RISK MANAGEMENT GUIDE

MINISTRY OF ADVANCED EDUCATION AND LABOUR MARKET DEVELOPMENT

GOVERNMENT OF BRITISH COLUMBIA

Table of Contents

Table of Figures

1 Risk Management Framework

1.1 *Purpose*

The purpose of this document is to provide a stand alone risk management framework for the development of post-secondary capital infrastructure projects in British Columbia. The framework is suitable for projects that range in size from under $5 million to over $50 million[1]. The risk management framework is constant independent of factors including the project's size, cost, and complexity, rather as these factors increase the effort to implement the system increases proportionally. The risk management framework is best described as qualitative and independent.

For projects exceeding $50 million, additional work is required beyond this framework. Larger projects need to integrate the risk management framework into its larger project management plan, as discussed in Appendix A. It is recommended that large, complex projects use an integrated and quantitative risk management framework with a foundation identical to the framework provided in this document.

The essence of risk management is to:

- Reduce the variability of project cost, scope, and schedule outcomes
- Increase the understanding of the forces that affect project outcomes
- Improve decision making to increase the delivery of project value

1.2 *Objective*

The objective of these documents is to provide a risk management framework that can be used to increase the chances of project success in terms of scope, schedule, and budget.

The methodology provided in this framework aligns with the Project Management Body of Knowledge.

1.3 *Benefits of Risk Management*

Effective risk management increases the likelihood of project success. Projects with effective risk management are more likely to:

- Finish on time
- Remain within budget
- Meet stakeholders' performance expectations

1.4 *Risk Defined*

While each project is by definition unique, all projects consist of only three items:

- Scope
- Schedule
- Budget

[1] $50 million is the threshold requirement to complete a P3 analysis.

Risk is defined as:

> "A possible, unplanned change to the project that has a potential impact to scope, schedule or budget."[2]

Risks are defined as project changes with a negative impact. Opportunities are defined as project changes with an advantageous impact. This framework only addresses risks, but could be adapted for opportunities.

Two key elements are mentioned in risk: probability and impact. Probability relates to the notion that the future is not certain, and events are not guaranteed to occur. Impact relates to the likely consequences of a risk should it actually occur. The expected impact of a risk is:

Expected Value = Probability x Impact

Project management activities may change a risk's probability of occurrence and adjust the consequences its impact.

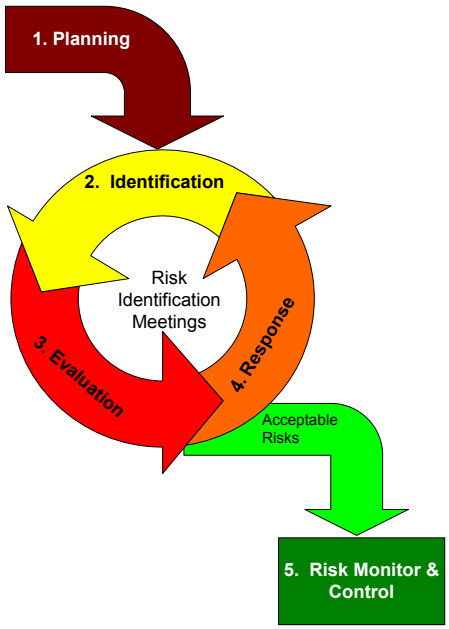
1.5 *Methodology Overview*

Risk Management has five key process steps:

1. Risk Planning
2. Risk Identification
3. Risk Evaluation
4. Risk Response
5. Risk Monitor and Control

The relationship between process steps is shown below. A detailed work flow is shown in Appendix B.

Figure 1.0: Conceptual Workflow



Risk Planning defines the project's approach to risk management capture in the Risk Management Plan. This plan includes probability and impact tables, risk tolerance, risk breakdown structure, schedule and roles and responsibilities.

Risk Identification is the process of locating and defining the risks of a project. Risks are identified five times during a project life cycle at Risk Identification Meetings. Each risk is defined by a description, a trigger, and possible consequences on scope, schedule, and budget. The level of effort required for risk identification is proportional to the project's complexity. Information is documented in the Risk Register.

