the risk management process is properly implemented and effective throughout the entire duration of the project.



**FIGURE 6 - INTEGRATION OF CONTRACTED STAKEHOLDERS
INTO THE RISK MANAGEMENT PROCESS**

11.6 Risk Management Reviews

In order to effectively address project-wide risks and external influences that may have an effect on the project, it is necessary for the Risk Manager to gather a group of people who represent the major components of the project. On most Public Works Programme projects, the Project Steering Committee is a group that will generally contain the major stakeholders and therefore, is representative of the major elements of the project. It is therefore, this group who are ideally placed to undertake the identification, assessment and treatment of project wide or external influences that may be a risk to the project.

The objective of such Risk Management reviews is to address specific risk areas at key stages of the project.

Chaired by the Risk Manager, the reviews should objectively address each area of the project that is relevant at the time. The Risk Manager must decide the most appropriate means of achieving this. Some of the methods that can be used are discussed in this User Manual.

The exact form and number of dedicated Risk Management reviews will be dependent upon a range of factors including scale and complexity of the project in question. However, the following sections outline some of the project related milestones at which project risks can be specifically addressed. Ultimately however, it is incumbent upon the Risk Manager (and by default the Project Manager) to ensure that there is appropriate and meaningful consideration of risk throughout the project, and commensurate with particular project circumstances.

11.6.1 Pre-feasibility Risk Management Review

The project start up process produces a preliminary justification for the project based on a strategic assessment of business needs and an assessment of the project's likely costs and potential for success. A Project Definition Statement is produced to explain the Client Department's rationale behind the project requirements and their commitment to the project.

The next phase in the Public Works Programme implementation process is to prepare the Technical Feasibility Statement (TFS). The pre-feasibility risk management review will take place prior to the production of this document.

The TFS finalises the project's scope and ensures that the project is technically feasible prior to its inclusion in the Public Works Programme as Category C project. The purpose of the pre-feasibility risk management review is to identify and assess the risks that require to be managed to ensure that a robust TFS that can be presented for approval. The briefing risk management review will also detail the necessary risk treatment measures that require to be undertaken during the TFS production phase.

As a minimum, the lead Works Department Director or his delegates, the Programme Manager, the Project Manager, the Risk Manager and the leading members of the TFS team, should actively participate in the review.

11.6.2 Post-feasibility Risk Management Review

One of the prime objectives of a feasibility study is to identify the major project risks that are present and ensure that none are insurmountable.

The pre-feasibility risk management review is an opportunity to identify risks that are evident prior to the feasibility study. During the feasibility study itself, it is natural that more risks will become apparent. The purpose of the post-feasibility risk management review therefore, is to address these risks and any others that may become apparent with the benefit of information gathered by the feasibility study. It is to ensure that project risk is rationalised prior to the acceptance of the project within the Public Works Programme under Category C.

As a minimum, the lead works department Director or his delegates, the Programme Manager, the Project Manager, the Risk Manager and the leading members of the TFS team, should actively participate in the review.

11.6.3 Preliminary Design Risk Management Review

Once the Resource Allocation Exercise (RAE) has been undertaken, the project will become a Category B project. This will enable the commitment of resources to commence the design phases of the project. The preliminary design risk management review will be held at this time.

The first stage of the design phase is to produce a preliminary design. The purpose of preliminary design is to develop the design from the conceptual level that was presented by the TFS to a level that is sufficient to form the basis for detailed design.

The purpose of the preliminary design risk management meeting is to identify and assess the risks that require to be managed to ensure that the objectives of the preliminary design are met. The preliminary design risk management review will also detail the necessary risk treatment measures that require to be undertaken during the preliminary design stage.

As a minimum, the Project Manager, the Risk Manager and the Project Steering Committee should actively participate in the review, along with other stakeholders as appropriate. The frequency of such reviews should be commensurate with the duration, scale and complexity of the project

11.6.4 Detailed Design Risk Management Review

Once the preliminary design has been completed, a basis for detailed design exists. The detailed design risk management review will be held at this time.

The purpose of the detailed design risk management review is to identify and assess risks that require to be managed to ensure that the detailed design objectives are met. It will also address operational issues that require to be addressed by the design.

As a minimum, the Project Manager, the Risk Manager and the Project Steering Committee should actively participate in the review, along with other stakeholders as appropriate. The frequency of such reviews should be commensurate with the duration, scale and complexity of the project.

11.6.5 Tender Risk Management Review

Toward the end of the detailed design phase and prior to a funding application for Category A status, contract documents will require to be prepared for Works Contract tendering purposes. The tender risk management review will be held prior to the production of these documents.

The objective of the review is to define the strategy for the allocation of risk in the Works Contract and to set in place measures to manage risks the Works Contractor's organisation may bring to the project.

As a minimum, the Project Manager, the Risk Manager and the Project Steering Committee should actively participate in the review, along with other stakeholders as appropriate.

11.6.6 Works Contract Risk Management Review

The forms of Contract widely used in the Public Works Programme result in the situation that most project changes that occur after a Works Contract has been entered into will often increase project costs, delay the project or be a source for conflict between the contracted parties. All this is counter-productive to the successful delivery of the project. Therefore, prior to the tendering of a major Works Contract, it is necessary to identify elements of the project that are susceptible to change and to address how their associated risks will be managed.

As a minimum, the Project Manager, the Risk Manager and the Project Steering Committee should actively participate in the review, along with other stakeholders as appropriate.

11.6.7 Construction Risk Management Review

The construction risk management review will be held once the works Contractor has been appointed and his management team have been mobilised. The objective of the review is to address the construction phase risks.

As a minimum, the review is to be attended by the Project Manager, the Risk Manager and the Project Steering Committee and key members of the Contractor's management team, along with other stakeholders as appropriate. The frequency of such reviews should be commensurate with the duration, scale and complexity of the project.

11.6.8 Commissioning Risk Management Review

The commissioning risk management review will be held prior to the testing and commissioning of the facility. The objective of the review is to address the risk to the testing, commissioning and handover of the building.

As a minimum, the Project Manager, the Risk Manager, the Project Steering Committee and key members of the Contractor's commissioning team should actively participate in the review..

11.7 Preparation for Dedicated Risk Management Reviews

Those attending the dedicated risk management review should have prior knowledge of the particular project risk management process that is being utilised on the project in question. If not an introductory presentation should be given.

Dedicated risk management meeting participants should be carefully matched to the objective of the particular review. Some meetings will be detailed, requiring technical input, some will be commercially based, requiring strategic and tactical management input. In each case it is imperative that those attending are able to make decisions and commitments on behalf of their own organisations on the subjects that will be discussed.

Dedicated risk management reviews should be well structured. Their format and the specific areas to be discussed should be defined beforehand and informed to those who will attend. This should be done to allow sufficient time for background research and to enable the attendees to become familiar with the chosen subjects.

Dedicated risk management reviews stand a greater chance of success if those attending come prepared and if they have given some thought to the dedicated risk management meeting topic. Dedicated risk management reviews in which attendees arrive with little understanding of what the risk management process is, what subjects are to be discussed and what is expected from them in terms of input are always less productive than those that are well organised.

11.7.1 Management of the Review

Each dedicated risk management review should be chaired by the Risk Manager.

It is not the responsibility of the Risk Manager to identify risk, but to develop the environment in which risks are identified by deftly controlling the direction and rhythm of the dedicated risk management review.

The control of individual personalities is an important aspect of the Risk Manager's role. Naturally quiet participants should be encouraged to share their views, voluble participants should be controlled so that they do not dominate the discussions.

All views are relevant. If a subject area is being considered that is either the responsibility, or the specialist area, of a particular participant, this does not mean that he has exclusive rights to consider the risks that may be there. Very often individuals will become protective of what they perceive to be their own 'territory'. A skilful Risk Manager will set the environment where observations from those outside that 'territory' are seen as constructive rather than threatening.

Avoid debates about whether an identified risk is relevant or not. If someone has mentioned it, then include it in the initial register. If it is not relevant, this will become apparent during the assessment stage.

Once a particular risk has been identified, it is often a temptation for those not fully conversant with the project risk management process, to immediately look for possible solutions and then get into discussion over the relative merits of those solutions. This approach will very quickly degenerate the dedicated risk management review into a detailed discussion, usually involving only two or three participants and will, at best, interrupt the flow of the dedicated risk management review and at worst defeat its objective entirely.

A skilful Risk Manager will ensure that each stage of the project risk management process is dealt with as time allows, before the next stage is considered; a period of time is allowed for risk identification, after which those risks are assessed and only after that are treatment options considered.

