Project Managed Change Program

PROJECT RISK MANAGEMENT FACILITATION GUIDELINES

JABATAN KERJA RAYA MALAYSIA

Cawangan Pengurusan Projek Kompleks
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PREFACE

This Guideline provides guidance to JKR project teams and project stakeholders on the application of the standard project risk management process in JKR. The Guideline is applicable to all JKR projects, programs, plans and activities..

The Guideline is based on the Joint Australian/New Zealand Standard, AS/NZS 4360:2004, *Risk Management* (the Standard) and adapted to the introduction and development of risk management particularly in Jabatan Kerja Raya, Malaysia.

This guide contains the framework on risk management in the JKR context and may be applied to all projects in other government organizations at all levels – national, state or district. It can also be applied to facilitate risk management workshops in non-government organizations, private entities and partnerships. The guide is intended to provide a simple approach to facilitation of risk workshops and organizations may use the guide in their own environments and develop their own specific risk management approaches.

The Guidelines provides background knowledge of the Risk Management processes including standard tools. Appendices include the Definition of Terms used and examples of risks in the form of a Risk Identification Checklist to help facilitators and participants in their risk identification process.

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1. INTRODUCTION

Jabatan Kerja Raya (JKR) is responsible for planning, designing and the construction of infrastructure projects in Malaysia and act as the implementing agency and technical consultant to the government.

As the implementing agency and technical consultant for the majority of the government projects, JKR provide the following services as their core business:

- Technical consulting service;
- Project management; and
- Maintenance management service.

Under the 9th Malaysian Plan, JKR is entrusted to handle major infrastructure projects and in order to deliver such projects effectively JKR has recognised the need to improve their capacity and competency in delivering these projects.

To achieve this, JKR has established the Complex Project Management Division (CPMD) and implemented a Project Managed Change Program (PMCP) to institute best practice project management and risk management within JKR.

1.1. Background

Risk Management (RM) is a major managerial tool and many organisations concerned with standardisation have adopted Risk Management as a key process in their work.

There are always risks associated with a project. The purpose of risk management is to ensure levels of risk and uncertainty are effectively managed, so that the project is completed successfully. It enables participants involved in a project to identify possible risks and the manner in which these risks can be contained and the likely cost of mitigation strategies.

Risk Management can also be used as a planning tool in that it identifies the possible alternatives a project may take to avoid or minimize damages.

Effective risk management is not achieved by simply reacting to problems. The Project Management (PM) team should work to identify risks in advance and to develop strategies and plans to manage them, by:

- Anticipating problems rather than just reacting to them when they occur.
- Addressing causes instead of just dealing with symptoms.
- Having problem resolution plans ready ahead of time—before a problem occurs.
- Using a best practice, structured, repeatable process for problem resolution.
- Using preventative measures whenever possible.

There is risk and opportunity in all projects and they continually change as we operate in a changing environment. Effective risk management is a means of monitoring the changes.

This document outlines the process involved in conducting a risk assessment and has been designed to better assist the JKR project managers to achieve their objectives, and to contribute to the continuous improvement of performance throughout JKR.

1.2. Purpose

The purpose of this Guideline is to provide guidance to JKR project teams and project stakeholders on the application of the standard project risk management process in JKR. The Guideline is applicable to all JKR projects, programs, plans and activities.

The Australian/New Zealand standard AS/NZS 4360:2004 *Risk Management* provides the generic framework for the project risk management facilitation guidelines developed for JKR. This framework uses an iterative process of sequential steps, as described in Section 3- Risk Management Process. Users of these guidelines are encouraged to refer to that standard to gain a fuller understanding on JKR's approach to project risk management.

The Guideline also provides information and advice useful to project teams and those concerned with project governance, but does not provide a detailed definition of all the actions to be taken, or of the detailed risk management organisation for a project or program. These will vary according to the circumstances.

The guideline covers the following:

- Introduction to Risk Management's objectives and benefits of Risk Management, the process to be followed by JKR risk facilitators and background material such as glossaries and standards. (Sections 1 - 3).
- Recommendation for the roles and responsibilities of personnel involved in Risk Management.
- References to Tools and Techniques.
- Risk Management Procedures that are used in the 7 Risk Management processes. (Appendix A)
- Risk Management Workshop Procedure. (Appendix B)
- Presentation of templates and forms used in Risk Management planning/implementation. (to be included in Appendix)

2. RISK MANAGEMENT

Managing risk is one of the major processes of Governance and all its aspects. Risk management is a core discipline that assists managers at all levels to make correct and informed decisions and provides a process for organised assessment and control of risks. It involves the identification, analysis and evaluation of the risks presented by the product being constructed and the activities to acquire it, and the development of cost-effective treatments for the risks. It applies to projects and programs of all sizes.

Risk management can be challenging because it requires thinking that may be seen as detrimental to a project. Good risk identification requires 'negative thinking' and looking for potential problems. This can be seen as at odds with the 'can-do' attitude often expected by senior management. However, looking for difficulties and then managing them so that there are 'no surprises' for senior management leads to successful projects and is a mark of mature governance. Ignoring risks can lead to increased costs and unsuccessful outcomes for projects.

2.1. JKR Risk Management Framework

Typically an organisation will develop a framework under which risk management operates within the organisation. This enables the overall context under which risks will be addressed, provides a

process for escalating risks and ensures a standard approach to risk management across the organisation.

Although JKR has not adopted an organisational approach to risk management, it is important that the establishment of project risk management positions itself within an appropriate framework to ensure future compatibility. The following figure provides an overview of a typical framework and positions the JKR project risk management process within that framework.

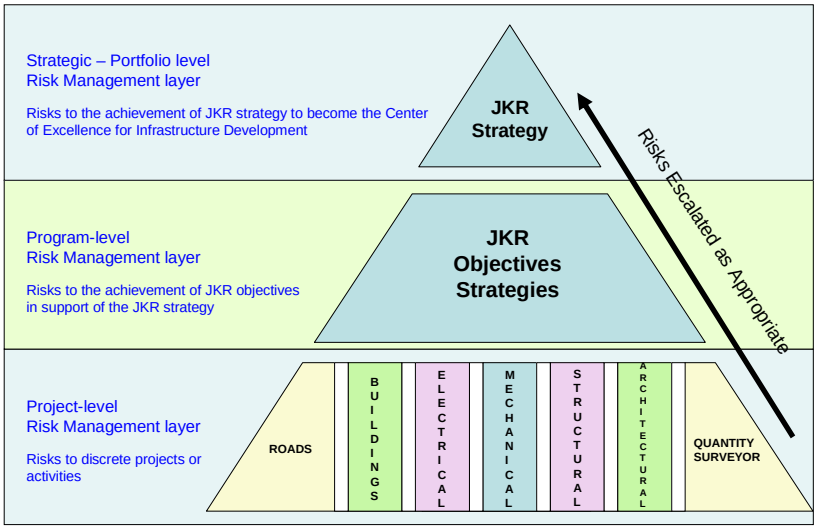

Figure 1: JKR Risk Management Framework

2.2. Benefits

Risk management is a planning tool that provides information in advance about what and when events can cause damage to the project outcomes. Use of risk management practices will lead to more creative and efficient planning of projects and provide the following benefits to JKR:

- Improve predictability and maximise potential to meet deadlines.
- Prevent additional costs and potential for budget overruns due to unforeseen and planned for events.
- Ensure projects and operations deliver promised functions.
- Achieve higher quality by increased conformance to defined requirements.
- Achieve better stakeholder satisfaction by avoiding damaging events of direct interest to them.
- Identify the requirement to prepare contingency plans where necessary.
- Ability for earlier problem resolution. Early detection makes risks less expensive to manage.
- Highlight options and trade-offs.

Furthermore, the process of standardisation of risk management itself has additional benefits:

- Ability to share information such as risk classification, identification of risky events and typical responses and solutions across projects.

- Ability to compare projects and operations in terms of their overall risk within or across JKR
- Supply risk analysis to various sponsors that require foreknowledge of potential troublesome spots in the projects they finance
- Encouragement for contractors to use such techniques when responding to projects for JKR
- Standardisation of risk management activities will reduce costs and improve schedules of projects across JKR.

2.3. Risk Management and the Project Life Cycle (PLC)

Today, risk management is recognised as a vital integrated project management tool that cuts across the entire project, addressing and interrelating cost, schedule, and performance risks. The goal is to make everyone involved in a project aware that risk should be a consideration in the design, development, and implementation of a system. It should not be treated as someone else's responsibility.

Risks associated with projects have a common flow path regardless of the project type. Initially the risks increase as a full understanding of the magnitude and extent of the whole project is obtained. The risks subside as the project progresses and the remaining uncertainties diminish. The Project Management Methodology Matrix (PMMM) identifies a number of instances in a project's life cycle where specific risk management activities must occur.

The accuracy of early project estimates is very dependant upon the nature and extent of the project's risks**.** The project manager must ensure that the customer understands that time and cost estimates, developed to deliver the project, to the agreed scope and quality standard, are contingent upon them accepting the assumptions, constraints and level of residual risk identified at the time of approval to proceed. This is critical and the project should not proceed until that understanding and agreement is reached.

Not all risks can be foreseen and problems that initially seem unlikely may in fact occur, so experience plays a key role in the identification of project-specific risks. This is a critical function that the project manager must perform. The question is: how does a project manager identify the project's risks and what do they do about it.

When is the best time to carry out the Risk Management Process? Too early in the Project Life Cycle and the thinking in the project is too fluid for a formal process to be meaningful. If it is done too late then it may be too late to correct any 'new' problems identified. The answer will depend on the classification and type of project, but the following figure identifies the key points within the JKR project life cycle that risk management could/should be undertaken.

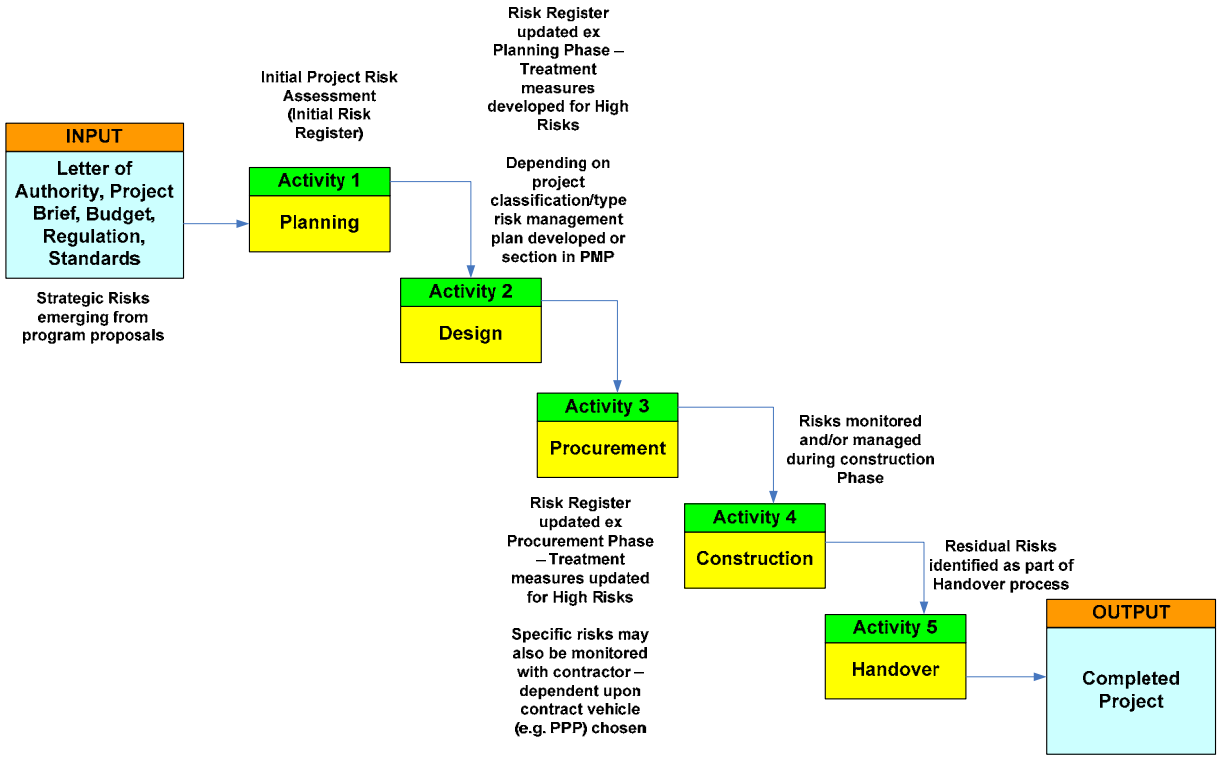

Figure 2: Risk Management Stages in PLC

The earlier a thorough Risk Management Process is carried out the more chance there is to influence the plan. Specific responses to the process can be considered in more depth which may lead to different approaches in managing the project.