Risk Evaluation is the process of assessing a risk's probability of occurrence and the severity of its consequences should it be realized. Recorded in the Risk Register, a risk's probability and impact and are multiplied to provide their expected value or risk ranking. All risks with risk rankings exceeding the project's risk tolerance must be addressed.

[2] An alternative definition of risk from BC's Capital Asset Management Framework is, "the chance of something happening that will have an impact, either positive or negative, on objectives and/or outcomes."

Risk Response is the process to develop responses to unacceptable risks and make them acceptable. Risk responses include mitigation, avoidance, transference, and acceptance. Once a response is developed, it is re-evaluated assuming effective risk response actions. This process is repeated until the risk's ranking is acceptable. Information is recorded in the Risk Register.

Risk Monitoring and Control is the most important part of the risk management framework. Here planned risk responses are tracked to ensure corrective actions are occurring and having the desired effect.

2 Framework Requirements and Expectations Guide

As with project management, risk management does not have a one-size fits all solution. To support project teams, the following guidelines have been developed and expectations set.

2.1 *Requirements*

Each project must:

1. Have a documented risk management plan included with its submission of the project's business case[3] and:
    a. Demonstrate adherence to the plan during project execution
    b. Includes at least two participants in each of the five risk identification meetings
2. At all times have a complete, active, and up-to-date risk register[4]
3. Have planned risk responses for at least all unacceptable risks, with sufficient risk responses to move these risks to an acceptable zone

2.2 *Suggested Effort Guide*

For a given project, the following are guidelines for level of effort and detail required to support effective risk management. This effort is over and above normal project management activities such as implementing risk responses. Care should be taken when using this guideline, as a relatively low-cost project can have high complexity, whereas a relatively expensive project may have only a few fixed price purchase orders and very little associated risk.

The drivers for the amount of effort required for risk management are:

1. The cost difference between the worst possible outcome and the expected outcome. The benefit of closing this gap must exceed the bridging effort and dollars spent to close the gap
2. Criticality of the project to the organizations success. The more important the project is to the success of the institution, the greater the risk management effort that should be expended
3. Complexity of the project. As the complexity of the project increases, the risks associated with the project increase exponentially – so too should the risk management effort.
4. Greenfield vs. brown field construction. Renovation projects are typically 50% more complex than new construction.

[3] Required by 2002 Capital Asset Management Guide
[4] Implied by 2002 Capital Asset Management Guide. CAMF only requires up-to-date risk regiseters to be submitted with Business Cases.

Table 2.0 provides suggestions for level of effort based on project size.

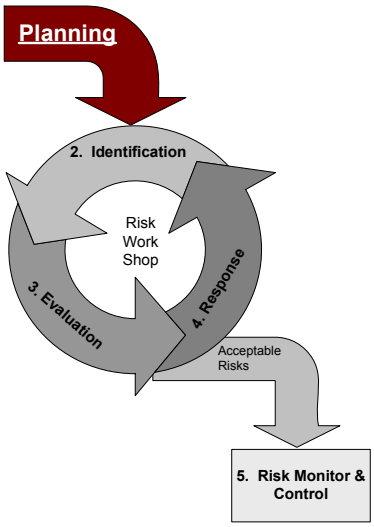
Table 2.0 Suggested Risk Management Effort by Project Size

Size of Project	$1-2 Million	$10 Million	$20 Million	$50 Million	Rule of thumb
Full time equivalent hours per risk identification meeting	1-4 hours	15-25 hours	30-50 hours	70-130 hours	2 hours/$1M
Minimum number of participants per risk identification meeting	2	3	5	7	• Do not exceed 15-25 as hosting the meeting becomes difficult
Minimum number of risks identified	4	15	30	60	• Minimum 1 risk per 5 WBS tasks
Other Items	• Project Manager and Risk Manager are likely the same person			• Integration of risk management into all project management and controls • Implement quantitative risk management • Facilitated risk identification meetings • Full time Risk Manager for projects greater than $100M	