The objective of most dedicated risk management reviews is not to treat particular risks, it is to put in place measures that enable treatment to take place. Planning for treatment takes place within the dedicated risk management review, the treatment itself takes place afterward.

The dedicated risk management meeting should have very clear stages of development. Ideally these will be segregated by short breaks.

APPENDIX A

Sample Prompt Lists and Check Lists

A.1 TYPICAL HEADS OF RISK AND ASSOCIATED PROMPT LISTS OF SOURCES OF RISK

This list below provides an indication of typical sources of risk on capital works projects. It may be of use in assisting in the identification of risks for a particular project or activity. However it is not intended to be an exhaustive list of all sources of risks. The use of the list does not negate the user from the need for a considered identification of risks specific to the project or activity in question.

Category 1 - Strategic / Planning / Feasibility / Business Case / Economic

Business Case

- Date of source data
- Data quality / reliability
- Private sector involvement
- Technological change
- New products / services
- Other future projects
- Benefits / disbenefits
- Change in regulations and standards

Forecasts

- Demand / growth forecasts
- Assumptions

Economic

- Discount rate
- Economic growth
- Energy prices
- Exchange rate variation
- Inflation
- Demand trends
- Population growth
- Commodity prices

Project Initiation

- Analysis and briefing
- Functional specifications
- Performance objectives
- Innovation
- Evaluation program
- Stakeholder roles and responsibilities

Planning

- Industry capability
- Technology and obsolescence
- Utility and authority approvals
- Completion deadlines
- Cost estimation

Project Scope

- Clarity of functional objectives and project outcomes
- Definition of performance criteria

Category 2 - Organisational / Legal / Commercial**Relationships**

- Alliance / joint venture / D&C partners relationships
- Financier-developer relationships
- Developer – designer / contractor relationships
- Contractor-subcontractor relationships
- Effectiveness of team working
- Personnel management
- Effectiveness of communication between stakeholders
- Industrial relations

Organisational

- Resource shortages
- Operational policies
- Management capabilities
- Management structures
- Personnel skills
- Work practices

Financial

- Project financiers support of the project
- Funding criteria / constraints
- Quantum of funding
- Alternative funding methods
- Debt/equity ratios
- Financing costs
- Taxation impacts
- Interest rates
- Investment terms
- Ownership
- Residual risks for Government

- Underwriting

Procurement / Contractual

- Tendering / procurement methods
- Quality or scope of contract documents
- Impact of alternative tender submissions
- Tenders do not match budget allocation
- Challenge of tender award
- Selection of form of contract
- Client commitment
- Consultant / contractor performance
- Negligence
- Damages and claims
- Errors in documentation
- Force Majeure events
- Insurance and indemnities
- Delays

Legislative / Regulation Issues

Market Issues

- Supply & demand variations
- Skilled-labour shortages
- Rate of cost escalation
- Oil / energy / commodity price fluctuation
- Escalation of insurance premiums (eg following major incident or natural disaster)

Insolvency

- Contractor becomes insolvent during construction

Contractual Claim / Dispute

- Disputes during construction
- Valuation of variations
- Level of professional indemnity insurance

Health and Safety

- Poor public security
- Poorly developed / implemented H&S procedures
- Inadequate temporary / permanent access / crossings
- Emergency service routes
- Safety audit findings

Quality Assurance and Control

- Management systems poorly implemented or inadequate
- Failures in QC

Post-construction Liability

- Non-compliance, omission or latent defect discovered after work completed

Category 3 – Community / Political / Environmental / Property**Community / Social**

- Identification of all stakeholders / affected parties
- Indigenous issues
- Impact on local economy and amenity
- Severance of social and community routes / networks
- Special interest group issues / interests
- Essential road users disrupted
- Neighbouring businesses disrupted
- Unrealistic community expectation
- Community expectations not met
- Poor public relations / breakdown of relationships
- Protest / public opposition
- Vandalism / sabotage / theft / arson

Environmental / Ecological Issues

- Amenity values
- Approval processes
- Site availability / zoning
- Protected flora / fauna found on site
- Conservation/heritage
- Degradation or contamination
- Visual intrusion
- Ecological impact
- Flora / fauna baseline data
- Watercourse and groundwater protection issues
- Erosion and sediment discharge
- Impact on habitat
- Landscape and aesthetic issues damaged
- Impact on special / protected features or environments

Impact on Public Health

- Nuisance eg noise, dust, vibration
- Emission levels
- Work-hours restrictions

Heritage Issues

- Heritage issues
- Special requirements for investigation / survey near or in heritage areas
- Heritage approvals
- Onerous conditions imposed
- Accidental damage to artefacts
- Heritage issues consent breached

Development / Building Approvals & Consents

- Timing of development / building approvals
- Breach of approval conditions
- Failure to identify all necessary approvals

Land and Property

- Land designation delayed / declined
- Land designation inadequate
- Establishment / borrow / dump area
- Property acquisition
- Property purchase / compensation valuations
- Residual property disposal valuations
- Compulsory purchase process
- Delay in obtaining land access agreements
- Entry agreements conditions breached
- Tenure arrangements for easements
- Access / way leave approvals
- Project-specific land / property issues not resolved eg tunnelling rights, airport proximity, navigation issues etc
- Damage to neighbouring property
- Post-construction complaints eg property access and drainage
- Post-construction rectification / mitigation measures required

Political

- Vulnerability of political support
- Change to project priority
- Government endorsement
- Adverse reaction of local council
- Pressure group action
- Changes in policy
- Toll charging considerations
- Terrorist action

Category 4 – Implementation / Site Conditions / Engineering / Services / Natural Events

Project Scope Definition

Design Standards Definition

Client Initiated Changes

Change in Technology / New Technology

Programming Issues

- Base programme flawed
- Staging of construction
- Unrealistic timeframes
- Productivity assumptions
- Protracted consultation
- Late client-approvals
- Information-supply delays
- Insufficient resources
- Late or defective material supply
- Contractor delays
- Third-party approvals

Systems

- Systems / hardware failure
- Software failure
- Policies and procedures

Site / Ground Conditions

- Topographical / survey data coverage
- Accuracy of topographical / survey data
- Knowledge of ground conditions
- Complex ground conditions
- Unforeseen ground conditions
- Limited experience of consultant / contractor with materials
- Hazardous materials found / occur on site
- Complexity of foundation / road design

Design Issues

- Design programme / timing
- Design omissions
- Design errors

- Quantities under / over-estimated
- Material workability issues
- Adequacy of material sources
- Surplus / waste material disposal
- Bulking factors
- Mass balance / mass haul
- Contractor's alternative proposals accepted without due consideration
- Failures / poor performance or works
- Material properties inappropriate
- Use of superseded documents
- Design changes resulting from actual field conditions
- Design changes invalidate consents
- Design changes invalidate designation / property agreements
- Design changes cause public dissatisfaction
- Design and / or rework arising from design errors or omissions
- Design and / or rework arising from construction errors or omissions
- Design and / or rework arising from breach of statutory obligations, consents, agreements etc

Buildability Issues

- Construction methodology
- New / unproven technology / methods
- Experience of contractors in the market
- Haul routes
- Construction access
- Availability of appropriate plant
- Supply of materials
- Restrictions on transportation of materials

Impact of Value Management / Engineering & Risk / Opportunity Findings

Construction and Maintenance

- Buildability
- Contractor capability
- Quality controls
- Equipment availability and breakdowns
- Obsolescence
- Industrial action
- Materials availability
- Shut-down and start-up
- Recurrent liabilities
- Health and safety
- Accident, injury
- OH&S procedures
- Contamination
- Noise dust and waste
- Disease
- Irradiation
- Emissions

Operational Management

- Effectiveness Traffic Management Plan (TMP)
- Failure of comply with TMP
- Temporary works / diversions
- Repairs following accidents
- Temporary signage, marking, lighting requirements
- Control requirements
- Revised working arrangements
- Barrier requirements

Changes Arising from Safety Audits**Services**

- Validity of data re existence, location, condition
- Limited site flexibility
- Delayed relocation works
- Un-cooperative utilities
- Un-cooperative consumers
- Disruption to services
- Failure of utility services

Natural Events

- Adverse weather eg. precipitation, wind / cyclone, snow, ice etc
- Landslip/subsidence
- Earthquake
- Fire
- Flood
- Lightning
- Tsunami