3. RISK MANAGEMENT PROCESS

This document will introduce Standards and Guidelines related to Risk Management which are based on 7 processes, as shown in the following figure:

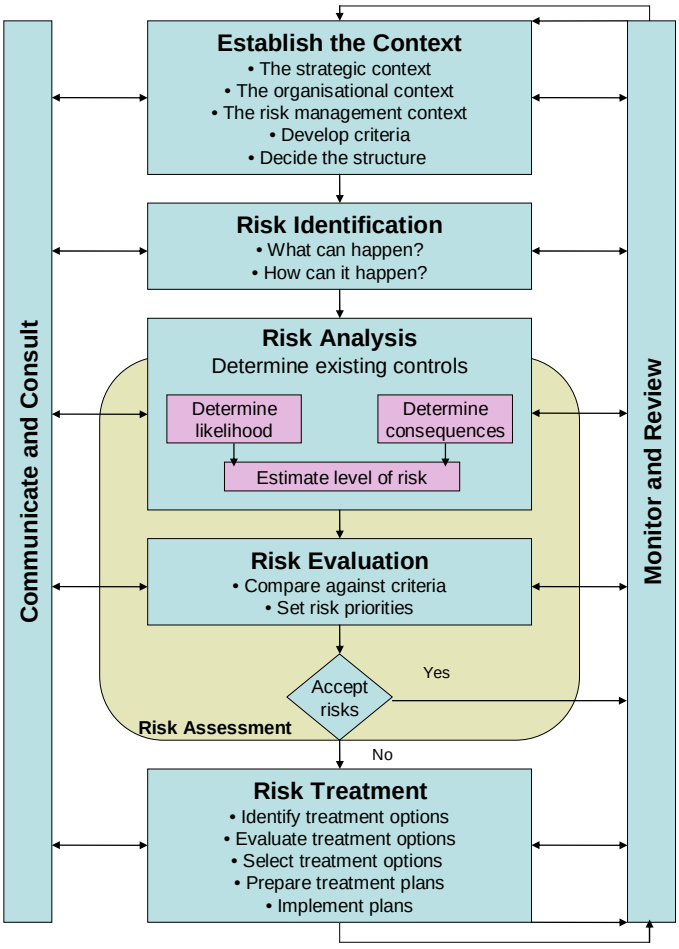

Figure 3: Risk Management Process

1. **Communication and Consultation:** Involves dialogue with stakeholders with efforts focused on communication and consultation rather than a one way flow of information from the decision maker to other stakeholders.
2. **Establish the Context**: Prepares JKR for the procedures needed to manage risks. The end result is a section of the Project Management Plan (PMP) or sub-plan to be subsumed under any JKR project plan or day to day operation.
3. **Risk Identification:** Allows JKR to identify the various risks and categorise them according to a suitable and controllable structure. The result of this is a list of risky events or conditions grouped under a suitable classification.
4. **Risk Analysis:** Analyses all events by assessing each against two major parameters. First of all, an assessment takes place of the likelihood that an event might take place. Secondly, the impact of the event would be evaluated in numeric, financial value and time period terms. The analyst would then compute the Risk Exposure by multiplying the

probability by the impact. The result of this process is the Risk Register (a list of risky events sorted by descending exposure), which gives the project manager the chance to address the most serious events first.

5. **Risk Evaluation:** Part of project planning and covers the ways and means of responding to each risky event. Different types of responses are considered. One type would be to do the necessary to avoid such events happening altogether. Another would consider ways to reduce the probability of their occurrence. Finally, the project manager may accept the inevitability of such events happening but develop contingency plans for when they do.
6. **Risk Treatment:** Identification, evaluation and selection of the appropriate treatment options and the development and implementation of the required plans.
7. **Risk Monitoring/Control:** Presents the procedures needed to monitor and track risky events, revising the Risk Register and learning from the various results.

3.1. Communicate and Consult

Since stakeholders can have a significant impact on decisions made, it is important that their perceptions of risk be identified and documented, along with the underlying reasons for their perceptions. Communication and consultation with all Key Stakeholders should be ongoing and not just part of the initial risk identification and analysis process. It should be linked with the overall *Communication Strategy* for the project and need not be a separate activity.

Effective internal and external communication is important to ensure that those responsible for implementing risk management and those with a vested interest, understand the basis on which risk related decisions are made and why particular actions are required.

Before developing the *Risk Management Plan* for large and/or complex projects, the Steering Committee and other Key Stakeholders should be brought together to undertake initial risk identification and analysis activities. As a minimum, changes in risk status must be reported to the Project Sponsor and the Steering Committee as part of the Project Status Report.

3.2. Establishing the Context

Establishing the context is a critical step within the RM process and is about determining the environment in which the project will operate. This includes:

- Determining the impact values for each risk category and the likelihood descriptions. In order to classify the risk impact, values must be established for each risk category that will determine its potential severity. Whilst the likelihood descriptions are consistent they need to be defined within the context of the particular project.
- Clarifying the assumptions that have been made.
- Understanding JKR's approach to risk management.
- Clarifying and reviewing the issues that have arisen from the key stakeholder groups.

Identification of the context for the risk management processes must include, particularly in the case of large and/or complex projects, identification of risks to the business environment where the project operates. Processes for escalating business risks to Senior Management should occur as part of the overall JKR risk management activities, including information and physical security risk management.

3.3. Risk Identification

Risk identification involves the identification and documentation of all the risks that may impact on the project during its life cycle that can be realistically predicted at the time.

Before risks can be managed, they must be identified. A very broad identification, analysis and evaluation of project risks should form part of the *Project Proposal* and/or *Business Case, as noted in Section 2.3*. Once the project has received approval to proceed, risk identification usually is done initially by involving Key Stakeholders, including Steering Committee members. One way of doing the risk identification may be through brainstorming sessions that identify and clarify the main risks, which may prevent the project achieving its stated outcomes/benefits. Further tools and techniques that can be used in the risk process are discussed in Section 6 - Tools and Techniques.

It is important to define clearly the scope of the project at this stage so that the identification of risks can remain focused on what potentially threatens the delivery of outputs (level of resourcing, time, cost and quality) and the realisation of outcomes/benefits by the Business Owner(s). Risks also can be categorised, for example in terms of type (ie Corporate Risks, Business Risks, Project Risks and System Risks). These categories can be broken down into other categories, including Economic, Environmental, Financial, Human, Information and Physical Security, Natural Hazards, Occupational Health and Safety (OH&S), Public Liability etc. Establishing categories can assist in ensuring all relevant risks are identified. Another way of establishing categories is to take each of the Key Elements of project management and identify which risks may impinge on the application of each Key Element. The following table provides some examples of categories, which to be modified overtime for applicability to JKR.

Table 1 : Categories of Project Risk

1	Political	9.	Contractual
2.	Scope	10.	Technical
3.	Schedule	11.	Environmental
4.	Financial	12.	Suppliers
5.	Human Resources	13.	Industrial Relations
6.	Quality	14.	Organisational
7.	Communications	15.	OH & S
8.	Other Resources	16.	Cultural / Social

Description

Risks need to be given a structured description using the following mantra:

Source of risk has a ***likelihood*** of causing an ***event*** which depending on the ***context*** will have an ***impact.***

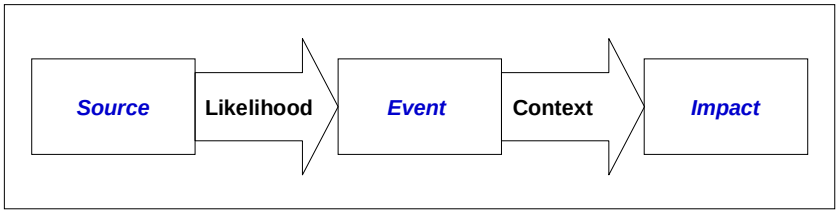

Figure 4: Profile of a Risk

Identified risks are described and communicated to management in the form of risk statements. These provide the clarity and descriptive information required for a reasoned and defensible assessment of the risk's occurrence, likelihood and areas of impact.

A well written risk statement contains two components :

- Statement of the *Condition Present*
- The *Associated Risk Event (or events).*

Risk statements are generally written in one of two ways:

1. An **IF – THEN** type of risk statement; or
2. A **CONDITION – CONSEQUENCE** risk statement.
   (Given the "condition", there is a likelihood that "impact" will occur).

Example Risk Description

Source	Likelihood & Event	Impact
There may be one or more sources …	… potentially causing a variety of events …	… leading to one or many impacts.
Loss of funding	Will cause a reduction in available resources	Leading to project delays or reduction in agreed deliverables

Once all risks have been identified, a filtering process should be used to determine which identified risks:

- Are best left, as the likelihood and impact would be so low that mitigation strategies are not required
- Need monitoring, but no proactive mitigation strategies required at this stage
- Are prevented by changing the scope of the work of the project, with appropriate sign-off
- Have to be escalated for the attention of Senior Management within JKR as a risk to JKR overall
- Need planned mitigation strategies, as detailed in the Risk Register

The results of this exercise should be documented in a Risk Register for the project.

3.4. Risk Analysis

Risk analysis may be undertaken to varying degrees of detail depending on the risk, the purpose of the analysis and the information data and resources available. Analysis may be qualitative or quantitative depending on the circumstances.

3.4.1. Qualitative Analysis

Qualitative analysis uses words to describe the magnitude of potential impacts (see Section 3.4.3) and the likelihood (see Section 3.4.3) those impacts will occur. These scales can be adapted or adjusted to suit the circumstances and different descriptions may be used for different risks.

Qualitative analysis may be used for the following reasons:

- As an initial screening activity to identify risks which require more detailed analysis;
- Where this kind of analysis is appropriate for decisions; or
- Where the numerical data or resources is inadequate for a quantitative analysis.

Qualitative analysis should be informed by factual information and data when or if available.

3.4.2. Quantitative Analysis

Quantitative analysis uses numerical values (rather than descriptive scales used in qualitative analysis) for both impact and likelihood using data from a variety of sources. The quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used.

Impacts may be determined by modeling the outcomes of an event or set of events or by the extrapolation from experimental studies or past data. Impacts may be expressed in terms of monetary, technical or human impact criteria.

3.4.3. Likelihood and Impact

Risks can be analysed according to the likelihood they will be realised and the level of impact they will have if they do occur.

Likelihood is classified as:

- rare (R),
- unlikely (U),
- possible (P),
- likely (L) or
- almost certain (AC),

The impact is classified as:

- insignificant (I),
- minor (Mi),
- moderate (Mo),
- major (Ma) *or*
- severe (S).

This classification will result in the development of a priority listing for evaluation and action that can be used to separating the acceptable risks from the unacceptable ones.

An example of possible risks might include a loss of funding (the effect of which is a lack of resources) or that crucial stakeholders are not interested in the project (the effect of which is they do not provide important input into the project or take responsibility for it). These identified risks are analysed in Table using likelihood and impact for each risk to provide a good indication of the project risk exposure.

Table 2: Example of Risk Analysis

	Likelihood					Impact				
	R	**U**	**P**	**L**	**AC**	**I**	**Mi**	**Mo**	**Ma**	**S**
Loss of funding			X				X			
Loss of stakeholder commitment				X					X	

It is essential to establish a common understanding of the scales applied to likelihood and impact of risk for each project. Table 3 and Table 4 provide **examples** of further analysis of project-specific descriptions or values that can be applied to the above scales.

Example of Likelihood Assessment Scale

Table 3: Qualitative Measures of Likelihood

Descriptor	Qualitative Statement	Probability that the event will Occur
Rare	May occur only in exceptional circumstances	< 10%
Unlikely	Is unlikely to occur	10% - 30%
Possible	May Occur	31% - 70%
Likely	Will probably occur	71% - 90%
Almost Certain	Can be expected to occur	>90%

Example of Impact Assessment Scale

Table 4: Qualitative Measures of Impact

Descriptor	Financial Impact	Image/ Reputation	Environment	Possible Delay to the Schedule	Community/Stakeholder Response to the Impact of the Event	Health & Safety
Insignificant	<RM250,000	Brief Local Media coverage	Short term damage	< 10 days	Minor complaint	No injuries
Minor	RM250,000 – RM1,000,000	Local Media coverage	Limited but medium term negative effects	10 – 20 days	Formal correspondence written by stakeholder	First aid required
Moderate	RM1,000,000 – RM5,000,000	Regional Media coverage	Major but recoverable ecological damage	20 – 30 days	Local political intervention	Medical treatment
Major	RM5,000,000 – RM10,000,000	Sustained Regional Media coverage	Heavy ecological damage, costly restoration	30 – 45 days	Ministerial involvement	Extensive Injuries
Severe	>RM10,000,000	National Media coverage	Permanent widespread ecological damage	> 45 days	Cabinet intervention	Fatality

In practice, it is often difficult to analyse the likelihood/impact of risks quantifiably and that is why a qualitative word scale often is used.

Risks analysed in Table can be graded easily using the risk matrix in as shown in the following figure.