3 Risk Planning

Risk planning is akin to other project management planning functions: it defines the roles, expectations, timelines, and resources that will be required to complete the work. This framework will simplify the risk planning process for the project manager leaving only four items to be decided upon and planned for:

1. Roles and Responsibilities
2. Budgeting
3. Scheduling
4. Reporting



The risk management plan must be submitted with the business case under the 2002 Capital Asset Management Framework (CAMF) guidelines. This submission requirement includes the current risk register but does not preclude planning at the beginning of the strategic option analysis stage.

3.1 *Roles & Responsibilities*

As part of the Risk Management Plan the project manager must define the project team's roles and responsibilities in regards to risk management. It is important that all project team members know what is expected of them and that all risk management functions have been clearly assigned to individuals. Care must be taken to distinguish between individuals and roles. On a small project, it is entirely possible for the Project Manager, Risk Manager, and Functional Lead to be one in the same person. An example of a roles and responsibilities matrix is shown below in Table 3.0.

Table 3.0 Sample Roles and Responsibilities Matrix

Roles	Typical Institution Positions	Responsibility	Competency and Requirements
Project Director/ Project Sponsor	• VP Finance • CFO • Facilities Director	• Secure the resources required to effectively execute the risk management framework • Hold the project manager accountable for executing the risk management framework and achieving improved project performance results • Resolve project issues that cannot be addressed by the project manager • Provide direction on the priorities of scope, schedule, and budget	• Understand the risk management framework • Authority to provide resources to the project team • Ability to translate corporate vision into applicable concepts to support decision making
Owner's Project Manager	• Facilities Director • Facilities Team member • Consultant	• Steward the risk management framework • Designate a risk manager • Integrate risk management into the other project management processes • Allocate the resources to complete the risk management process • Hold team members accountable to meeting expectations • Resolve team issues and conflicts	• Demonstrate project management skills • Understand risk management framework
Risk Manager	• Facilities Director • Facilities Team member • Consultant	• Provide single point of knowledge for all risk related items and processes • Direct and control the risk management process • Support team members in risk response activities • Facilitate risk management identification meetings • Ownership of the project's risk register • Ownership of the budget and schedule for risk management	• Complete understanding of the Risk Management Framework • Facilitation skills
Risk Owners	• VP Finance • Facilities Director • Facilities Team member • Other Faculty • Consultant/Contractors	• Ownership of an identified specific risk item • Create effective risk response actions • Complete actions items included in the risk response • Provide monitoring and reporting on risks • Evaluate actual effectiveness of implemented risk response	• Ability and authority to execute risk response
Functional Lead	• Facilities Team member • Other Faculty • Consultant/Contractors	• Functional knowledge relevant to some aspect of the project • Ability to identify and evaluate risks • Support execution of risk response actions	• In depth knowledge of area of expertise

Roles	Typical Institution Positions	Responsibility	Competency and Requirements
Stakeholder	• Faculty • Students • Neighbours • Ministry staff • Consultant/Contractors	• Identify interests and outcomes that benefit affected groups • Support resolution of issues to increase the maximum benefit for all affected groups	• Understand their constituencies' goals and objectives
Consultants		• Provide data, information, and options to support the risk management process	• Competent in their realm of expertise
Contractors		• Provide data, information, and options to support the risk management process	• Competent in their realm of expertise

3.2 *Budgeting*

Typically risk management costs money upfront and saves money over the life of the project. Since these upfront costs are clearly defined with benefits hidden by successful execution, it is tempting to not spend the money and effort required to adequately execute risk management. Costs associated with risk management can be broken into two categories:

1. Risk management process costs
2. Risk response costs

Both categories need to have explicit funding. Guidelines for budget costs associated with risk management process controls can be found in Section 6.2. Budgeting for risk response costs are difficult to quantify, and can be viewed as being similar to an insurance policy. While the upfront project cost avoids serious consequences, for some it may be difficult to understand the benefit, because of the very fact that these consequences never materialize. Effective risk management decreases a project's total installed cost.