Additional Sample Prompt List 1

Political	International & government policy, public opinion, change in ideology, legislation, old legal statutes, architectural tolerance, public relations
Planning	Permission requirements, policy, land use, social impact, local regulations, utilities & service authority requirement /diversions etc
Economic	Treasury policy, Environment, Transport & Works Bureau policy, taxation, cost inflation, interest rates, exchange rate fluctuations, demand, competition, obsolescence, letting
Financial / Legal	Leases, existing concessions & agreements, commercial obligations, funding, development plans, insurance, consultants, contractors, suppliers, tenants, joint ventures, tenants, PPP
Environmental	Nuisance, permits, public opinion, pollution, environmental impacts and regulations, amenity values approval processes, community consultation, site availability/zoning, endangered species, conservation/heritage, degradation or contamination, visual intrusion
Procurement	Industry capability, technology and obsolescence, private sector involvement, regulations and standards, land issues, deadlines, cost estimation, utility and authority approvals, completion
Design	Alterations to end user requirements, value, change to clients brief, change to design standards / regulations, design adequacy, teamwork, co-ordination/interfaces, client sign-off, innovative design / materials
Natural /Existing Conditions	Flood, weather, earthquake, fire / explosion, unforeseen ground conditions, archaeological discovery, contamination, accuracy of as-built information, existing structures, utilities, adjacent slopes, traffic management
Construction	Performance requirements, planning and quality control, programme, labour and resources, standards, competence and financial stability of contractor, cost overruns, skill shortages, special skills restrictions to working hours, craneage & other restrictions, temporary works, supply restrictions, utilities, diversions, long lead times, access, working space, construction method, adjacent users. design change
Project Control	analysis and briefing, functional specifications, performance objectives, innovation, evaluation program, stakeholder roles, management systems
Operations & Maintenance	Ease of maintenance, reliability, life cycle costs, maintenance access, supply of spares, operational efficiency, planned opening dates
Human	Error, efficiency, incompetence, communications, culture, continuity of key staff, community expectations, pressure groups, public opinion

Additional Sample Prompt List 2

Commercial /Strategic	Competition, market demand levels, growth rates, technological change, stakeholder perceptions, private sector involvement, new products/ services, site acquisition
Financial	debt/equity ratios, funding sources, financing costs, taxation impacts, interest rates, investment terms, ownership, residual risks for Government, underwriting
Social/ Human	community expectations, pressure groups, public opinion, personality clash, culture clash, competence, corruption/ sabotage, health and safety
Economic	discount rate, economic growth, energy prices, exchange rate variation, inflation, demand trends, competition, bankruptcy, population growth, purchasing power
Environmental	amenity values, approval processes, community consultation, site availability/zoning, endangered species, conservation/heritage, degradation or contamination, visual
Project Initiation	analysis and briefing, functional specifications, performance objectives, innovation, evaluation program, stakeholder roles
Procurement Planning	industry capability, technology and obsolescence, private sector involvement, regulations /standards, land issues, cost estimation, Utility providers, completion
Political	community support, government endorsement, policy change, taxation, ideology, international influence
Construction/ Operation	Buildability, contractor capability, design and documentation, geotechnical conditions, latent conditions, quality controls, equipment availability, obsolescence, industrial action, materials availability, shut-down and start-up, recurrent liabilities, health and safety, accident, injury, OH&S procedures, contamination, noise dust and waste, disease, irradiation, emissions
Technological	Predictability, obsolescence, residual maintenance, lifecycle/durability
Organisational	Industrial relations, resources shortage, scheduling, operational policies, management capabilities, management structures, personnel skills, work practices
Natural	landslip/subsidence, typhoon, fire/explosion, flood
Human	estimation error, operator error, sabotage, vandalism, personality clash, cultural clash, corruption
Contractual	contract selection, client commitment, consultant/contractor performance, tendering, negligence of parties, delays, damages and claims, errors in documentation, force majeure events, insurance and indemnities

A.2 TYPICAL CHECK LISTS

Setting Project Objectives

- Have broad or initial project objectives been defined and are they feasible?
- Has the significance of outside influences on the project objectives been determined?
- Have the benefits required from the project been identified and quantified?
- Has the scope of the project been determined and reviewed?
- Has sufficient information been gathered to assess the relevance of these factors?
- Are changes to project objectives or success criteria required as a result?
- Are stakeholders' requirements aligned with project requirements?
- Are detailed project objectives stated in terms of measurable outcomes?
- Are stakeholders involved where appropriate?
- Have stakeholders agreed to the project objectives?
- Has success criteria been developed, reviewed and agreed?
- Have relevant legislative and regulatory requirements been identified?
- Have constraints that could influence the objectives been defined?
- Is there sufficient information to support the project proposal?
- Have alternative options to meet the project's objectives been identified and developed?
- Have risks and constraints associated with each option been identified?
- Have other factors affecting the feasibility of project options been identified?
- Has each option been evaluated against these risks, constraints and other factors?
- Is there a preferred and approved project option?
- Do project objectives reflect the business needs?
- Has potential expenditure been reviewed?
- Has a cost benefit analysis taken place?
- Have trends and developments, which might influence future expenditure, been considered?
- Has a budget been agreed?
- Have the major project stages been identified and considered against a timeframe?

Defining the Project Scope

- Are the boundaries and parameters of the project clearly delineated and understood?
- Are opportunities for improving the outcome of the project clear?
- Are the criteria for what would constitute change understood?
- Prepare and present the project brief in an approved format for authorization?
- Is it clear what is expected, by when and from whom?
- Is the project in relation to the business context understood?
- Are requirements on cost, quality and time clear?
- Are lifetime and durability requirements clear?
- Is project's functionality/ capacity understood?
- Have the project assumptions understood?
- Are success criteria clear and measurable?
- Have potential conflicts been identified?
- Is sufficient information available to determine the operational objectives of the project?

- Are critical or uncertain issues related the project clearly identified?
- Are factors affecting the feasibility of project objectives understood?
- Is the significance of outside influences on the project objectives identified and understood?
- Are relevant legislative and regulatory requirements defined?
- What constraints that could influence the objectives?
- Have the objectives and the stakeholders' expectations for the project been understood?
- Have all the factors that affect the project been identified and understood?
- Is the procurement strategy clear?
- Is there a clear scope definition and understanding of what would constitute change?
- Have options and opportunities for achieving objectives been stated?
- Does the project brief correctly interpret the requirements of the strategic brief?
- Is there ambiguity in what the project should deliver?
- Are there any contingencies?
- How will contingency be dealt with?
- Is there understanding of the functions to be included and excluded from the project?
- Are project approval requirements clear?
- Are there any options for innovation or improvement over current practice?
- Are there any options for developments that could save significant costs?

Planning The Project

- Have the outline activities required to achieve the project objectives been identified?
- Are they to a level of accuracy and detail suitable for outline project planning?
- Is there sufficient information on the project to prepare an appropriate work breakdown structure?
- Has a project WBS been developed and agreed?
- Is the work breakdown structure compatible with the project brief?
- Is the WBS product, task, function, or cost-centre based. Is this appropriate?
- Was the outline schedule developed from a WBS?
- Is the schedule developed to the appropriate level of detail?
- Do the methods of scheduling activities and resources conform to best practice?
- Are they appropriate to the scale and complexity of the activities?
- Have all the activities needed to meet the requirements of the project been specified?
- Have assumptions been identified and verified?
- Has a method statement been produced?
- Is the method statements and schedule compatible?
- Are contingencies clear?
- Is the schedule understood by stakeholders?
- Are stakeholders in agreement of the schedule?
- Have opportunities for total duration reduction been considered?
- Have critical or near critical activities been understood?
- Has sufficient contingency been allowed?
- How sensitive is the programme?
- Is the schedule is realistic, and are available resources are capable of meeting it?
- Are resources employed in a timely manner?
- Is progress monitored to ensure that any departures from the schedule are identified?
- Are identified departures from the schedule assessed and likely consequences established?
- Are corrective actions routinely defined and implemented?