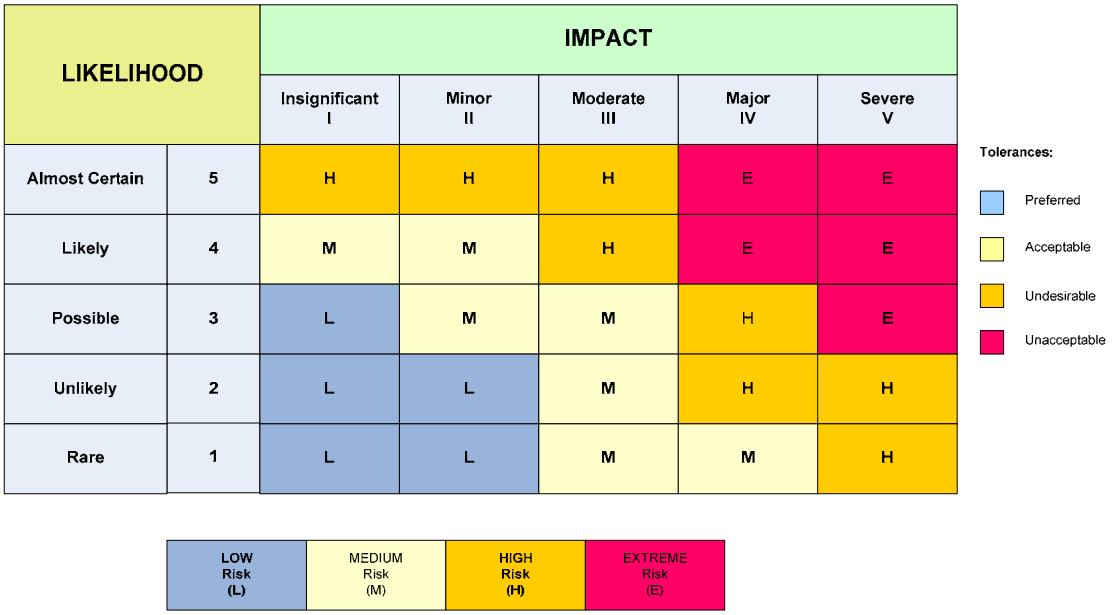

Figure 5: Risk Matrix for Rating Risks

Rare Likelihood/Insignificant Impact equates to a Low grading for overall risk exposure. Likely Likelihood/Major Impact equates to a High grading for the risk exposure. An example of a High Risk to the project might be unexpected legislative changes.

The resulting **Rating** of risk help the Steering Committee and Project Team to focus on treating the most important risks, once analysed, evaluated and prioritised. That is not to say that risks may not re-emerge after treatment and that is why it is stressed that risk management is an iterative process throughout the life of the project.

Table recommends the type of actions that should be used, and agreed to, in relation to each grade of risk.

Table 5: Recommended Actions for Ratings of Risk

Ratings	Risk Mitigation Actions	Who
E	Mitigation actions, to reduce the likelihood and impact, to be identified, costed and prioritised for implementation **before** the project commences or **immediately** as they arise during project execution	Steering Committee/Project Sponsor
H	Mitigation actions, to reduce the likelihood and impact, to be identified, costed and prioritised. Appropriate actions implemented during project execution	Steering Committee/Project Manager
M	Mitigation actions, to reduce the likelihood and impact, to be identified and costed for possible action if funds permit	Project Manager
L	To be noted; no action is needed unless grading increases over time	Project Manager

There are more sophisticated tools available to assist with risk analysis and many include extensive numeric scales and algorithms. For very large and/or more complex projects, it is wise to investigate the use of these tools, although the approach above is a starting point and is easily explained to non-specialists. The approach above is just a suggested starting point.

3.5. Risk Evaluation

Risk analysis helps those people involved with a project to evaluate and prioritise the most significant risks requiring or needing careful management. Risk evaluation involves assessing the risks in order to prioritise those risks that should be addressed by treatment or mitigation plans. Once risks have been analysed and graded in terms of likelihood and impact they have to be evaluated. Risk evaluation involves monitoring and understanding the factors that can reduce project success and determining what is an acceptable or unacceptable risk based on agreed criteria. Risks can result in four types of consequences:

- Benefits are delayed or reduced
- Timeframes are extended
- Costs are advanced or increased
- Output quality (fitness-for-purpose) is reduced

Once this evaluation has been undertaken decisions then can be made. For example, a risk is acceptable in terms of extended timeframes, if the project is not tied strictly to set deadlines, but is not acceptable if it reduces the planned benefits or affects output quality. If, on the other hand, a project has fixed deadlines, then the decision might be made that the level of risk is acceptable in terms of reducing the quality of the outputs, with a view to enhancing quality after the initial deadline has been achieved.

Once priorities are agreed, mitigation strategies must be developed and implemented for all unacceptable risks. Projects assessed as Extreme risk will need the project manager to ensure that a facilitated risk management workshop is held and a risk management plan is prepared and implemented. Lower risk projects will require the project manager to ensure that a risk management plan is prepared, however the frequency of reviewing the risks can be suitably reduced.

3.6. Risk Treatment/Mitigation

The intent of this step is to develop a strategy for managing the risks of the project. Choosing any form of treatment may in itself expose the project to additional risks associated with it. Care must be taken to ensure that the treatment strategy does not expose the project to greater risk than the original risk it was designed to treat.

Risk mitigation actions or treatment reduce the chance that a risk will occur and/or reduce the seriousness of a risk that is realised. The costs of these actions should be identified as part of the Evaluation activities. To effectively manage a risk, it may be necessary to adopt a combination of strategies to treat it. The selection process can be iterative until the most effective treatment strategy or strategies are developed. There are 5 methods of risk treatment:

- **Avoidance.**
    - This involves avoiding the activity that exposes the project to the risk.

      e.g. if the risk is associated with securing internal resources for the project team, then choosing to utilise the services of a contractor would avoid that risk.

However, choosing to use a contractor in itself brings risk to the project which would clearly need to be understood and assessed.

- **Reduction in the Likelihood**.
  - Undertaking additional investigation to better understand the existing conditions (Geotech/survey)
  - Surveillance (inspectors)
  - Applying internal controls
  - Undertaking training (increase technical competency)
  - Increasing the level of communication.
- **Reduction in the Impact.**
  - Through some form of tactical response, such as preventative maintenance or individual design elements considerations
  - Some form of contingency planning, such as financial contingency, time contingency or disaster recovery plan.
- **Transfer.**
  - The use of insurance, where it is applicable, may be an appropriate method of risk transfer.
  - Another method is to transfer the risk through some form of contractual obligation. It must be remembered however, that no one will willingly accept a risk without some form of compensation for doing so.
  - Whilst it is obvious that insurance carries a cost, the transference of a risk through contractual obligations will also inevitably increase the cost of the contract.
- **Acceptance or Retention.**
  - If the other methods fail to adequately or fully treat the risk, the project will be faced with accepting the entire risk or any residual risk remaining after some initial treatment.
  - Should this occur, the project will be exposed to some degree of impact that it must manage internally. To ensure the initial project estimates are not exceeded it must include sufficient contingency (time and dollars) to cover the eventuality.
  - It may be possible for a risk to have a number potential treatments equally suitable but varying in cost. The selection of a final treatment must be made on a "value" basis. The cost of managing a risk should be commensurate with the benefits gained.

Risk mitigation or treatment actions should be cost efficient and effective in that they help reduce the risk exposure of the project. Conscious decisions need to be made regarding the wearing or transferring of certain risks as opposed to the costs of mitigation, e.g. for serious risks, an extremely effective risk mitigation strategy could be justified in terms of its cost.

A portfolio of cost-effective risk mitigation actions forms part of the *Risk Register* for large and/or complex projects. Mitigation strategies to reduce the likelihood and impact of risks should be built into the budget and activities of the project and should be measured, comparing cost and benefits.

Recovery actions are the subsequent actions that allow you to move on after a risk has occurred. They include management of residual risks. Hopefully, the seriousness of a risk's impact on the project will have been reduced due to the planned contingencies being implemented. These

recovery actions should be built into the work breakdown structure for the project. In other words - what should be done and when.

3.7. Monitor and Review

Risk monitoring systematically tracks and evaluates the performance of risk-handling actions. It is part of the project management function and responsibility and should not become a separate discipline. Essentially, it compares predicted results of planned actions with the results actually achieved to determine status and the need for any change in risk handling actions.

To ensure that significant risks are effectively monitored, risk-handling actions (which include specific events, schedules, and "success" criteria) should be reflected in project planning and scheduling. Identifying these risk handling actions and events in the context of Work Breakdown Structure (WBS) elements establishes a linkage between them and specific work packages, making it easier to determine the impact of actions on cost, schedule, and performance.

The functioning of the project team is crucial to effective risk monitoring. They are the "front line" for obtaining indications that risk-handling efforts are achieving the desired effects and are responsible for monitoring and reporting the effectiveness of the handling actions for the risks assigned.

The project Risk Management Plan documents how the chosen treatments will be implemented. The plan should also identify who should be responsible, when it is to be done, the expected outcomes, costs, performance measures and how/when it will be reviewed.

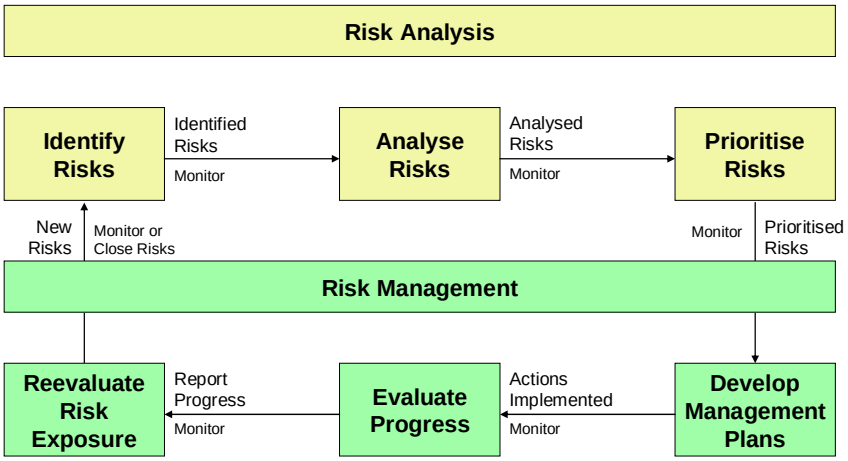

Figure 6: Review and Monitor Risks

Risk management is not a one-off activity. Risks should be monitored throughout the project, as their likelihood or impact ratings may change or new risks and previously treated risks may emerge. As a guide, risks and the effectiveness of the mitigation strategies should be assessed approximately every two weeks. Over a long, significant project there should also be regular formal monthly reviews. It is important to remember that the whole process is iterative throughout the life of the project. Regular reporting, at agreed intervals, of **Risk Status** must be conducted by the Project Manager and must be required by the Project Sponsor/Steering Committee.

4. ROLES AND RESPONSIBILITIES

Everyone associated with a project has a part to play, although everyone is not involved in addressing and reviewing and reporting on risks, all should be involved in identifying and assessing risks. The general approach should be '*No risk is too small*.' Once discussed, there may be no need to record the risk or take any additional action , but if it is important, then the general rule of *escalation* will apply – if it cannot be managed satisfactorily at the project level, it needs to be passed up to the next level of management to be owned and addressed.

The key to effective risk management is ownership. Each risk must be owned so that there is clear responsibility and accountability for that risk. People need to take responsibility for different risks at different levels and although a risk will have one owner, there may be several people responsible for action to deal with that risk and each action must have an owner too. For example as a guide:

- The Project Board/Steering Committee should own any risks that threaten the overall successful delivery of a project.
- The Project Board/Steering Committee should own any risks that affect the business case. For example any risks that would prevent the benefits of the project from being fully realised
- The Project Manager should own any risks that might affect the delivery of any project level product. For example any risks that affect the project schedule, cost, quality, etc

But the most important thing is that the risk owner should:

- Be whoever is best placed to manage the risk
- Agree to own the risk
- Be aware of the responsibility for managing it

The project manager has overall responsibility for delivering the project and is therefore, responsible for the risk management plan. This means controlling risks (and any actions associated with them) and communicating the plan so that all parties understand their role(s).

Risk Owners

A designated position in an organisation assigned the responsibility for managing a specific risk. (Appendix C – Definitions)

Each risk that is identified in the risk register will have a corresponding risk owner. Ownership must sit at the appropriate level, with the person who can take effective action (for example by being able to switch resources to tackle a risk or give agreement not to deliver other work of lower priority). If a risk owner finds that they cannot take such action, then the risk needs to be escalated to the next level.

The owner is responsible for ensuring the quality of data recorded about the risk in the register. They will oversee the countermeasures that are in place and will review the proposed contingencies and develop additional actions as required. Where there is a different individual nominated as the day-to-day manager of the risk, the risk owner will provide appropriate oversight.

Risk Managers

The role responsible for operating the project's risk management process and the custodian of the Risk Management Plan and Risk Register. (Appendix C – Definitions)

The risk manager is the individual with day-to-day responsibility for implementing the countermeasures and monitoring their impact on the risk and reporting on their effectiveness to the risk owner and others. They are responsible for providing early warning of the current measures becoming ineffective.

Note: In most projects this role will be performed by the Project Manager

5. RISK MANAGEMENT PLAN (RMP) TEMPLATE

In many projects a 'stand-alone' RMP would not be justified. Instead risk management matters would be included in the overall project plan, with a separate Risk Register. A RMP is a dynamic document and its initial version, excluding the Risk Register, is a product of the process of establishing the risk context. The most dynamic component is the Risk Register, which will be updated frequently.

Note: The following outline is an example only at this stage – this will be adopted to suit the JKR environment in the next iteration of the Facilitation Guidelines.

5.1. Outline of a RMP

1. Introduction

1.1 RMP Purpose

- To manage the actions to identify, assess and treat risks to the project objectives and its delivered system.
- To create, maintain, action and report upon the Risk Register.

1.2 Intended audience

- All those stakeholders actioning risk management.

2. Risk Management Policy

2.1 General

- In accordance with AS/NZS 4360 and as outlined in this guideline in the context of the project and participating organisation(s).
- Reference enterprise risk management policies and risk appetite.