3.3 *Scheduling*

Table 3.1 below is a suggested frequency of risk management events.

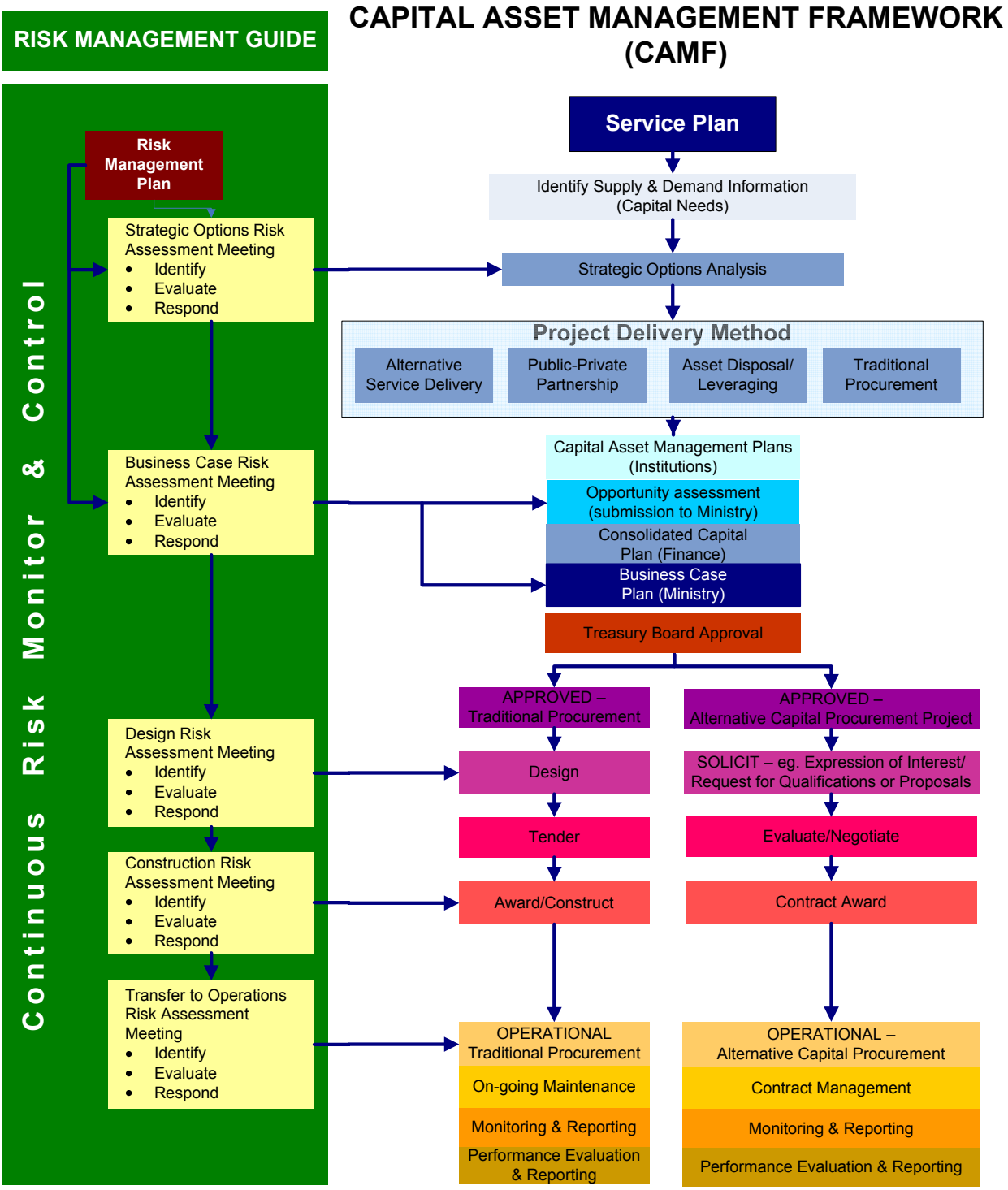
Table 3.1 Suggested Frequencies of Risk Management Events