- Are changes to the original schedule agreed before implementation?
- Are methods for recovery of losses arising out of departures from project schedule effective

Defining Resource Requirements

- Has the work breakdown structure for the project been verified?
- Is the type and sources of information needed to evaluate procurement options clear?
- Have alternative means and options for procuring the resources been considered?
- Have the benefits or disadvantages of grouping resources together been considered?
- Are the preferred procurement options reflective of this?
- Are selected procurement methods relevant to the resources?
- Have the disadvantages of the selected procurement options been considered?
- Are the stakeholders in support of the means of procuring resources?
- Do specified resources meet the requirements of the project?
- Is the relationship between time, cost or quality being considered
- Are specifications and estimates for the project suitable to allow resourcing to proceed?
- Is any additional information needed to define the resource requirements precisely?
- Are there any variations to the specifications that may improve resource acquisition?
- Have the benefits of grouping resource requirements together been considered?
- Are the appropriate procedures to secure the resources being followed?
- Are the appropriate requisitions and contract arrangements in place?
- Have key objectives and criteria for the procurement strategy been identified and evaluated?
- Have a range of procurement methods been evaluated?
- Has an outline procurement strategy been prepared and agreed with stakeholders?
- Has the most effective procurement method been detailed and agreed with stakeholders?
- Have precedents cases for use of particular types and forms of contract been reviewed?
- Have the appropriate scopes been determined for particular resources?
- Have the parties to, and the purpose of, the contract been clearly identified?
- Has the type, scope and form of contract been discussed and agreed?
- Has the apportionment of risk been discussed and agreed?
- Do the conditions of contract reflect the apportionment of risk that has been agreed?
- Do the conditions of contract meet the project requirements?

Procuring Resources

- Have the elements of the project to be procured through contractual arrangements been defined?
- Has the interest of potential providers of these elements been confirmed?
- Are the specifications for elements to be contracted out unambiguous?
- Are they in sufficient detail for potential providers to make competitive bids?
- Do the types and forms of the contract selected for each element conform to the procurement strategy?
- Is the type and number of providers invited to bid, sufficient to meet the project objectives and best practice?
- Is there sufficient information on the capabilities of potential suppliers?
- Will the tender list attract competitive bids?
- Do invitations to tender comply with project, best practice and legal requirements?
- Is there sufficient time to adequately complete the tender within the specified period?

- Are queries being dealt with promptly and equitably, and in accordance with agreed procedures? Are records being kept for future reference?
- Are changes, clarifications and the lie being dealt with promptly?
- Has criteria for the selection of bids with interested parties been developed and agreed?
- Does it maximise the likelihood of achieving both specific and overall project objectives?
- Do the procedures for bid selection and acceptance conform with best practice and legal requirements?
- Are they clearly understood by those involved in the selection process?
- Have relevant qualifications been clearly explained and understood?
- Is the tender is sufficiently detailed to prepare the required type and form of contract?
- Is the documentation specifying the contract requirements and terms and conditions accurate and complete?
- Does the formal contract offer comply with the agreed procedures and legal requirements?
- Is the contractor's acceptance of the contract offer complete and does it conform to agreed procedures and legal requirements?
- Is the information required to commence and carry out the contract clear, accurate and available?
- Have those affected by the letting of the contract been provided with appropriate information?

Managing the Team

- Have proposals for the composition of the project management team been reviewed?
- Are the project team's roles, responsibilities and limits of authority understood and accepted?
- Are the capabilities of the project team appropriate for the project?
- Are project management team support requirements and constraints clear?
- Have operational parameters within the project team been defined and understood?
- Are arrangements for effective communication operating?
- Are appropriate methods for project monitoring, evaluation, and control operating?
- Are appropriate methods and procedures of change control operating?
- Is the allocation of work consistent with achieving the project objectives and in keeping with the policies and values of the organisation?
- Has work been allocated in a manner appropriate to those concerned?
- Is the team's understanding of the work allocations being reviewed at appropriate intervals?
- Is prioritisation of work or re-allocation of resources considered regularly?
- Do changes have adverse impact on the project?
- Are team responsibilities clearly defined and communicated?
- Are work plans consistent with team and project objectives?
- Are work plans and schedules realistic and achievable within project and organisational constraints?
- Do work plans take account of the team members' abilities?
- Are work plans explained in sufficient detail, and at a level appropriate to team members?
- Is team and individual understanding of, and commitment to, work plans reviewed at appropriate intervals?
- Are work plans updated regularly, to take account of any individual, team and organisational changes?
- Are team members consulted during preparation of work plans?
- Is the performance of the project team and individuals within it monitored and assessed?
- Are assessments conducted objectively, against clear, agreed criteria?
- Does feedback provide the team with constructive suggestions for improving performance?

Controlling the Project

- Have systems and procedures requirements been identified?
- Have existing systems and procedures been reviewed to verify that they are applicable?
- Is the authority and responsibilities for all activities clearly defined?
- Have the proposed systems, procedures and responsibilities been discussed?
- Have the relevant regulatory requirements, and the actions necessary to implement them, been identified?
- Are there any regulatory requirements that appear to be conflicting, inaccurate or unclear?
- Is there a plan to achieve compliance throughout the project's life cycle?
- Have proposed methods of compliance been discussed with the relevant regulatory authorities?
- Is communication with regulatory authorities regular and in a professional and courteous manner?
- Is the process of approval being monitored and reviewed regularly?
- Are items upon which feedback is required identified?
- Are reliable methods and sources, both for obtaining feedback and for coordinating, reviewing and recommending improvements for future activities identified?
- Are stakeholders included in the process of obtaining feedback?
- Is feedback data matched against original requirements and objectives and the discrepancy summarised?
- Are potential improvements based on the analysis of the feedback?
- Are agreed improvements recorded and classified?
- Are savings, benefits and lessons learnt recorded?
- Is progress against project plans or schedules being reviewed and evaluated regularly?
- Is the review and evaluation techniques appropriate for the project?
- Are emerging risks, difficulties and their causes being identified and managed in a timely manner?
- Is work being undertaken in accordance with work plans?
- Is the project team actively seeking ways to improve the work in a way that keeps disruption to a minimum?
- Is the project team actively seeking ways to control changes in a way that keeps disruption to a minimum?
- Is activity, resource and plan adjustment undertaken with the agreement of stakeholders?
- Are adjustments accurately recorded and securely stored?
- Are stakeholders informed promptly of a need to review the project objectives and definition?
- Are the available resources meeting the project schedule, objectives and specification?
- Are resources deployed in a timely manner?
- Is progress being reviewed to ensure that any departures from schedule are identified?
- Are the likely consequences of departures from schedule being assessed?
- Are changes being agreed?
- Are the relevant stakeholders being provided with accurate and timely information on progress?
- Are the evaluation procedures for the project the most appropriate means?
- Has clear and precise criteria for evaluating the project established?
- Is accurate and valid information on the project being used for project evaluation?
- Is all relevant information relating to the project being reviewed?
- Are all relevant people being consulted during the evaluation?

-
- Are changes or improvements resulting from the project evaluation process?
 - Are the results of the evaluation being presented to the appropriate people?
 - Is the impact of the evaluation on the project management process being monitored?
 - Does the system for the monitoring and controlling project income and expenditure meet the needs of the implementation schedule?
 - Does it comply with legal and organisational requirements?
 - Is payment approval in accordance with requirements and the authorised procedure?
 - Is project income and expenditure reviewed and monitored in accordance with agreed procedures?
 - Are variances calculated accurately, in accordance with agreed financial control procedures?
 - Is appropriate corrective action to meet or adjust financial forecasts being implemented?
 - Are stakeholders informed of causes of variances, their implications, and corrective action?
 - Do methods of estimating conform to preferred practice?
 - Are resources required for activities being estimated and specified accurately?
 - Is the degree of accuracy appropriate?
 - Are any assumptions on which estimates are based being clearly stated?
 - Are contingencies and the basis for them being verified?
 - Is the scope and consequences of changes being accurately assessed?
 - Are quality assurance procedures appropriate and sufficient to meet the requirements?
 - Is performance against specified or expected targets or milestones accurately assessed?
 - Are areas of non-conformance identified promptly and reported clearly?
 - Is effective remedial action to correct the causes of non-conformance initiated promptly?
 - Are records that are needed for quality audits produced and maintained?
 - Is available information from the perspectives of all major stakeholders analysed, identifying and prioritising all known factors according to the project objectives, scope and definition?
 - Do stakeholders contribute effectively to the development of solutions?
 - Are solutions developed and presented in a manner compatible with the project scope?
 - Do proposed make optimal use of the resources available?
 - Do such presentations objectively outline the strengths and weaknesses of each solution?
 - Are stakeholders routinely identified and considered?
 - Is the plan or schedule for hand-over adequately defined and clear to those involved?
 - Has the state of the project at hand-over been defined, record and agreed?
 - Will the transfer of responsibilities be executed in a way that avoids gaps in responsibility?
 - Are resources and facilities to be transferred specified and agreed?
 - Is the transfer of responsibilities communicated accurately and in a timely manner?
 - Is the schedule for outstanding works agreed?
 - Is the risk management process clearly recognised as being employed on the project?
 - Is there a recognised focus for this activity?
 - Are stakeholders aware of the risk management process and procedures?
 - Are stakeholders aware of their roles and responsibilities to risk management?
 - Are stakeholders proactive in their approach to risk management activity?
 - Are stakeholders contributing to the development of the risk management process?
 - Are emerging risks being identified early enough?
 - Have all areas of perceived risk been identified and reviewed with stakeholders?
 - Have all appropriate sources of information been considered?
 - Are risk assessments and treatment options being considered early enough?
 - Is risk assessment being undertaken at an appropriate level of sophistication?