2.2 Risk Management Objectives

- Broadly, to identify and appropriately treat risks affecting project objectives.

2.3 Risk Criteria

- The criteria to be used in risk assessment.

3. Risk Management Organisation

3.1 Roles & Responsibilities

- Identify all roles that have responsibilities that include risk management and outline their responsibilities.

3.2 Resources

- Available for risk management, budget and control.

3.3 Structure

- Including relationships with stakeholders outside the project boundary.

4. Risk Assessment

4.1 Risk Identification & Definition

- Outline methods and activities to produce risk management deliverables in associated work packages.

4.2 Risk Analysis

- Outline methods and activities to produce risk management deliverables in associated work packages.

4.3 Risk Evaluation

- Outline methods and activities to evaluate risk management deliverables in associated work packages.

5. Coordination

5.1 Risk Register

- Configuration control arrangements, probably different to remainder of RMP.

5.2 Risk Monitoring

- Arrangements for risk monitoring, including of accepted risks.

5.3 Risk Reviews

- Frequency and arrangements for periodic, milestone related and other reviews.

5.4 Risk Reporting

- Nature, frequency and recipients of risk management reports.

5.5 Coordination with related projects

- If necessary.

6. Risk Register

- The Risk Register is probably best managed as a separate document or database although it is part of the RMP.
- Generally, each identified risk will need a page to itself, however, a tabular summary is preferred for status reporting.
- Each risk that is not rejected requires a treatment, including contingency arrangements if appropriate.

Contents for a Risk Register are outlined in the Table below; sometimes it may be appropriate to record treatments in a separate plan or schedule cross-referenced to the Risk Register:

RISK REGISTER

Project Title :	Date :
Project Ref. No. :	Compiled by :
Project Manager :	Reviewed by :

CATEGORY OF PROJECT RISK	
1. Political	9. Contractual
2. Scope	10. Technical
3. Schedule	11. Environmental
4. Financial	12. Suppliers
5. Human Resources	13. Industrial relations
6. Quality	14. Organisational
7. Communications	15. OH & S
8. Other resources	16. Cultural / Social

Likelihood Rating	Impact Rating	Risk Rating
5. Almost certain	V. Severe	E– Extreme risk, immediate action required
4. Likely	IV. Major	H – High risk, will jeopardize project if not managed
3. Possible	III. Moderate	M – Medium risk, will impact time, cost or quality if not managed
2. Unlikely	II. Minor	L – Low risk, acceptable project management risk, monitor only
1. Rare	I. Insignificant	

Risk Matrix

LIKELIHOOD						
	5	H	H	H	E	E
	4	M	M	H	E	E
	3	L	M	M	H	E
	2	L	L	M	H	H
	1	L	L	M	M	H
		I	***II***	***III***	***IV***	***V***
		IMPACT				

Ref No. (WBS)	Risk Event There is a risk that …….	Category of Risk	Likelihood Rating	Impact Rating	Risk Rating	Treatment Measures	Responsible Party	Action Date

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Risk Analysis Template

Ref No (WBS):	Risk Title:		
Risk Description:			
Risk Nature: Strategic/Operational	Risk Category:	Risk Manager:	Business Unit:

Risk Factors:	Possible Effects:
o ..	o ..
o ..	o ..
o ..	o ..

Existing Risk Treatments:	Effectiveness: (H, M, L)
o ..	
o ..	
o ..	

New/Propose Risk Treatments :	Responsibility Party:	Deadline:
o ..		
o ..		

Assessed Risk Date Last Review	Inherent Risk	Likeli-hood	Impact	Rating	Assessed Risk	Likeli-hood	Impact	Rating	Target Risk	Likeli-hood	Impact	Rating

Risk Analysis Template Instructions:

1.	**Ref. No:**	Sequential numbering of each risk identified.
2.	**Risk Title:**	Give the risk a title.
3.	**Risk Description:**	Provide a brief description of the risk.
4.	**Risk nature:**	Select one of the following – Strategic or Operational.
5.	**Risk Category:**	Select the appropriate category to classify the risk:
6.	**Risk Manager:**	Person responsible for managing the risk.
7.	**Business Unit:**	Provide name of Business Unit, including project name.
8.	**Risk factors:**	Describe the causes of the risk.
9.	**Possible Effects:**	Describe the impacts of the risk arising.
10.	**Existing Risk Treatments:**	Identify all existing risk treatments and controls that are in place and any mitigating factors.
11.	**Effectiveness (H,M,L):**	Rate the effectiveness of the existing risk treatments as either High (H), Medium (M) or Low (L).
12.	**New/ Proposed Risk Treatments:**	Identify a range of options or strategies for treating risks.
13.	**Responsibility Party:**	Specify person who is responsible for the implementation of each new/proposed risk treatments.
14.	**Deadline:**	Specify a final date when the implementation of the strategy will be completed.
15.	**Assessed Risk at Last Review:**	Specify date of last assessment and the assessed level. If this is the first time the risk has been identified then field is not applicable.
16.	**Inherent Risk:**	Determine the risk level by applying the risk matrix assuming no Existing Risk Treatments.
17.	**Assessed Risk:**	Determine the risk level by applying the risk matrix after forming a judgment on the effectiveness of Existing Risk Treatments.
18.	**Target Risk:**	Advise the target level that will be achieved after implementation of the new/proposed risk treatments. The target risk is the desired risk level after implementation of new/proposed risk treatments. There may be instances where the target risk remains high due to the nature of the activity undertaken. In this case new/proposed risk treatments should be closely monitored and reported.

6. TOOLS AND TECHNIQUES

The Risk Management process may include some or all of the following methods for identifying risks:

1. **Meetings:** This involves meeting with team members, management, project managers of earlier projects, users, unit directors and suppliers on medium to large projects.
    a. Brainstorming techniques can be used in such meeting as brainstorming sessions rely on the experience and knowledge of such members.
2. **Review earlier or historical documentation:** If proper documentation is kept of earlier projects, troubles or ongoing operations, this technique can be used to review such documentation as:
    a. Lessons learned (Document prepared on completion of projects)
    b. Earlier risk management plans and tables
    c. Risk monitoring reviews
    d. Top Ten tables
    e. Analysis of Variation Orders as these would help identify why changes occur.
    f. Problem or trouble lists
    g. Maintenance and support registers
3. **Checklists:** These are standard lists that may be prepared for generic projects. They can then be used as a basis for Risk Identification. If such lists are used, they should not be the only resource for Risk Identification. An example is shown at Appendix E.
4. **Published material:** Many industries have managed to produce many guides, tables and questionnaires that can be used as standards. These can be used to as an aid to identification of risks.
    a. Surveys / Taxonomies (a systematic way of organizing and eliciting risks within a logical framework
    b. Taxonomies - comprehensive list
    c. Industry lists
5. **Interview** individuals who are experts or knowledge in specific aspects of the operation or the project.
6. **SWOT analysis**: This has become a standard Risk Identification method. It refers to the military SWAT technique but means Strengths, Weaknesses, Opportunities and Threats. Analyse the Weaknesses and Threats to the project.
7. **Cause and Effect Diagrams:** A graphic/team-based method that presents a problem and attempts to resolve it by breaking down the problem to all its causes.
8. **Flow charts or other business models:** Such models describe the workflow in an organisation. Analysing them will show the project manager if there are bottlenecks, unrealistic designs, possible lack of controls, etc.

Using **Project Planning Outputs** is a crucial method for identifying risk. Since it is made up of a variety of sources, it has been given its own section, below.

When planning a particular project using a product such as Microsoft Project™ or Primavera™, the Risk Officer can review such items as the following and concentrate on the entries in each to search for risky events:

- **Critical activities:** Look for tasks that are on the critical path. These would be highly sensitive to delays.
- **Resources:** Look for tasks that have a large number of resources and ensure their availability. Coordinating is always a source of problems.
- **The Work Breakdown Structure (WBS):** the WBS is a hierarchical decomposition of all work units or activities or tasks in a project. Using the WBS, the Risk Officer can identify those activities which may present risks to the project.
- **Product specifications**: A review of systems designs, network topologies, web structures, etc., is a good way to identify risks by testing for the stability of user requirements, the validity of designs and other requirements such as integration, scalability, interoperability, etc.
- **Resource plans:** these identify all human resources and any other required resources. Analysing the resources gives the Risk Officer a chance to assess availability, suitability, competence levels, etc.
- **Competence:** Assessing this is usually a good source for risky events.
- **Assumptions:** Review the assumptions of the project or the operation. Unstated assumptions usually contain hidden problems.
- **Constraints:** Examining the constraints would lead to identifying troublesome areas.
- **Critical Success Factors (CSF):** These are factors without which an operation or a project cannot succeed. Review all CSFs and ensure they can be met.

A sample and generic description of a selected range of tools and techniques that can be used in the risk management process are shown in Appendix F.

6.1. Risk Questionnaires for Identifying Risks

The approaches so far have been based on classification of risks followed by identification. However, often, Project Managers have enough experience in certain areas to be able to judge over a range of responses whether there will be a risk or not.

Example: A project estimated to take 10,000 hours is inherently more risky than one that takes 1,000 effort hours. Likewise, a project utilising new technology or a new architecture will have a higher degree of risk than one utilising an older and more stable technology. Therefore, knowing these parameters about a project assists the Project Manager in identifying risks.

Guideline: This scheme for identification relies on stating questions whose response is a number between 1 and 5 (or any other scale). The Project Manager can then identify the risky situations based on the responses as shown in the following example.

Assume in the questionnaire that a response of 5 signifies strong disagreement while a response of 1 signifies strong agreement.

Example :

- Is the project large?
- Is the project of major importance to JKR?

- Is the project functionally complex?
- Is the design of the project dependent on very few people?
- Is the project objective poorly documented?
- Is the project scope poorly defined?
- Is the project scope not clearly agreed upon?
- Is the project plan poorly defined?
- Will the system change existing user procedures?
- Are organisational changes likely during the project?
- Are users to be faced with untried new technology?
- Is the project technologically complex?
- Is the quality of existing data poor?
- Are the project team roles poorly defined?
- Are users not interested in the project?
- Is there low commitment of staff assignments to project?
- Are the required skills unavailable?
- Is the project dependent upon third parties?
- Is there a large number of interfaces with third parties?
- Is the implementation going to take place in one go?
- Are there poorly defined test/contingency plans?

The Risk Officer can then select the questions with responses of 5 and 4 (Disagreement) and use them to identify the risky events in the project or the operation.

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Appendix A

Procedures
for
Risk Management Processes

Step 1 Establish the context

Purpose

The purpose of this step is to establish, for the project, the parameters for risk management and the criteria against which risks will be assessed.

Commentary

The first step is to establish the strategic, organisational and risk management context in which the risk management process will occur. The starting point for this is JKR's enterprise level risk management policies and processes.

The strategic and organisational context is the relationship between the organisation and its environment, characteristics and functions. This also includes identifying stakeholders. Projects that acknowledge and understand that risk management takes place in this wider context successfully identify and assess risks and plan for relevant treatments.

The specific project risk management context must also be established. This identifies the boundaries of the risk management activities and the necessary risk interfaces with other projects and organisations.

Risk management must be appropriate to the overall risk exposure. One approach for smaller projects is to undertake a 'flash' assessment to identify any significant risks. The results of this will determine the subsequent scope of risk management activity. For some larger projects regular independent external reviews may be appropriate as a strategic risk treatment.

The project context leads to the appropriate level of risk management effort and initiates the Risk Management Plan. A template for a Risk Management Plan is in Appendix C.

Outputs

The initial version of the Risk Management Plan including the risk management policy for the project or program.

Summary of key elements in establishing the risk context for a project:

- Establish the strategic context
- Establish the organisational context
- Establish the risk management context
- Prepare the initial version of the Risk Management Plan

Step 2 Identify and define risks

Purpose

The purpose of risk identification is to identify and define the positive and negative risks that may affect the project or program.

Commentary

The identification of the risks associated with a project should start when the concept for the project is first developed.

Risks are uncertainties affecting the achievement of the project's objectives. It therefore follows that risks cannot be fully identified if objectives are unclear. The project's Business Case must identify all known risks that may affect the complete life cycle from concept to eventual disposal of the system delivered by the project. The project's cost benefit analysis must consider the estimated life cycle costs for the management of risks from initiation onwards. At this stage the project's Risk Register (part of the Risk Management Plan) must be opened.

Unidentified risks cannot be managed. Effective risk identification must overcome barriers such as a 'can-do' or 'it will be right' attitude, the unthinkable must be considered and not seen as 'undermining' or 'negative thinking'. A typical failing in risk identification is to focus on the easy and minor problems and ignore the potential 'show-stoppers'. One effective approach to severe risks is to start with the catastrophe and work back to its sources.

Risk management is a continuous process; it is an inherent component of analysis, design, implementation and in-service support planning of any project. Risks will change during these activities; risk estimates will be refined, some risks will disappear and new ones will emerge.

Risk management is an integral part of requirements engineering. This means applying it during analysis, synthesis, trade-offs and design during the engineering processes and to architectural and detailed designs. Established techniques such as Event Trees, Fault Trees, Master Logic Diagrams and Event Sequence Diagrams , may be applicable.

A sample and generic description of a selected range of tools and techniques that can be used in the risk management process are shown in Appendix F.