Risk Management Event	Frequency	Timing	Purpose
Risk Planning	Once	At the beginning of the project, during option analysis	Confirm and document risk management items: • Roles & Responsibilities • Schedules • Budgets • Expectations • Reporting
Risk Assessment Meeting • Identify • Evaluation • Response	Five Times: 1. Strategic Option Analysis 2. Business Case 3. Design 4. Construct 5. Commissioning/Turnover to Operations	Prior to the five major project life cycle stages	Develop and update the risk register to reflect the next stage of the project life cycle.
Risk Monitor and Control	Once per month	Integrate risk monitoring with existing status reporting & meetings	Follow up on active risk responses, assess the effectiveness of implemented risk responses, and deal with emerging risks.

It is important to tailor the extent of risk identification sessions to complexity of the project. A small, simple project's risk identification session for turn over to operations could consist of three people around a desk for thirty minutes. This would not be appropriate were it a $400 million project.

Figure 2.0 shows where risk assessment meetings tie into the CAMF definition of the project life cycle.

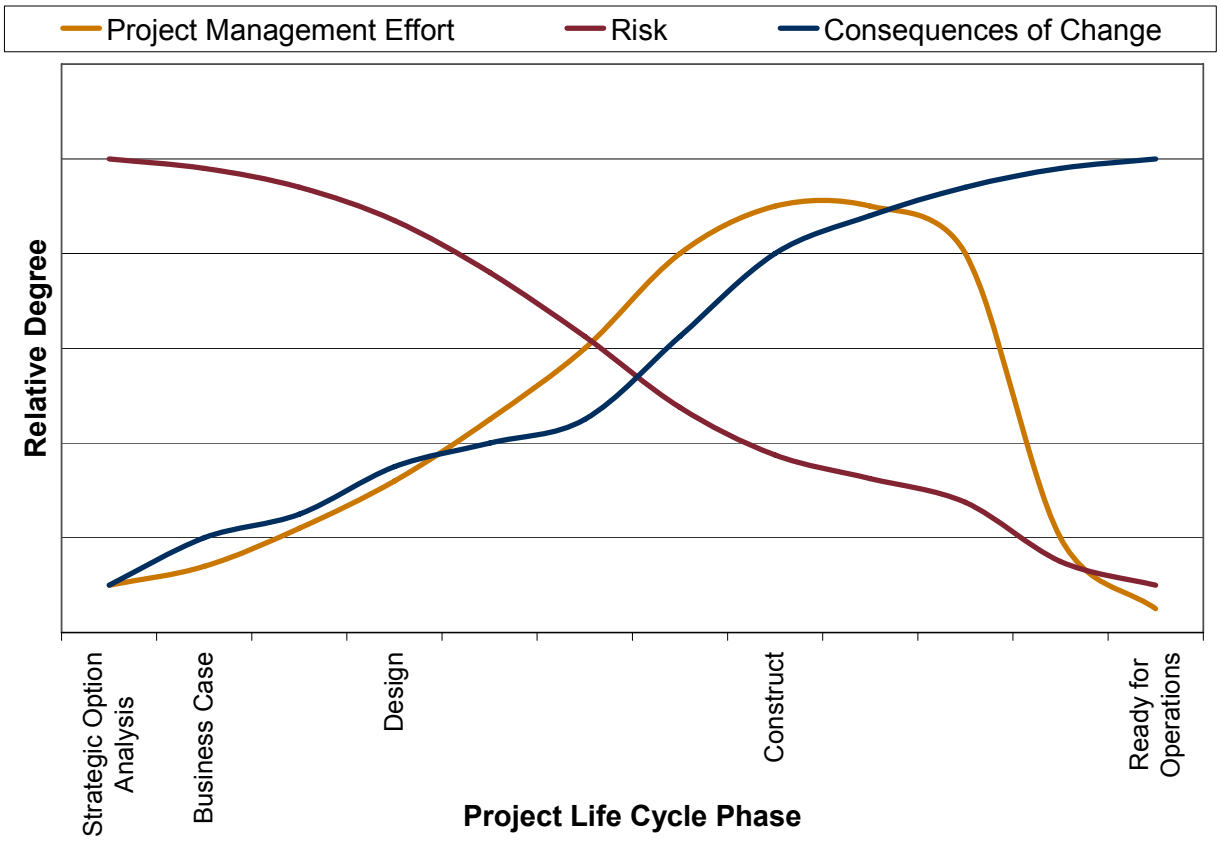
Figure 2.0: Risk Assessment Meeting during the Project Life Cycle