- Is risk treatment activity being communicated efficiently?
- Are contingency plans being produced and implemented effectively when necessary?
- Are effective risk treatment measures in place for all risks?
- Is risk treatment being undertaken in a timely manner?
- Is this being monitored and controlled?
- Are risk management and change control in alignment?
- Are risk treatment measures reviewed for effectiveness?
- Are appropriate records being maintained, are they accurate and up to date?

Project Feasibility Stage

- Are the required skills and capabilities for the feasibility available?
- Has responsibility for managing the project risk process been assigned?
- Is there an understanding of the business needs?
- Have the project objectives been clearly stated?
- What are the additional factors that could affect success?
- Is the proposed project affordable?
- Are all relevant government initiatives being addressed?
- Have options been identified for a potential way forward?
- Are senior management committed to sound project management systems?
- Is there commitment to key roles and responsibilities for the feasibility?
- Is funding available for feasibility?
- Have any major risks been identified?
- Is there an understanding of the scope of the project?
- What will constitute success?
- Who are the stakeholders and are they supportive?
- Is there a clear best option, or would several options meet the business need?
- What assumptions have been made about the project?
- Are appropriate management controls in place?

Post Feasibility

- Have all the likely stakeholders been identified?
- Is there a clear and agreed understanding of business goals and how the project will deliver these?
- Has the feasibility examined a wide enough range of options that will meet the business need?
- If there are several options in the feasibility, how was the preferred option selected?
- Is the feasibility case complete or are there outstanding issues?
- Are there inherent weaknesses or limitations in technical solutions proposed by the feasibility
- Have the internal and external factors affecting the project been identified and assessed?

- Has the validity of assumptions been checked?
- Has the proposed project option been fully assessed for risk?
- Is there a clearly defined project organisation with agreed roles and responsibilities?
- Are the necessary internal and external skills available at the right time and in the right numbers?
- Are the external stakeholder issues being addressed?
- Is there an understanding of project design or technology involved
- Are the needs of end-users and other stakeholders clearly understood?
- What are the critical success factors, are they understood and can they be quantified or measured?
- Are their fallback options where design solutions were unresolved?
- Does the preferred option meet wider government and departmental policies and strategic objectives?
- Do financial constraints make the development of design vulnerable?
- Do stakeholders support the preferred option?
- Is there an overall project management process in operation?
- Is there an ongoing process to identify, assess and monitor current, anticipated and emerging risks?
- Have previously raised risk issues been satisfactorily resolved?
- Has the project assessed whether it is breaking new ground in any areas?
- Have requirements for external specialist advice been determined?
- Is the time plan realistic?

All Project Stages

- Lack of contractor experience in technology, design or construction processes involved.
- Adverse performance by contractor on recent projects overlooked
- Materialisation of failures on similar projects overlooked
- Non performance by contractor concerning quality control procedures (concessions, defects etc)
- Design review procedures inadequate
- Lack of contingencies/fallbacks to cover delays, errors, damage, catastrophes in general
- Non availability or scarcity of materials
- Problems with supply base e.g. single source
- Dependency on overseas supply
- Non availability of alternative materials or components
- Lack of contingency supplies e.g. stockpiling of scarce materials or components
- Limitation or obstruction due to industrial relations problems
- Adverse environmental or safety hazards associated with supply of materials/components

- Use of unproven proprietary materials/components
- Sensitivity to trade agreements or licensing agreements e.g. Building approvals
- Use of non standard materials or components
- Use of poor quality materials or component
- Material specifications and tolerances too tight or unachievable
- Materials or component subject to overlong lead times
- Contractor insolvency or lack of financial and legal stability
- Unstable project senior management and organization
- Contractor vulnerability to take-overs, buy-outs, rationalization, re-location etc
- Lack of senior management commitment to sound project management systems
- Poor quality of contractor or project management decision-making.
- Lack of investment in testing, ground surveys topographical surveys etc. prior to project management.
- Client investment proposal unsound
- Lack of proper application of risk management techniques by client, contractor or project organization.
- Lack of effective management control of sub-contractors
- Design/technical principles unproven
- Design/technical principles applied to an extent not previously experienced
- Specification not within bounds of physical possibility
- Conflicting or incompatibility of design/technical principles
- Design Brief or project objectives not clearly stated
- No fallback where design solutions were unavailable to meet project timescales or technical requirements
- Lack of facilities to prove design/technical principles
- Vulnerability of design development to financial constraints
- Immaturity of design/technology
- Little or no history of application of design/technology to the required scale
- Little or no history of application of design/technology in the particular environment
- Unforeseen ground conditions
- Inherent weakness/limitation in design/technical solutions
- Interfacing/integration problems of different design specialists
- Non availability of test methods to prove design/technical solutions
- Known failure of technology not recognized
- User or functional limitations imposed by design/technical solution
- Technological obsolescence
- Technology did not lend itself to proving
- Problems with environmental/safety implications of technology adopted

- Dependency on supporting technological or design development
- Acceptance testing limitations
- Interface/integration problems of complex/hi-tech components
- Interfacing/integration problems of work undertaken by different trade contractors or specialists
- Interfacing/integration problems between design disciplines
- Engineering solutions unable to be proven by testing
- Engineering solutions unable to be demonstrated by modelling
- Extrapolation from models inadequate
- Use of unestablished design principles
- Unproven design solutions adopted
- Testing techniques unproven
- Inadequate contractor capability in terms of management, labour, skills, plant etc.
- Inadequate contractor capacity in terms of management, labour, skills, plant etc.

APPENDIX B

Outline of Some Selected Quantitative Methods of Risk Analysis

OUTLINE OF SOME SELECTED QUANTITATIVE METHODS OF RISK ANALYSIS

B1 General

Quantitative risk analysis is a process which enables the analysis and management of risks associated with a project. Properly undertaken it will increase the likelihood of successful completion of a project to cost, time and performance objectives.

All methods of quantitative risk analysis rely on the pre-requisite that a qualitative analysis in line with the SRM process has been carried out. This SRM process must be continuous to enable quantitative analysis to deliver the wider benefits available throughout the delivery of the project.

Various quantitative risk analysis techniques are available to assist in increasing certainty in project delivery. The more detailed techniques, such as simulation, have the ability to provide the project team with some powerful benefits including:

- Refined contingency setting and monitoring of contingency draw-down
- Insurance benefits

Some of the quantitative methods of risk analysis that can be used for projects include:

- Expected Value (EV)
- Simulation
- Sensitivity Analysis
- Decision Trees

In the construction project context, the most common methods are Simulation, and Expected Value. The Estimating using Risk Analysis (ERA) approach as described in Works Branch Technical Circular No. 22/93 is based on the Expected Value method.

All methods of quantitative risk analysis rely on information from the qualitative SRM process. Any quantitative analysis must be based on a robust and ongoing qualitative risk management (SRM) process.

The cost of resources required to carry out quantitative risk analysis vary according to the technique adopted. Experience shows that carrying out quantitative risk analysis is an investment when compared to the benefits it brings.

Brief descriptions of various quantitative risk analysis techniques are as follows.

B2 Expected Value

Outline Process

The concept of calculating the expected value of a risk is similar to that of the probability and impact matrix. A figure for probability is multiplied by a figure for impact to gain a value that represents the notional level of exposure posed by the risk. However, in this case specific values are used; percentage for probability, a monetary value for cost and a period of time for programme. For example a risk with a probability of 20% and an impact of \$50,000 would result in an expected value of \$10,000.

The calculation of expected value can be used for two purposes:

- To prioritise risks for treatment (since the expected value of each risk can be calculated and so risks can be put in order – risk with the highest expected value being treated first)
- To assign contingency (a monetary sum to the cost estimate or days to the programme). To explain the logic behind this method of assigning contingency, consider the following example. A particular risk is assessed as having a probability of 20% and an impact of \$50,000. Therefore, a contingency amount of \$10,000 is assigned to the budget.