In addition to embedding risk management into all aspects of a project, the Risk Register should be periodically reviewed as a formal activity established by the Risk Management Plan. This should be at milestones, particularly at the start of stages, but for larger and longer projects it should be periodic, as frequent as every two months.

Effective methods of risk identification include:

- Brainstorming, with a facilitator and range of stakeholders
- Interviews with stakeholders.
- Scenario, business analysis and event tree modeling.
- Dependency modeling.
- Experience from other projects, metrics and published data for norms.
- Reviewing project information, including plans, analysis and designs.
- Checklists.

Many risks are products of estimates, which are inherently uncertain. One way of identifying risks is to recognise those areas and seek input from two or more people competent in the area and compare responses.

Stakeholders include the Business Owner, business managers from key functional and business areas, project team members, relevant specialists, operators, users and clients. The last are particularly important because well managed projects often deliver 'solutions' that are not fully adopted by their ultimate users. This means the project at least partially fails.

Many common risk sources can be identified at the start of a project and treated before they have any significant impact. Risk identification requires a broad and forward-looking view, experience, and an element of lateral thinking. An example of a checklist for risk identification is at Appendix E. In some domains consideration of vulnerabilities is another useful approach to identifying risks. The possibility of risk treatments failing is itself a risk that has to be considered.

Identified risks should be meaningfully expressed, the preferred form of expressing a risk is – '*There is a Risk that [Risk Source] cause [Consequences] that impacts [Project Specific Objectives]*.'

It is also important to record relationships and commonalities between risks to facilitate their subsequent management and identify impacts that may compound or chain. For example one risk event may have several impacts, one impact may have knock-on effects on others and two or more risks may disproportionately increase a shared impact. Risks that affect the key project managed elements of cost, schedule and scope/quality (fulfilling functional and non-functional requirements) should also be clearly identified.

Output

Identified risks are recorded in the Risk Register.

Summary of the key elements in the identification of a project's risks:

- Identify risks in the initial and revised business cases
- Review risks throughout the project in accordance with the Risk Management Plan
- Document identified risks in the Risk Register
- Encourage wide participation
- Use a formal process and appropriate methods and techniques
- Consider all risk sources

Step 3 Conduct risk analysis

Purpose

The purpose of risk analysis is to consider all identified or changed risks to produce valid input for decision making in the evaluation step.

Commentary

The analysis of the risks associated with a project requires high levels of participation by key representatives of the business, project team and other stakeholders.

Risk analysis can be undertaken using similar methods as used for risk identification and is also a continuous process in the same way that risk identification is and the two may often be combined, in a structured way, into one activity.

Project or program risks are analysed to identify the:

- Estimated likelihood that the risk will occur (preferably probability using quantitative methods);
- Estimated impacts of the risk occurring in terms of its cost, schedule, 'quality' and other impacts on the project objectives including its products;
- The most appropriate risk owner; and
- Potential impact of the risk on third parties such as other projects and organisations.

It can also be useful at this stage of the analysis to conduct an initial high level assessment of whether the risk should be managed. There are three cases where a risk may not need managing by a project:

- The likelihood of it happening is extremely small.
- The impacts are insignificant and require no treatment
- The risk belongs outside the project; in this case the outside owners must formally take responsibility for it.

Where the impacts cannot be quantified they are normally qualitatively estimated on a scale from low to high or similar. A qualitative approach to both likelihood and impacts may be the only option at the very earliest stages of a project, but should migrate to quantitative as soon as possible. Qualitative estimates should use the 'most likely' (i.e. not best or worst case) criterion for rating the likelihood and impact of a risk.

When considering the likelihood of a risk that is outside the project schedule then a time-period usually needs to be adopted. Typically the products expected life but possibly some term such as 5 years, whole-life cost time frame or the period used for benefits realisation. In some instances, it may be appropriate to consider vulnerability to a risk as part of its probability, including representing vulnerability as a risk source.

When analysing risks it is important to document the information and assumptions underpinning the analysis, including the interdependencies between risks. This documentation forms a baseline to facilitate subsequent reviews and assess changes.

Outputs

Estimates of the likelihood and impacts of risks and identification of the Risk Owners documented in the Risk Register.

Summary of the key elements in the analysis of a project's risks:

- Estimate the likelihood and impacts of each risk and the resultant risk exposure.
- Identify the most appropriate Risk Owner for each risk and assign the risk to them.
- Document the outcome of risk analysis in the Risk Register.

Step 4 Conduct risk evaluation

Purpose

The purpose of risk evaluation is to decide which risks need treatment and their priorities.

Commentary

Once an analysis or review has been made of the risks associated with a project, the risks are evaluated to determine their treatment. The first action is to sort the analysed risks by classifying them as one of:

- Accepted Risks, risks that are currently acceptable and do not require treatment, but will be kept under review.
- Rejected Risks, risks that are considered non-existent after analysis or of no significance.
- Significant Risks to be treated, these may need prioritisation.

Classification and prioritisation will be against risk criteria in the light of contexts and policies established in the Risk Management Plan. It is important to remember that one risk source may have several impacts, direct or chained, and that there will be inter-relationships between risks.

Risk evaluation should also consider the sensitivity of the estimates to errors. This is significantly less of an issue when estimates have the form of a probability distribution because quantitative methods facilitate it.

Optimism bias is another consideration, and reflects a human tendency to optimism. Quantitative methods can reduce this bias, which can be significant when project team members make the estimates. Other solutions include applying to estimates standard 'multipliers' derived from experience with similar projects or ensuring a process of rigorous independent review of risk identification and analysis.

In some instances it may be necessary to develop contingency plans:

- In case the risk eventuates;
- A critical decision point is reached without effective treatments being found; or
- There is a likelihood that an effective risk treatment will not be found.

When a risk has not been treated in a way that entirely eliminates it, then indicators of the risk eventuating may need to be identified. Manifestation of the indicators means that the likelihood of the risk is increasing and contingency plans may need to be executed.

If risks are positive then treatments should endeavour to make them more likely to occur or enhance their beneficial impact.

Treatments may have Secondary Risks, which must be analysed and evaluated. Most typically where treatment involves re-work or additional work that affects cost, schedule, performance, scope or quality.

Accepted risks require a Risk Owner who is responsible for reviewing and monitoring them and reporting any changes that affect their likelihood or impacts.

In some instances a risk can be so severe that the viability of the project may need to be reassessed. These risks must be highlighted and formally considered by the Sponsor and, depending on the scale of the project and JKR procedures, senior management.

Outputs

The outcome of the risk evaluation is an updated Risk Register. This is reviewed by the Sponsor. Any changes to risk must be fully reflected in approved revisions of the Business Case.

Summary of the key elements in the evaluation of a project's risks :

- Classify the risks
- Prioritise significant risks
- Update the Risk Register

Step 5 Develop and implement risk treatments

Purpose

The purpose of this step is to identify, assess and implement measures to modify risks.

The Risk Owners prepare treatments for the risks assigned to them. Risk Owners may be members of the project team, business or other managers elsewhere in the agency, participating agencies or other stakeholder bodies. They will require an appropriate allocation of resources for their task(s), which may require negotiation by the Sponsor depending on their relationship to the project.

Treatments will either reduce the risk's likelihood or impacts or both. Preparation of treatments usually requires inputs from stakeholders and coordination with the Project Manager and Risk Manager. If there is an unacceptable risk of treatment failing (or not being found) or when a risk may reach an unacceptable level then a contingency plan must be developed. Secondary risks may be a consequence of risk treatment and may necessitate their own treatment or contingency plans.

Risk treatment has both tangible and intangible costs and care must be taken to ensure that the cost of treating a risk does not exceed its anticipated impact. This means that treatments must be costed, cost-effective and practical.

In some cases risk treatments will be embedded in the project. For example the risk of project estimating errors is best handled quantitatively and treated by appropriate allowance in the project schedule and cost plan. However, there is then a risk of self-fulfilling worst case prophecies, which have to be managed by setting 'stretch' targets and carefully selected 'must achieve' milestones. This is best done in a staged project design.

The major approaches for treating risks are:

- **Reduce likelihood**, where the project or its environment is changed to reduce the probability of a risk occurring;
- **Reduce impact**, where action is taken to minimise the impact of a risk if it occurs. Treatment includes contingency planning that should address significant risk areas where preventive action is either unavailable or the cost of prevention is prohibitive;
- **Avoid risk**, by not proceeding with the aspect that may suffer the risk event;
- **Risk transfer**, where the responsibility for a risk is transferred to another party such as a supplier or insurer.

A range of treatments may be available for each risk and the Risk Owner must assess each option. Risk treatments may be reflected in project planning and can affect cost and schedule. However, early action may permit them to be undertaken as modified future activities without cost or schedule impacts. Risks that are identified later in a project's implementation stage are more likely to have a significant impact on costs and schedule. It may be necessary to update the project's cost benefit analysis to reflect the anticipated costs of the risk treatments. For each risk that is to be treated the risk treatments should identify:

- The Risk Owner responsible for treating the risk;
- Any relationships between risks;
- Indicators of the risk increasing or decreasing;
- The approach to be used to treat the risk;
- Assessment of the likelihood of the treatment being effective and mechanisms for measuring the effectiveness of the risk treatments;

- If necessary, a contingency plan, including an implementation decision point, if the risk treatment is insufficiently effective;
- The budget for the treatment; and
- If appropriate a time-scale for the completion of the risk treatment.

The risk treatments must be integrated with the overall project plan. This will ensure that any dependencies or potential resource conflicts between project tasks and risk treatments are identified and resolved. Where appropriate, the risk treatments should be linked to other business plans within the agency such as the corporate risk management plan.

Formal risk treatment reporting mechanisms should also be developed. Risk treatment must by monitored by the Risk Manager and incorporated with the regular project progress reporting to the project's Sponsor and agency management as applicable.

Outputs

Planned treatment actions for all risks that have been identified as needing treatment and the Risk Register and project plans appropriately updated.

Summary of the key elements in the development and implementation of risk treatments:

- Identify risk treatments options
- Assess each treatment including the need for contingency plans
- Integrate treatments into the project plans
- Document and cost risk treatments
- Develop risk reporting mechanisms to the Sponsor and other stakeholders in accordance with agency delegations and procedures

Step 6 Monitoring, reporting, updating and managing risks

Purpose

The purpose of this step is to monitor and report on the effectiveness of all steps in the risk management process.

Commentary

All projects should have a position with a Risk Manager role. The person with this role has overall responsibility and authority for ensuring that the risk management process operates effectively in accordance with the project plans including the Risk Management Plan. This role should also seek continuous improvement to the project's risk management processes and enable other projects to learn from their experience. However, this role is not the owner of all risks.

It is at least highly desirable that when a contractor is undertaking any part of the work then their risk management is appropriately integrated with that of the customer agency. This may be achieved through a joint register of risks and its regular review, although both parties may have additional risks in their own registers. Of course a shared list of risks does not mean a shared responsibility for managing them. The extent of a contractor's risk reporting to the customer will depend on what is agreed in the contract.

As a project progresses its risks will change due to unforeseen factors. These include new or revised business requirements, changes in legislation or a supplier no longer able to provide a particular product. It is therefore essential that the project's risks are continuously monitored, regularly reviewed and updated. The frequency of these reviews depends on the duration of the project but should be a mixture of periodic and event based reviews. On larger projects they should be at a minimum of every two months.

Particular care must be taken to reassess risks to a project when:

- a new stage of the project starts;
- there is a significant change in the scope or approach of the project; or
- a substantial change occurs in the project's stakeholders or environment such as a new Sponsor or Project Manager.

Review of risks may lead to the:

- identification of new risks;
- elimination of risks that no longer apply; and
- reclassification of existing risks where the estimated likelihood or impact has either increased or reduced.

Care must be taken to ensure that project management attention is not overly focused on areas that were initially assessed to be high risk. This may result in a failure to detect the emergence of new risks or the escalation of existing risks in other areas.

The assessment of any newly identified or changed risks is conducted in the same manner as described in the earlier sections of this Guideline. The outcome of this process is used to update the Risk Register. The risk treatments are also updated or new ones created to reflect the new or revised risks treatments that are to be adopted for the project. Ensure that changes to risks are fully reflected in any updates of the Business Case provided for Gateway Reviews.

Formal risk reporting arrangements to the appropriate organisational level must be established. Risk reports must highlight changed risks and contain relevant and concise information that can

be efficiently assimilated by the reports' audience. Risk monitoring and reporting needs to address two matters:

- Progress in the treatment of significant identified risks, including any indications that treatments may fail.
- Monitoring the project for indicators of other risks, that may or may not have been identified, emerging or growing. This involves analysis of project metrics, and when the risk has been identified its indicators should be recorded in the Risk Register.

The following table is an example set of types of project metrics:

Area	Measurement Category	Indicator
Schedule	Milestones	Milestone Achievement
Product Completion		Requirements Fulfilled Earned Value Graph & Indices
Resources & Cost	Personnel	Staffing Profile
Financial Performance		Earned Value Graph & Indices
Complexity & Stability	Physical Size & Stability	Components, Lines of Code Interfaces
Functional Size & Stability		Requirements Fulfilled
Requirements Changed		
Product Quality	Functional Correctness	Defect Profile
Software Design Coverage		
Test Coverage		Test Coverage
Execution Failure Rate		
Process Performance	Process Efficiency	Productivity
Process Effectiveness		Defect Containment
Configuration Management	Amount of Change	Change Requests
Interfaces		Percentage of Interfaces Defined

Table 1: Example Project Metrics

Outputs

Updated Risk Register and reports as required by the Risk Management Plan.

Summary of key elements in monitoring and updating a project's risk profile:

- There must be an overall Risk Manager
- Regularly review the risks
- Monitor the emergence of new or changing risks
- Update the risk treatments
- Maintain the Risk Register
- Risk Reports to appropriate recipients including the Sponsor and management in accordance with agency delegations and procedures.

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Appendix B

TEMPLATES FOR RISK MANAGEMENT

1. RISK REGISTER

2. RISK ANALYSIS TEMPLATE

3. RISK MANAGEMENT PLAN TEMPLATE – SEE SEPARATE DOCUMENT

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RISK REGISTER

Project Title :	Date :
Project Ref. No. :	Compiled by :
Project Manager :	Reviewed by :

CATEGORY OF PROJECT RISK	
1. Political	9. Contractual
2. Scope	10. Technical
3. Schedule	11. Environmental
4. Financial	12. Suppliers
5. Human Resources	13. Industrial relations
6. Quality	14. Organisational
7. Communications	15. OH & S
8. Other resources	16. Cultural / Social

Likelihood Rating	Impact Rating	Risk Rating
5. Almost certain	V. Severe	E– Extreme risk, immediate action required
4. Likely	IV. Major	H – High risk, will jeopardize project if not managed
3. Possible	III. Moderate	M – Medium risk, will impact time, cost or quality if not managed
2. Unlikely	II. Minor	L – Low risk, acceptable project management risk, monitor only
1. Rare	I. Insignificant	

Risk Matrix

LIKELIHOOD						
	5	H	H	H	E	E
	4	M	M	H	E	E
	3	L	M	M	H	E
	2	L	L	M	H	H
	1	L	L	M	M	H
		I	***II***	***III***	***IV***	***V***
		IMPACT				

Ref No. (WBS)	Risk Event There is a risk that …….	Category of Risk	Likelihood Rating	Impact Rating	Risk Rating	Treatment Measures	Responsible Party	Action Date

Ref No. (WBS)	Risk Event There is a risk that …….	Category of Risk	Likelihood Rating	Impact Rating	Risk Rating	Treatment Measures	Responsible Party	Action Date

Risk Analysis Template

Ref No (WBS):	Risk Title:		
Risk Description:			
Risk Nature: Strategic/Operational	Risk Category:	Risk Manager:	Business Unit:

Risk Factors:	Possible Effects:
o ..	o ..
o ..	o ..
o ..	o ..

Existing Risk Treatments:	Effectiveness: (H, M, L)
o ..	
o ..	
o ..	

New/Propose Risk Treatments :	Responsibility Party:	Deadline:
o ..		
o ..		

Assessed Risk Date Last Review	Inherent Risk	Likeli-hood	Impact	Rating	Assessed Risk	Likeli-hood	Impact	Rating	Target Risk	Likeli-hood	Impact	Rating

Risk Analysis Template Instructions:

19.	**Ref. No (WBS):**	Sequential numbering of each risk identified.
20.	**Risk Title:**	Give the risk a title.
21.	**Risk Description:**	Provide a brief description of the risk.
22.	**Risk nature:**	Select one of the following – Strategic or Operational.
23.	**Risk Category:**	Select the appropriate category to classify the risk:
24.	**Risk Manager:**	Person responsible for managing the risk.
25.	**Business Unit:**	Provide name of Business Unit, including project name.
26.	**Risk factors:**	Describe the causes of the risk.
27.	**Possible Effects:**	Describe the impacts of the risk arising.
28.	**Existing Risk Treatments:**	Identify all existing risk treatments and controls that are in place and any mitigating factors.
29.	**Effectiveness (H,M,L):**	Rate the effectiveness of the existing risk treatments as either High (H), Medium (M) or Low (L).
30.	**New/ Proposed Risk Treatments:**	Identify a range of options or strategies for treating risks.
31.	**Responsibility Party:**	Specify person who is responsible for the implementation of each new/proposed risk treatments.
32.	**Deadline:**	Specify a final date when the implementation of the strategy will be completed.
33.	**Assessed Risk at Last Review:**	Specify date of last assessment and the assessed level. If this is the first time the risk has been identified then field is not applicable.
34.	**Inherent Risk:**	Determine the risk level by applying the risk matrix assuming no Existing Risk Treatments.
35.	**Assessed Risk:**	Determine the risk level by applying the risk matrix after forming a judgment on the effectiveness of Existing Risk Treatments.
36.	**Target Risk:**	Advise the target level that will be achieved after implementation of the new/proposed risk treatments. The target risk is the desired risk level after implementation of new/proposed risk treatments. There may be instances where the target risk remains high due to the nature of the activity undertaken. In this case new/proposed risk treatments should be closely monitored and reported.

Appendix C

DEFINITIONS

Assumptions List	A record of the assumptions embedded in the project plan. Assumptions that are not validated are potential risks.
Business Case	The document that justifies the need for the system to be delivered by a project, what the business changes will be and the resources required to deliver, operate and dispose of the system. It provides the basis for project funding and may undergo approved revisions during the project
Impact	The outcome of an event expressed in qualitative or quantitative terms (for example, financial or reputational) being a loss, injury, disadvantage or gain
Inherent Risk	A raw risk that is a risk that has no mitigation factors or treatments applied to it.
Monitoring and Accountability	The processes used to manage the Enterprise Risk Management Framework on an on-going basis to reduce risk and take advantage of risk as an opportunity.
Opportunity	The possibility of realizing a favorable outcome and the impact this outcome has on the involved party. Opportunity is positive risk and can be identified and managed in a similar way.
Probability	a qualitative description of the likelihood and/or frequency of a risk occurring.
Residual risk	the degree of risk left after mitigation factors have been identified.
Risk	Risk is anything that may happen that impacts the achievement of an organization's objectives. Risk encompasses the following three dimensions: • **Hazard -** preventing an exposure from turning into a loss • **Uncertainty -** coping with volatility and change; and • **Opportunity -** harnessing opportunities to one's advantage. Risk is an event having a cause and a impact that could be either positive or negative.
Risk Acceptance	the informed decision to accept the impact and the likelihood of a particular risk.
Risk Analysis	A systematic use of available information to determine how often specified evens may occur and the magnitude of their

	impacts.
Risk Appetite	Risk appetite is the amount of risk, on a broad level, an entity of willing to accept in pursuit of objectives. It reflects that organization's risk management philosophy and, in turn, influences the organization's culture and operating style.
Risk Avoidance	An informed decision not to become involved in a risk situation.
Risk Event	The occurrence of an event which has the potential to affect the viability of a project.
Risk Management Framework	A formalized process for managing risk on an explicit basis. The framework consists of a risk assessment, response and accountability for the risk and mitigation activities around it.
Risk Manager	The role responsible for operating the project's risk management process and the custodian of the Risk Management Plan and Risk Register
Risk Mitigation	The processes built into the controls environment, such as policies, frameworks, accountabilities etc to lower the residual risk.
Risk Owner	A designated position in an organisation assigned the responsibility for managing a specific risk
Risk Reduction	A selective application of appropriate techniques and management principles to reduce either the likelihood of an occurrence or its impacts, or both.
Risk Register	A record, under formal change control, of all identified risks, their assessment, treatments and outcomes
Risk Retention	Intentionally or unintentionally retaining the responsibility for loss or financial burden or loss within the organization.
Risk Response	The decision to accept, decline, treat or mitigate a risk or share a risk with another party.
Risk Sharing	Sharing the responsibility for the impact of a risk with another party such as through an outsourcing contract or insurance policy.
Strategic Risk	Any risk event which has serious or catastrophic consequence even though the likelihood of occurrence may be quite low
Uncertainty	The gap between the information required to estimate an outcome and the information already possessed by the decision maker

APPENDIX D: RISK IDENTIFICATION CHECKLIST

The following checklist is designed as a guide to identifying the risks associated with a particular activity, area or situation. It should not be used as a definitive list and should not be substituted for a thorough examination of a particular case and the potential risk exposures. However it may be useful as a guide during 'brain storming' of the risks associated with a scenario.

The following are broad areas of risk with particular sub-categories which are common risk exposures:

1. Business Planning/Strategy

a. Competition risks, Failure to meet performance expectations
b. Failure of main elements of business plan (revenue/profit margins etc.)
c. Failure to develop new business, Failure of new venture
d. Political risks, Sector dependency risks
e. Legislation changes, Market intelligence
f. Organisational structure

2. Finance

a. Cash flow risks, Over extension (of investment, capital)
b. Currency risks, Credit risks (supplier and customer)
c. Investment loss Interest rates
d. Fraud Bribery/covert rewards
e. Taxation Inability to account effectively
f. Capital availability

3. Liabilities

a. Inadequate liability transfer (insurance/other)
b. Health (hazardous substances etc both current and past)
c. Safety (working environment, specific hazards)
d. Environmental contamination
e. Environmental pollution
f. Impacts on public health
g. Impacts on property
h. Product Liability
i. Breach of Intellectual Property Rights
j. Financial Guarantees
k. Other Guarantees

4. Commercial

a. Contract conditions, Contract Liability transfer
b. Contract dispute, Terms and conditions
c. Payment conditions, Breach of contract
d. Contract Delay, Sub-contractor delays

e. Sub-contractor liability, Customer delays
f. Force Majeure (e.g. act of war, strike etc.) Technology changes
g. Loss of contract, Loss of tender
h. Inability to compete, Damage to customer relations
i. Inability to meet customer expectation/requirement
j. Error in contract pricing, Inflated bid costs
k. Failed product launch, Failure to exploit opportunities
l. Authorization levels, Partnering risks

5. Production/Operational

a. Delay Equipment failure
b. Equipment loss IT/MIS failure
c. Failure of MIS to support business growth Capacity of business limited
d. Process change problems HR issues
e. Quality control, Data control
f. Loss of operating licence, Loss of certificate (quality etc.)
g. Loss of supply, Loss of utilities
h. External factors (weather, national strike) Loss of production areas (fire, condemnation etc.)
i. Customer satisfaction, Product development (R&D) risks
j. Failure to develop new products Inflation of prices (raw materials/labour)
k. Over commitment of resources

6. Regulatory

a. Suspension or closure of site/process
b. Compliance failure
c. Inquiries into malpractice
d. Prosecution, Remediation costs
e. Restrictions to business practices, Other country legislation
f. Capital costs required for compliance, Decommissioning costs
g. Copyrights and licenses, Taxation
h. Employment, discrimination etc., Changes to legislation in future

7. Assets

a. Upkeep or upgrade costs, Loss of assets
b. Partial loss of assets, Loss of services
c. Liabilities associated with assets Criticality
d. Shared assets, Leased assets
e. Security of assets Disaster plans
f. Contingency Plans Business Continuity plans
g. Loss of intellectual property, Disruption
h. Loss of commercially sensitive information
i. Terrorism Damage to work in progress

j. Damage to stores, Damage to product stores
k. Loss of IT, Structural integrity

8. Dependencies

a. Loss of critical equipment, Loss of critical raw material
b. Loss of supplier, Loss of customer
c. Over dependency on single contract or
d. customer
e. Over dependency on a market sector
f. Technology
g. Dependency on 3rd party

9. Human Resources

a. Skills are not available, Loss of key personnel
b. Industrial action/unrest, Knowledge not available
c. Inability to recruit, Effect on morale/motivation
d. Inability to retain personnel, Breach of employment law
e. Personal injury risks (violence/kidnap etc.), Inflexibility of skill acquisition

10. Information Systems

a. Inadequacy of current systems Protection
b. Contingency Change management
c. Knowledge base/support, Communications equipment
d. Virus protection, Security
e. Suitability External linkages
f. Bespoke software Intellectual property
g. Web site risks e-commerce risks
h. Failed implementation of new/upgraded systems
i. Loss of data, Data protection
j. Availability, Integrity
k. Compatibility

11. Reputational

a. Performance to expectation, Media response
b. Incidents, Incident response
c. Sensitivities, Stakeholders
d. Brand damage, Stakeholder communication
e. Leaked information, Careless comments
f. Poor handling of situations (senior and local management)

12. Projects

a. Delay Budget
b. Force Majeure Contracts
c. Supplier stability, Critical paths
d. Project phases, Implementation/integration
e. Unforeseen conditions, Weather
f. Procurement strategy Planning
g. Quality Programme
h. Resources Adequacy for need
i. Efficiency, Reliability
j. Confidentiality/security, Compatibility

Appendix E

Tools and Techniques for Risk Management

BRAINSTORMING

Brainstorming is an excellent way of developing many creative solutions to a problem. It works by focusing on a problem and then coming up with a range of solutions to that problem. Ideas can be as broad and different as possible and should be developed as fast as you can. Brainstorming is a lateral thinking process and it helps to break out of thinking patterns into new ways of looking at things.

During brainstorming sessions there should be no criticism of ideas, as the session is trying to open possibilities and break down wrong assumptions about the limit of the problem. Judgment or analysis at this stage will stunt idea generation. Ideas should only be evaluated after a brainstorming session has been completed and solutions can be further explored using conventional methods.