Works Branch Technical Circular No.22/93 on “Estimating Using Risk Analysis” employs the Expected Value technique to assign contingency to the capital cost estimate. This technique is a simple tool and currently used worldwide for quantification in risk assessment.

If the expected value technique of risk assessment is to be implemented on a project, there are a number of practical considerations that are required to be taken into account. These include:

- More accurate information is required to estimate the expected value of a risk than is required by the probability/impact matrix. Single figure estimates will need to be established for both the time and cost impacts of each risk. Also, a single figure probability for each risk will also need to be established.
- The project planner will be required to establish how each identified risk affects the critical path. The cost engineer will be required to establish the potential cost impact of each risk. These resources and the information required from them are available in the normal course of project delivery. A risk practitioner with experience in the field of risk analysis will be required to bring together the cost and time information.
- The probability/impact matrix is a much quicker assessment technique than expected value. However, the effort invested in the more detailed quantitative assessment has benefits including better cost and time certainty.
- The estimation of probability and impact will rely on the experience of personnel and resources within the project team.

Example of an Assessment by the Expected Value Technique

Consider the following scenario. During a risk management meeting it was identified that the planned driven piling works may destabilise an adjacent slope and lead to the collapse of that slope. The following activity may be required to establish the expected value of the risk:

- A geotechnical engineer will be required to establish the probability of the slope collapsing and the physical implications of that collapse. There are a number of ways in which to achieve this, including:
 - Desktop studies to establish the type of slope stabilisation method that has been applied to the slope, the date when the slope was last maintained, future maintenance plans etc.
 - Site investigations to determine the existing condition of the slope
 - Computer based soil and slope behaviour modelling to establish failure modes.
 - Location and interpretation of statistical data relating to slope collapse.
- Once the probability and physical implications of the collapse have been estimated by the geotechnical engineer, the cost of the collapse will need to be established. This will require the services of a cost engineer.
- The programme implications of the slope collapse will also require to be established. This will require a planning engineer.
- Once values for probability, cost impact and programme impact have been established, the expected values can be established for cost and time.

Comparison of Expected Value and Matrix Assessment Techniques

Using the same scenario, the expected value technique is compared to the matrix technique (see sections 5 and 6 of this Manual for details) below.

	Probability	Impact/Consequence	Assessment
Matrix	Possible	Moderate	Medium
E.V.	50%	Cost = \$1,400,000 Time = 22days	\$700,000 11 days

The purpose of each assessment is explained below:

Probability/Impact Matrix: The assessment identifies the level of risk exposure as medium and the recommended management actions are to exercise specific ongoing monitoring and review so as to ensure level of risk does not increase.

Expected Value: The two values give a more considered indication of the level of exposure. This assists with setting a more considered level of contingency for the project.

Expected Value used in Project Decision Making

The expected value technique can also examine project decisions or project activities to either provide information for that decision or to determine the probable outcome of that activity. If the determined outcome is undesirable, then mitigation measure can be proposed.

For example, consider the tender of a works contract. The expected outcome of this event is the award of a contract with an estimated tender sum of \$1,000,000 (which has been provided by the QS prior to tender). The returned tenders and subsequent award may exceed this figure, or may be less. Based on experience and an diagnosis of the market condition, the uncertainty associated with the tender price may be expressed as follows:

Tender Sum ²	Probability ³	Consequence	Expected Value
\$1,000,000	70%	Zero (base case scenario)	\$0
\$800,000	20%	-\$200,000	-\$40,000
\$1,100,000	10%	+\$100,000	+\$10,000
			-\$30,000

The expected value of the activity is therefore \$1,000,000 less \$30,000 = \$970,000.

The above example of the use of expected value models the fact that uncertainty most often results in the possibility of a range of outcomes, both in terms of cost and time impact. This approach adds a significant degree of consideration to contingency setting and monitoring.

A disadvantage of using the above expected value approach is that there remains significant chance of the aggregated estimated contingency being exceeded. This in turn reduces certainty in project cost and time outcomes.

² The project team considers the probability of the likely return tender prices. These could be higher or lower than the estimate.

³ The summation of the probabilities for the various scenarios is 100%

It should be noted and understood that the expected value approach is a simple method for bringing some level of consideration into contingency setting.

B3 Simulation

Outline Process

Simulation takes the expected value approach, with ranges applied and considers the range of scenarios which are possible based on the probability and cost and time impact of the risks associated with a project. Simulation techniques also account for the inter-relationships which are inherent between certain risks.

Simulation is industry standard and considers the effect that the variability of project risks is likely to have on the project outcome, both in terms of cost and time. The main difference between expected value calculation and simulation is that simulation is able to model an array of different probability distributions that reflect the identified risks associated with the activity. For example, a uniform distribution considers that the value of the activity has an equal probability of falling at any point between two values. Other distributions such as discrete or normal are also commonly used to model the uncertainty and inherent variability of the cost and time impacts of activities. Simulation gives a much more realistic view of the characteristics of project delivery.

Results from simulation are expressed in statistical terms. In line with this, predicted project outcomes in terms of cost and time, have associated levels of confidence.

Simulation normally requires software and a sound level of risk analysis expertise. The overall effect of a number of risks requires a statistical approach to be adopted in order to determine a range of probable outcomes for both total cost and time.

Risk Analysis Software

There are various proprietary softwares that can carry out the simulation process available in the market. Two industry-standard software packages that are commonly used for risk analysis simulation are:

- @Risk for Microsoft Excel – cost risk
- @Risk for Microsoft Project – time risk

Analysis is generally performed using a statistical random selection technique such as Monte Carlo sampling and summing the resulting values. The number of iterations required for stable results is dependent on the complexity of the model, but generally 2,000 simulations are sufficient.

Departments are expected to procure the required softwares from the proprietor on their own to suit their own needs. For budgetary purpose or determination of insurance coverage, in general a software for cost risk would be adequate. Software for time risk is normally not required since delay and change in programme issues could more adequately be treated using other simple techniques. What is important is that any added costs of these delays are factored into the budget in the same way as other risk costs.

The above examples are just quoted as reference. Softwares that can produce equivalent or similar result could always be considered.

Example of an Assessment by Simulation

Consider the following insurance-related scenario. A Client has decided to procure insurance using an Owner Controlled Insurance Programme (OCIP) in line with TC(W) 7/2005 “Procurement of Construction Related Insurance” and wants to know what the Third Party

Liability exposure may be for the project at hand. The following represents the main steps in using simulation in order to determine Third Party Liability insurance cover and associated premium:

1. Assume that a comprehensive SRM process is in place and a detailed risk register is available and has now been precipitated to come up with a list of risks which may affect third party liability and the intended treatment process is to transfer these risks to the insurer. Project team could then make use of the “Expected Value” technique, as describe above, to convert the likelihood and consequence of these risks into specific probabilities and cost impacts. Whilst the project team would need to work out the specific cost impact (i.e. the consequence in term of financial implication if such risk materialises) for each risk basing on one’s own experience/assessment, they could make reference to the probability graph/table in WBTC 22/93 to assist preparing the specific probability. A table of the probability percentages against the qualitative descriptions are reproduced below for reference.