The following process should lead to an effective brainstorming session:

1. Clearly define the problem you want solve and lay out any criteria to be met.
2. Keep the session focused on the problem.
3. Ensure that no one critics or evaluates ideas during the session as criticism introduces an element of risk to members putting forward new ideas. This stifles creativity and cripples the free running nature of a good brainstorming session.
4. Encourage an enthusiastic, uncritical attitude among members of the group and try to get everyone to contribute and develop ideas, even the quietest members of the group.
5. Ensure that no train of thought is followed for too long.
6. Encourage people to develop other people's ideas, or to use other ideas to create new ones.
7. Appoint one person to note down ideas that come out of the session, using a flip chart or white board. This should be studied and evaluated after the session.

Note:	Using a mind mapping technique is a fast and easy way to capture ideas from a brainstorming session.

Where possible, participants in the brainstorming process should come from a wide a range of disciplines as possible. This brings a broad range of experience to the session and helps to make it more creative.

CAUSE AND EFFECT DIAGRAM

The Cause & Effect (CE) diagram, also sometimes called the 'fishbone' diagram, is a tool for discovering all the possible causes for a particular effect. The effect being examined is normally some troublesome aspect of product or service quality, such as 'a machined part not to specification', 'delivery times varying too widely', 'excessive number of bugs in software under development', and so on, but the effect may also relate to potential risks identified within a project.

The major purpose of the CE Diagram is to act as a first step in problem solving (or risk identification) by generating a comprehensive list of possible causes. It can lead to immediate identification of major causes and point to the potential remedial actions or, failing this, it may indicate the best potential areas for further exploration and analysis. At a minimum, preparing a CE Diagram will lead to greater understanding of the problem.

The CE Diagram was invented by Professor Kaoru Ishikawa of Tokyo University, a highly regarded Japanese expert in quality management. He first used it in 1943 to help explain to a group of engineers at Kawasaki Steel Works how a complex set of factors could be related to help understand a problem. CE Diagrams have since become a standard tool of analysis in Japan and in the West in conjunction with other analytical and problem-solving tools and techniques.

CE Diagrams are also often called Ishikawa Diagrams, after their inventor, or Fishbone Diagrams because the diagram itself can look like the skeleton of a fish.

Construct a CE Diagram whenever you need to investigate the causes or contributing factors for an effect (be it a quality characteristic or other outcome) which is of concern to you. This will most likely be after you have conducted a general investigation of problems for a particular function, product, or service, and ranked them. The effect ranked highest provides the starting point for a CE Diagram.

For example, you may just have completed an investigation of all the reasons recorded for goods being returned by customers and found that the highest incidence relates to incorrect goods being sent. A CE Diagram can be constructed to explore the possible causes for this.

Developing a CE Diagram in a team meeting is a very effective technique for,

- concentrating team members' attention on a specific problem
- pooling, and reflecting back, team thinking
- constructing a picture of the problem at hand without resorting to the tight discipline of a flowchart

Follow these steps to solve a problem (identify a risk) with a Cause & Effect diagram:

1. Identify the problem

   Write down the exact problem you face in detail. Where appropriate identify who is involved, what the problem is and when and where it occurs. Write the problem in a box on the right hand side of a piece of paper and draw a line horizontally across the paper from the box.

2. Work Out the Major Factors Involved

   Next identify the factors that may contribute to the problem. Draw lines off the spine for each factor and clearly label. These may be people involved with the problem, systems, equipment, external forces, etc. Try to draw out as many factors as possible. If you are trying to solve the problem as part of a group then this may be a good time for brainstorming

3. Identify Possible Causes

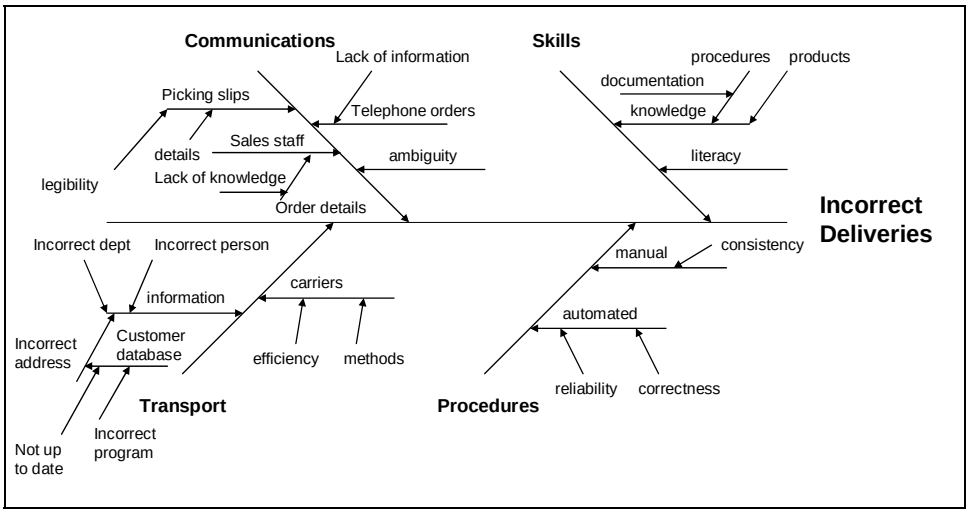
   For each of the factors you considered in 2 above, brainstorm possible causes of the problem that may be related to the factor. Show these as smaller lines coming of the ‘bones’ of the fish. Where a cause is large or complex, you may be better to break them down into ‘sun causes’. Show these as lines coming off the cause line.

4. Analyse Your Diagram

   By this stage you should have a diagram showing all the possible causes of your problem. Depending on the complexity and importance of the problem you can now investigate the most important factors further. This may involve setting up investigations, carrying out surveys, etc. These will be designed to test whether your assessments are correct.

Cause & Effect Example

The following is a simple example of a cause and effect diagram.



Cause & Effect Template

A cause and effect template (based on MS Excel) is attached at Annex A.

DECISION TREE ANALYSIS

Decision trees are used to select the best course of action in situations where you face uncertainty. Many business decisions fall into this category. For example, a manufacturer must decide how much inventory to build before knowing precisely what demand will be. A litigant must choose between accepting an out-of-court settlement or risking a trial. A speculator must decide to buy an asset before knowing if it can be sold for a profit.

In all of these cases, the decision-maker faces an unknown that seems to make it impossible to choose the *right* option with any certainty. Although the decision-maker does not know what the outcome of the unknown will be, generally there is some knowledge about what the possible outcomes are and how likely each is to occur. This information can be used to select the option that is most likely to yield favorable results. Decision trees make this type of analysis easy to apply.

Drawing a Decision Tree

You start a decision tree with a decision that you need to make. Draw a small square to represent the decision that you need to make on the left hand side of a piece of paper.

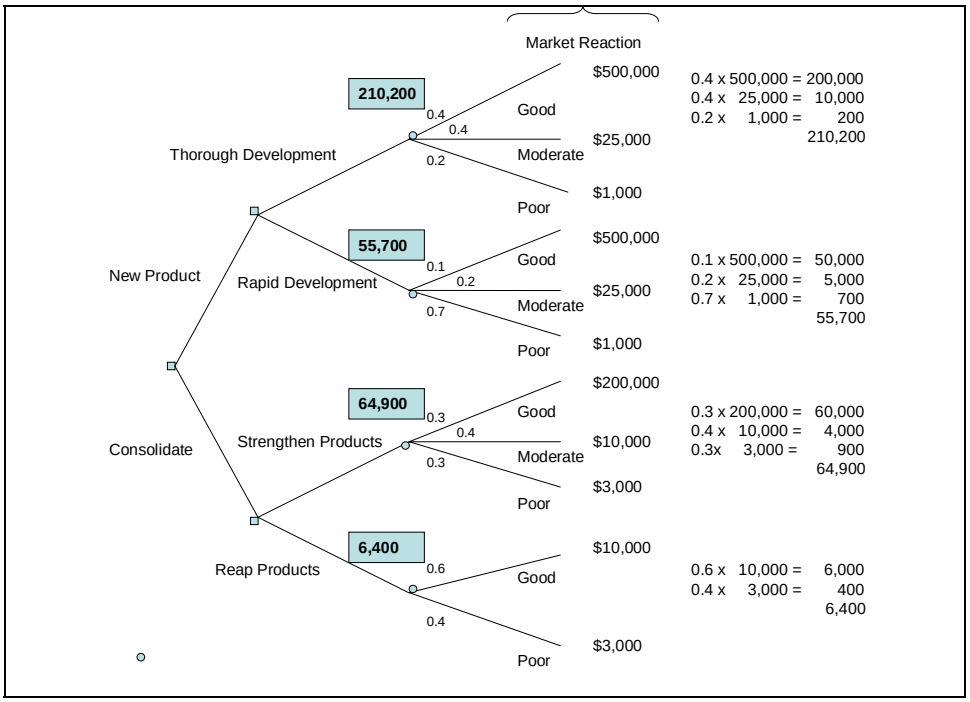
From this draw out lines towards the right for each possible solution and write that solution along the line. Keep the lines apart as far as possible so that you can expand your thoughts.

At the end of each line consider the results. If the result of taking that decision is uncertain draw a circle. If the result is another decision that you need to make, draw another square. Squares

represent decisions and circles uncertain outcomes. Write the decision or factor above the square or circle. If you have completed the decision at the end of the line just leave it blank.

Starting from the new decision squares on your diagram, draw out lines representing the options that you could possibly select. From the circles, draw lines representing possible outcomes. Again, make a brief note on the line saying what it means. Keep on doing this until you have drawn out as many of the possible outcomes and decisions as you can see leading on from the original decisions.

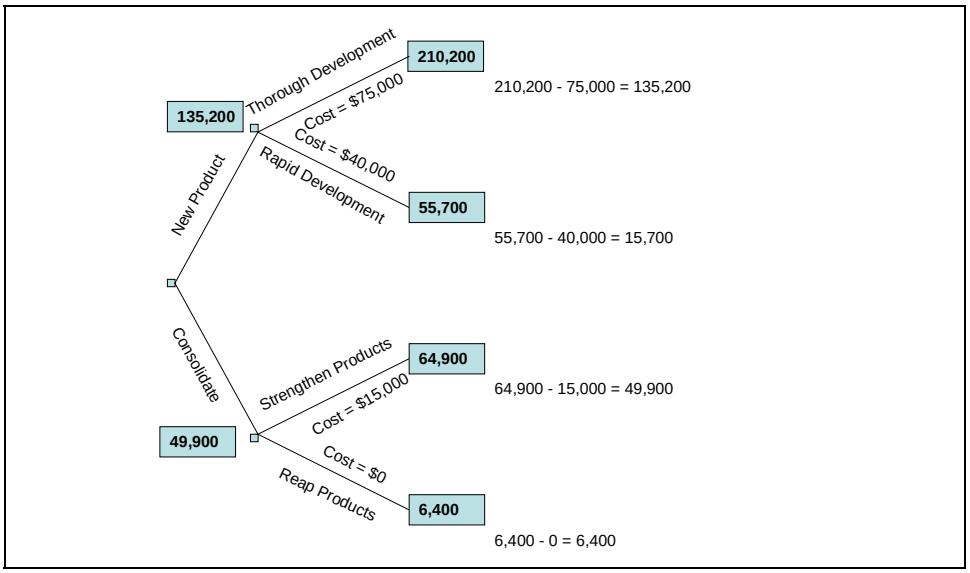
Next look at each circle (representing an uncertainty point) and estimate the probability of each outcome. If you use percentages the total must come to 100% at each circle.



Calculate the Value of the Decision Nodes

When you are evaluating a decision node, write down the cost of each option along the decision line. Then subtract the cost from the outcome value that you have already calculated. This will give you a value that represents the value of that decision.

When you have calculated these decision benefits, choose the option that has the largest benefit, and take that as the decision made. This is the value of that decision node.



In this example, the benefit we previously calculated for 'new product, thorough development' was $210,200. We estimate the cost of this approach as $75,000. This gives a net benefit of $135,200.

The net benefit of 'new product, rapid development' was $15,700. On this branch we therefore choose the most valuable option, 'new product, thorough development' and allocate this value to the decision node.

Similarly we apply the same logic to the consolidate branch.

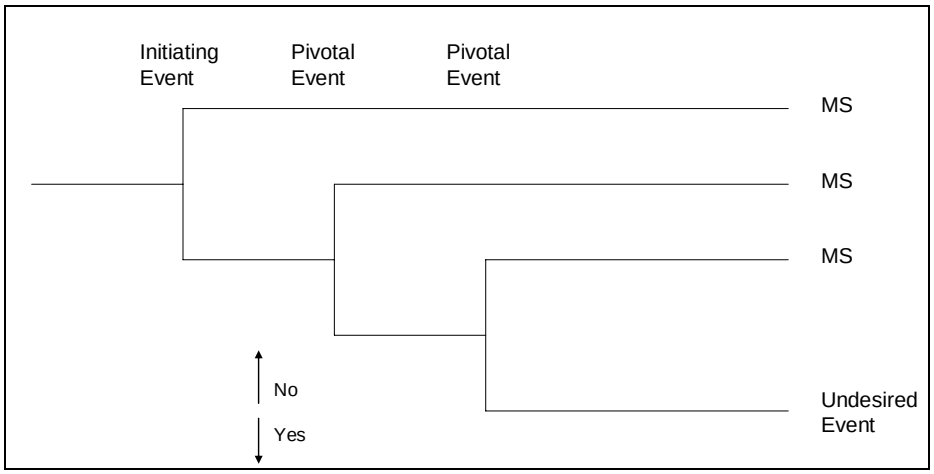
By applying this technique we can see that the best option is to develop a new product.