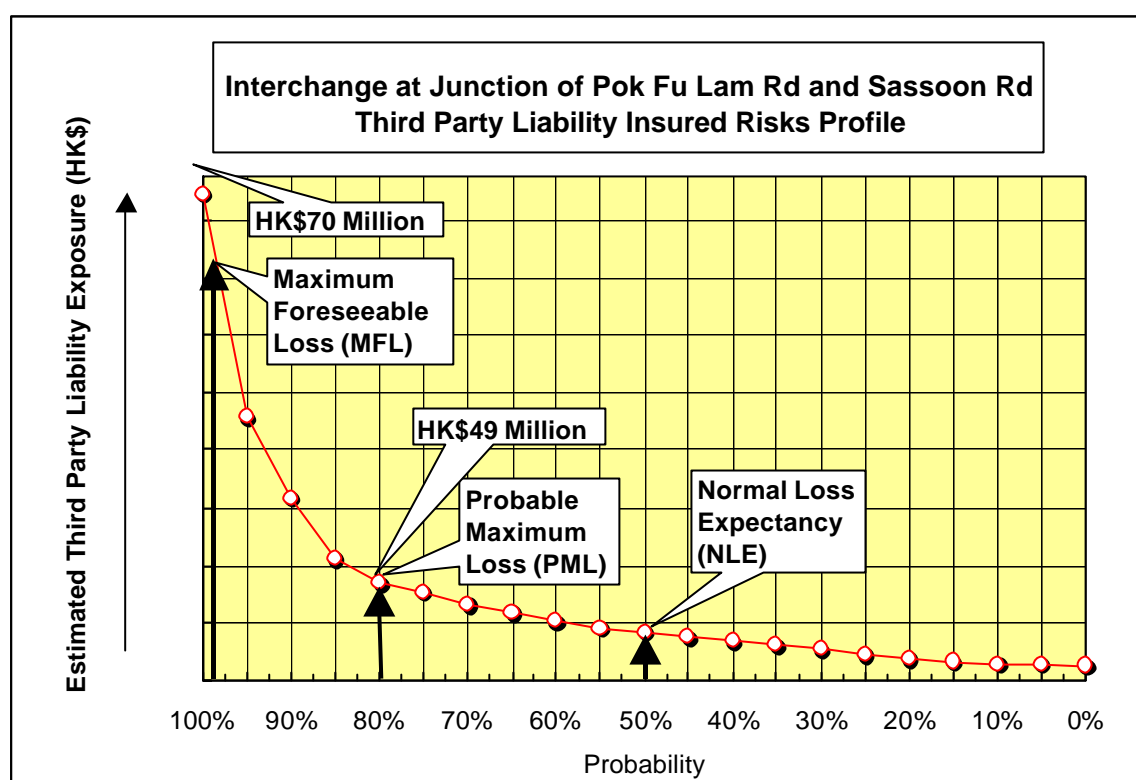
Statement	Meaning	Probability Suggested
Rare	Chances are slight	1-10%
Highly unlikely	Very little chance	10-20%
Little chance	Not more than slight probability - of occurrence (fixed risks) - of exceeding (variable risks)	31-40%
Unlikely	-	41-50%
Possible (Better than even)	Average likelihood - of occurrence (fixed risks) - of exceeding (variable risks)	51-60%
Likely	-	61-70%
Highly likely	-	81-90%
Frequent/Almost certain	-	90-99%

2. The allowances for each risk item could then be derived by multiplying the probabilities with the cost impact. An extract of a sample risk register (with quantitative risk allowances calculated) is shown below containing some risks for which Third Party Liability insurance is to be sought:

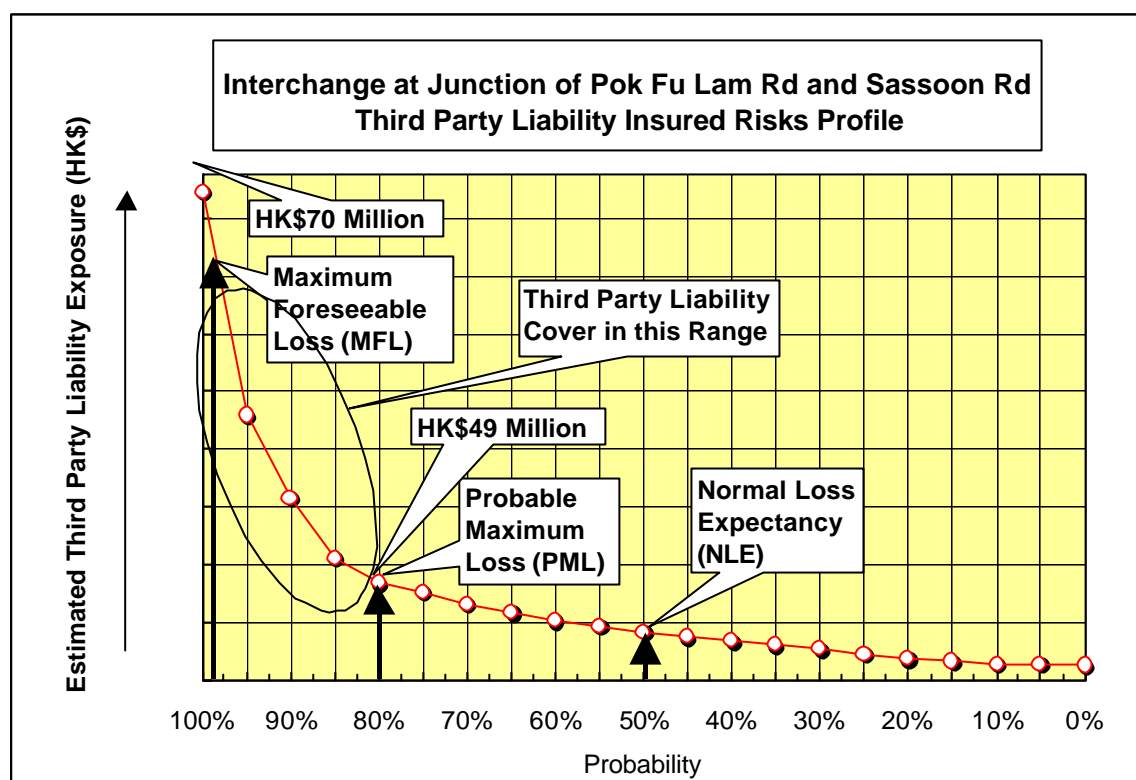
Risk Head	Risk ID	Identified Risk Item		Existing Control Measures (ECMs)		Type of Risk	Risk Assessment Prior to Treatment with Additional RCMs		
		Risk Item	Consequences & Additional Comments / Notes	ECMs Already in Place	ECM Owner	Fixed or Variable?	Consequence of Risk with existing controls	Likelihood of Risk with existing controls	Average Risk Allowance (HK\$ Million) with existing controls
Site Conditions	1	Existing carriageway and working space limited	Though a feasible construction sequence has been devised to minimise the impact on existing traffic, sufficient measures still necessary to be implemented during construction to safeguard road users	Traffic management (with Transport Department) including traffic diversion, bridge construction method to uphold temporary traffic arrangement	Contractor	Variable	31.5	70%	22.02
Health & Safety	2	Poor public security	Lack of adequate site security leads to member of public becoming injured.		Contractor	Variable	11	75%	8.26
Health & Safety	3	Disruption of emergency service routes	Emergency services not able to access hospital leading to member of public being injured.		Contractor	Variable	51	70%	35.78
Health & Safety	4	Significant environmental impact mitigation measures may be required	Delays to environmental approvals may be caused by not implementing agreed mitigation measures in design and construction method.	Environmental pollution mitigation measures were identified in the Environmental Impact Assessment (EIA).	Arup	Fixed	6.9	80%	4.13

**Summation
= \$70M**

- The next key issue is to determine the likely combined effect of these risks. The combined effect represents the overall Third Party Liability risk exposure that the Client will be facing. It should be stressed that the combined effect of the risks should not be a simple summation of all the risk allowances (eg. \$70M in the above example which contains 4 risk elements), because in the real world, these risks would not occur all at the same time or at least within the time frame of that particular project cycle. It would not be practical nor economical to procure an amount which represents the concurrent occurrences of all the risk so identified. In fact, the overall risk exposure could normally be determined by employing proprietary risk model software packages as mentioned above (eg. @Risk). Departments should refer to the specific instructions as given in the packages on the input and running of the risk model and seek advice on their use from the proprietor if necessary. In general the risk model will account for the possible inter-relationships between the risks and simulate various combinations of their occurrences with varying impacts. By using the simple risk model) a risk profile based on statistical outcome will then be produced as output from the software package. An example of the resulting risk profile showing different confidence intervals is shown below for illustration purpose:



4. The profile above shows several important features which are important to insurers in determining risk exposure and hence the associated insurance premiums. These parameters include
- Maximum Foreseeable Loss (MFL) which is an estimate of the amount of damage that would be expected to occur in the event that all loss protection measures failed. This is roughly at 97 to 98% confidence level;
 - Probable Maximum Loss (PML) is the maximum loss which probably will happen when, and if, the peril insured against actually occurs. A PML-80 means an 80% confidence that the actual loss will not be exceeded, or there is a 20% chance that actual losses experienced over the designated time duration would be exceeded. This point could roughly be interpreted as the point at which the risk exposure (liability) increases at a greater rate than the corresponding increase in confidence level. This might be seen as a point where the gradient of the curve starts to change/increase; and
 - Normal Loss Expectancy (NLE) being the largest loss expected under normal circumstances.
5. Basing on these definitions, we should be reasonably confident in acquiring an insurance coverage roughly at the PML level. However in practice, the Client may wish to be more safeguarded if the additional premium charged will not be dis-proportionally higher when compared with the increased coverage.
6. From the above profile and based on the figures adopted, the required insurance cover will be in the range between MFL and PML as shown in the following chart.