EVENT TREE ANALYSIS

Event tree analysis is a method for illustrating the sequence of outcomes which may arise after the occurrence of a selected initial event. This technique, unlike fault tree uses inductive logic. It is mainly used in consequence analysis for pre-incident and post-incident application. The left side connects with the initiator, the right side with plant damage state; the top defines the systems; nodes (dots) call for branching probabilities obtained from the system analysis. If the path goes up at the node, the system succeeded, if down, it failed.

ETA has seen application in the nuclear industries for operability analysis of nuclear power plant as well as accident sequence in the Three Mile Island-2 reactor's accident.

Basic Event Tree Model



FAULT TREE ANALYSIS

The concept of fault tree analysis (FTA) was originated by Bell Telephone Laboratories in 1962 as a technique with which to perform a safety evaluation of the Minutemen Intercontinental Ballistic Missile Launch Control System. A fault tree is a logical diagram which shows the relation between system failure, ie. a specific undesirable event in the system, and failures of the components of the system. It is a technique based on deductive logic. An undesirable event is first defined and causal relationships of the failures leading to that event are then identified.

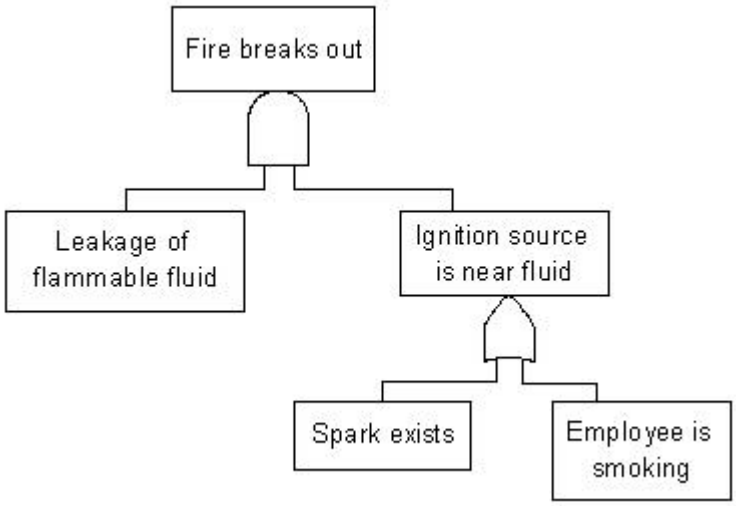


Figure 1 : A fault tree depicting the event "Fire breaks out".

Fault tree can be used in qualitative or quantitative risk analysis. The difference in them is that the qualitative fault tree is looser in structure and does not require use of the same rigorous logic as the formal fault tree. The above figure shows a fault tree with top event "Fire breaks out". This method is used in a wide range of industries and there is extensive support in the form of

published literature and software packages, such as CARA.]. An application of fault tree analysis on causal relations for large vehicle accidents is documented in.

FUNCTIONAL EVENT SEQUENCE DIAGRAMS

Functional event sequence diagrams (FESD) are often used to present an outline of the system response to subsystem or component failures. An FESD is made up of an initiating event, pivotal events, and damage states. The pivotal events depict all the possible occurrences which could arise from the initiating event. An FESD is made using inductive reasoning which means that consecutive events are developed by thinking of the next possible outcome. Each FESD presents a different scenario which is usually converted to an event tree.

MASTER LOGIC DIAGRAMS

When a fault tree is used to identify the hazards then it is often called a Master Logic Diagram (MLD)

A master logic diagram is used to depict an arrangement of initiating events that is reasonably complete. It would be quite impractical to try to completely predict the occurrence of system perturbations in every detail. For this reason analysts who wish to predict the relevant events use a functional categorization of perturbations to the system which lead to a component characterization of each function. The top event in a master logic diagram is the damage state such as failure of an entire system. The lower levels of the diagram represent subsystem or component failures which lead to failure of the system.

MIND MAPPING

Mind Maps™, developed by Tony Buzan are an effective method of note-taking and useful for the generation of ideas by associations. Mind Maps are a very versatile brainstorming technique that can be used to get the creative juices going, develop consensus on direction and concepts, and generate metaphors and ideas for visual exploration. To make a mind map, one starts in the center of the page with the main idea, and works outward in all directions, producing a growing and organized structure composed of key words and key images. Key features are:

- **Organization**
- **Key Words**
- **Association**
- **Clustering**
- **Visual Memory** - Print the key words, use color, symbols, icons, 3D-effects,arrows and outlining groups of words
- **Outstandingness** - every Mind Map needs a unique center
- **Conscious involvement**.

Mind Maps are beginning to take on the same structure as memory itself. Once a Mind Map is drawn, it seldom needs to be referred to again. Mind Maps help organize information.

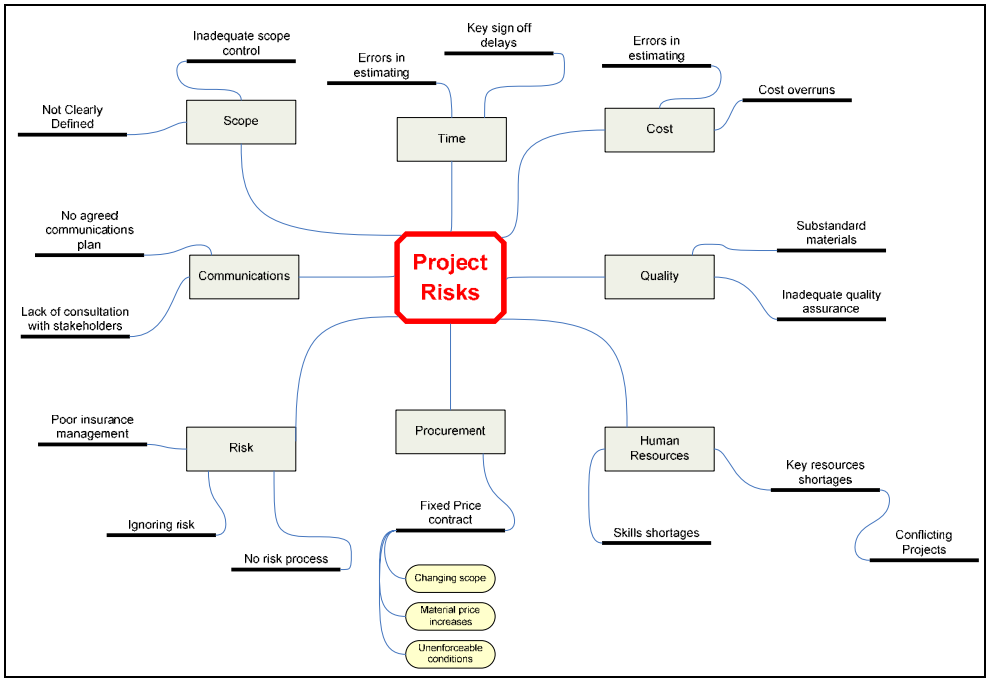
Because of the large amount of association involved, they can be very creative, tending to generate new ideas and associations that have not been thought of before. Every item in a map is in effect, a center of another map.

The keys to a successful mind mapping session are:

- **Comfort -** nothing cramps creativity more that feeling pressured, rushed, or awkward
- **Space -** use a large whiteboard, chalkboard, or rolls of paper
- **Color -** use color coding to make connections or groupings
- **Energy -** keep the energy level up, move around, listen to music
- **Keeping an open mind -** never dismiss an idea or train of thought, you never know where it might lead
- **Knowing when to move on -** if you get stuck or run out of steam, try to find a new path or try thinking about the concept in a new way (for example, map the antonym of your keywords). Once you've exhausted an idea completely, move on.

Mind Map Example

The following example was produced using the MS Visio brainstorming template.



ROOT CAUSE ANALYSIS

Root Cause Analysis (RCA) is a method for exploring the fundamental causes of an identified problem, in an effort to correct it. It is a tool designed to help categorize what, how and why an event occurred. After the answers to these three questions have been formulated, the investigators strive to specify the workable corrective measures that can prevent the repetition of such failures.

A structured systems approach is employed in a Root Cause Analysis. The participants ensure that they gain a clear picture of the problem or critical event and then proceed to put actions into place.

General Guidelines

The general principles can be applied to any problem-solving activities. However, it should be noted that a full root-cause-analysis can be a **resource-intensive** procedure; hence it is normally applied to high risk or high impact events only.

It should be kept in mind that the success of the analysis is dependent on the effectiveness of the investigative and drilling techniques. The general guidelines for the process are:

- Description of the event
- Organization of the root-cause-analysis team
- Gaining a detailed insight into the **process leading to the critical event**
- Understanding the causes of variation
- Opting for the optimal strategies to **reduce risk** involved
- Going through the PDCA cycle

By employing the **proactive methods** for identifying and eliminating the repetitive problems, the root-cause-analysis helps reducing the maintenance and operational costs of a project and helps achieve improved equipment availability and reliability.

SWOT Analysis

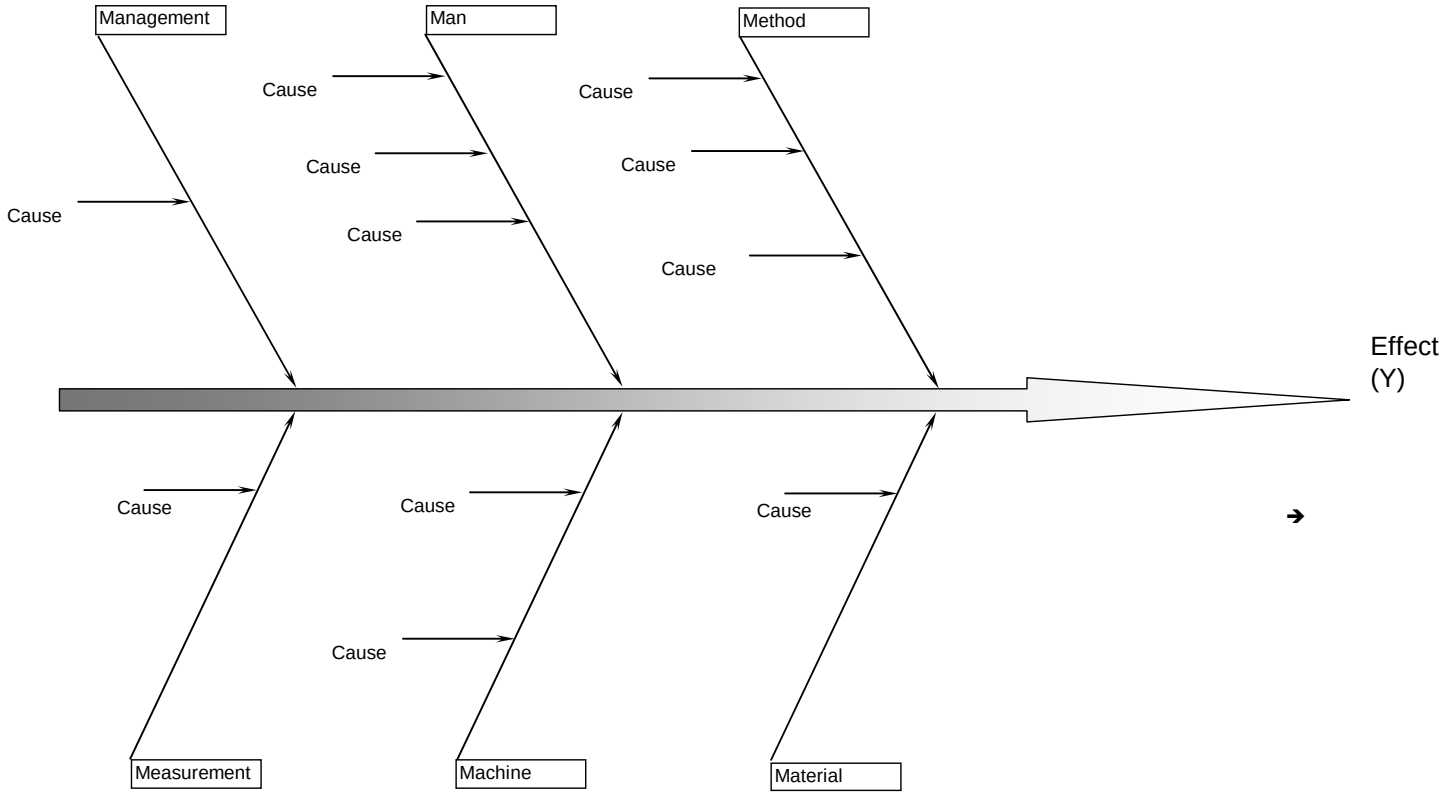
SWOT analysis is a good way of identifying your project's strengths and weakness and the opportunities and threats it faces. Carrying out an analysis using the SWOT framework will help focus the activities into areas of strength and where the greatest opportunities lie.

To carry out a SWOT analysis the answers to the following should be documented:

- **Strengths**
  - What are the advantages?
  - What is done well?
  - What are the strengths that other people see?
- **Weaknesses**
  - What could be improved?
  - What is done badly?
  - What should be avoided?
- **Opportunities**
  - What are the good opportunities being faced?
  - What are the interesting trends?
- **Threats**
  - What obstacles are faced?
  - What is competition doing?
  - Are the required specifications for the job, products or services changing?
  - Is changing technology a threat?

ANNEX A

CAUSE AND EFFECT TEMPLATE



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