7. The final determination of amount of cover required will however be a management decision by the Client. As with contingency setting, the amount of coverage required will be based on the Client's attitude towards risk and how much risk they are comfortable with retaining. Though it is not possible to provide quantitative guidelines on making this decision, it is suggested that economic consideration should be a factor that warrants due attention. In other words, this decision will be highly affected by the gradient of the profile, which in turn affects the location of MFL and PML (the steeper the gradient, the less additional confidence that will be achieved with an increase in premium paid and hence less economical.).

- Some further key points to note regarding Third Party Liability (TPL) are:
 - TPL is difficult to quantify due to the direct and indirect nature of risk. The simulation process indicated above however provides a systematic approach to assist in making such decision.
 - The amount of TPL to be covered by the Client in a multi-layer placement, as set out under ETWB TCW No. 7/2005, will need to take into account the primary layer (i.e. the first HK\$10 Million) covered by the contractor in the calculation process set out above.

B4 Sensitivity Analysis

A sensitivity analysis can be carried out on both the expected value and simulation techniques. Sensitivity analysis involves altering the parameters of a particular set of probability or impact variables for a particular activity and then re-running the simulation to establish the sensitivity of the initial assumptions.

Sensitivity diagrams can be produced automatically using simulation software. This information prioritises the risks which will have most impact on output parameters such as total cost and time.

B5 Decision Trees

Decision trees assess the level of risk associated with various courses of action following a decision and therefore, may be used for risk-based decision making. Decision trees start from a single node that represents the decision to be made. Branches emanate from the decision node and represent various courses of action. If the value (usually an expected value calculation) of adopting each course of action can be established, then a particular course can be selected. Once all variables have been investigated, the one which presents the best value will be discernable.

This technique is useful when making high level and complex decisions as the full implications can be established. An example of the application of decision tree analysis is in the evaluation of value engineering options.

APPENDIX C

Sample Risk Management Documentation

APPENDIX D

Example Project Risks and Treatment Options

EXAMPLE PROJECT RISKS AND TREATMENT OPTIONS

When implementing the risk management process, it is important that it is implemented cost effectively. It is impractical to consider every risk that may occur, no matter how small.

Frequent, but uncertain small problems such as the risk that days will be lost to sick leave, the risk that construction drawings will require minor amendments are technically risks. However, they are too minor to be considered formally under the risk management process covered by this document. They should therefore be considered as problems that can be reacted to rather than risks that require pro-active management.

Example risks, which are considered typical of the type of risk that should be addressed under the risk management process, are identified below. It should be stressed that these risks may not be relevant for every project and treatment options may change. The examples are given only to inform the reader of the type of issues that would be considered as risks and would fall within the risk management process

Risk	Options for Treatment
<p>Political</p> <p>During the Feasibility stage of a project it was identified that there may be a risk that the proposed project does not serve stated Government policy directives</p>	<p>Avoid: This risk cannot be completely avoided, there will always be the chance that the project is not fully aligned to a particular policy or that policy will change.</p> <p>Reduce: The risk can be reduced by demonstrating the justification for the project in the Technical Feasibility Statement. (TFS).</p> <p>Transfer: Risk transfer would not be appropriate in this case as a Works Department would be the party most able to deal with this risk.</p> <p>Accept: Demonstration of alignment with Government policy is a requirement of the Project Definition Statement (PDS). If the project is now in the feasibility stage, it may be assumed that this alignment has already been demonstrated and so the risk of subsequent rejection on these grounds is minimal. The risk may therefore, be accepted with no further action than perhaps a reference to the PDS.</p>
<p>Economic</p> <p>Inflation may lead to a reduced number of patrons visiting a facility (such as a sports centre) and therefore the business case for providing the facility is not met.</p>	<p>Avoid: Works departments cannot avoid the risk of inflation.</p> <p>Reduce: The impact of this risk may be reduced by making the project less reliable on patronage to generate income to meet the business case. This can be achieved by generating revenue by other means; introducing retail outlets, advertising space etc.</p> <p>Transfer: This risk can be transferred to a third party by selection a build/operate/ transfer (BOT) contract strategy. It is possible in such contracts to pass the risk of reduced patronage to the BOT organisation.</p> <p>Accept: It may be considered during feasibility that the risk is acceptable at this stage. Therefore, it may be decided to address means to improve the business case during the Preliminary Design.</p>

<p>Procurement</p> <p>The proposed Contract allocates responsibilities to inappropriate parties and the pricing of this adds cost to the project.</p>	<p>Avoid: Selecting an appropriate Contract for the works and using it without amendment may avoid much of the risk of adding cost for inappropriately allocated risk. However, it is unlikely to avoid the risk completely</p> <p>Reduce: If a review of the Contract is undertaken prior to the issue of the tender and clarification of where risk has been placed, the appropriateness of that may determined. Subsequently, replacement of risk with the appropriate party may reduce the risk of increasing project cost.</p> <p>Transfer: This is not a risk that would normally be transferred. The Owner, Employer or Client, as named in the Contract, would normally take responsibility for the content of that Contract.</p> <p>Accept: If a particular Works Department repeatedly uses the same Contracts, it may be considered acceptable to take the risk of inappropriate allocation of responsibilities, as it may be assumed that such issues would have been reviewed by the Department in the past.</p>
<p>Project Management</p> <p>Project management controls are not suitable to the scale of the project and add additional cost due to unnecessary management staff appointed to the project.</p>	<p>Avoid: Management is required for every project and so there will always be the risk that the detail or level at which it is applied may be inappropriate and therefore, unavoidable.</p> <p>Reduce: The development of internal guidelines which enable the matching of specific management control procedures to project size and complexity would reduce the probability of overstaffing.</p> <p>Transfer: The appointment of a project management consultant would transfer much of the responsibility to implement project control and therefore the risk of inappropriate staffing.</p> <p>Accept: This risk may be considered acceptable since although additional staff will add cost, it is unlikely to be significant in the context of the project budget.</p>
<p>Land Issues</p> <p>Current leaseholder may object to proposed ground investigation and access to site may be delayed.</p>	<p>Avoid: Continuing with the design based on existing ground information and implementing any necessary changes during construction stage, would result in access for a ground investigation being unnecessary. The risk would therefore be avoided. However, secondary risks such as the likelihood of post contract variations would be introduced. The decision therefore, would need to take into account the level and availability of existing information, the probability of significant design changes post-contract etc.</p> <p>Reduce: The risk of the current leaseholder objecting is significantly reduced if his needs and concerns are understood and are catered for in the ground investigation proposals. This may include recompense for disturbance.</p> <p>Transfer: The responsibility to ensure that a ground investigation is undertaken in a timely manner and the design is delivered by a particular date can be transferred in the Consultant's Contract.</p> <p>Accept: It may be considered that existing site information is sufficient for the purposes of design and that the improbability of post contract changes is acceptable.</p>

<p>Human</p> <p>Public opposition to proposals delays construction</p>	<p>Avoid: Construction projects by their nature do impact heavily and usually adversely on the public in the immediate area and so some sort of public opposition is to be expected. This cannot be avoided completely</p> <p>Reduce: Formalised stakeholder management activity would reduce both the probability that particular elements of the public would be opposed to the project and would reduce the impact that they would have. For example, keeping the local community involved with the project and ensuring that their needs are identified and satisfied would reduce public concern.</p> <p>Transfer: Works Departments implementing public works projects would not normally transfer the responsibility to ensure that the project meets the requirements of the public. However, a transfer of responsibility to ensure that opposition to the project addressed may take place. The consultant for example, may have a responsibility to design suitable construction noise mitigation measures for adjacent tenants and the works contractor may have penalties associated with complaints regarding construction noise imposed on him.</p> <p>Accept: Accepting the risk of public opposition is an option, especially if the project will directly benefit the same public.</p>
<p>Construction</p> <p>Escalating material costs due to improving economy</p>	<p>Avoid: Escalating material costs due to an improving economy is not an avoidable risk.</p> <p>Reduce: If during the design stage of the project material costs are increasing, the impact could be reduced by a direct purchase of particular materials prior to contract award.</p> <p>Transfer: The use of a fixed price, lump sum contract, would largely transfer risks associated with this issue during the construction phase.</p> <p>Accept: It may be acceptable that material costs will increase since the improving economy may result in a higher patronage and so a higher income being generated.</p>