3.3.1 Risk, Effort, and Consequences through the Life of a Project

The amount of risk in a project decreases as the project gets closer to completion, as risks have either manifested themselves or have passed their trigger point and will never happen. This is not true of the consequences of unexpected changes nor effort required to manage a project. Once design decisions have been made, changing them in construction is costly, both in terms of money and time. During construction there are more contractors on site, resulting in a higher cash burn rate resulting in more day-to-day issues arising that demand a project manager's attention than during any other stage of a project's lifecycle. One might assume that risk management is more important during these busy, frantic times than during other stages of the project. In fact, these busy, frantic times are the consequences of risk management decisions that have been made early in the project. For example, the decision that led to a foundation being dug during the winter in Vancouver, the season with the heaviest precipitation months, can result in many weather-related delays. The greatest benefit of risk management can be seen early in the project, when options still exist and decisions can be easily made. For instance, project delivery methods (Public-Private Partnership, Design-bid-build, design-build, construction management, unit pricing, time and material, etc.) should be decisions that are driven from risk management responses.

Figure 3.0: Risk, Effort, and Consequences during a Project Life Cycle



3.4 *Reporting*

Risk reporting should be integrated into regular project status reporting. Suggested content includes:

- Number of risks
- Number of risks requiring a response
- Number of planned responses/percent of risks with planned response
- Number of implemented responses/percent of planned responses implemented
- Number/percent of past due action items

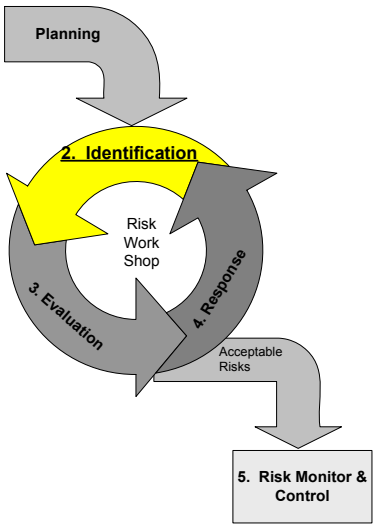
The excel risk register file in Appendix C, calculates many of these statistics automatically.

3.5 *Working Example of Risk Planning*

See Appendix D1 for a working example of Risk Planning.

4 Risk Identification

The success and failure of risk management is directly proportional to the effectiveness of risk identification. Comprehensive risk identification is a prerequisite for effective risk management.



By definition, each project is unique. There is no cure-all checklist or method to ensure that a team has identified all possible risks: there is no substitute for direct project knowledge.

4.1 *Risk Register*

The risk register is the key document for recording all the information regarding the risks for a given project. This document captures the results of:

1. Risk Identification
2. Risk Evaluation
3. Risk Response
4. Risk Monitor and Control

A sample risk register is included in Appendix C. The risk register is broken into two sequential halves:

1. Risk Identification and Evaluation for the inherent risk
   - Used for capturing, defining, and evaluating a risk so that the project team can determine what, if anything should be done about the risk

2. Risk Response & Evaluation
   - The second portion of the risk register is essentially an action item data base for recording and monitoring risk responses. Information on how to complete the risk register is included in Appendix E.

Figures 4.0 and 5.0 provide an overview of a typical risk register.

Figure 4.0: Risk Register Overview

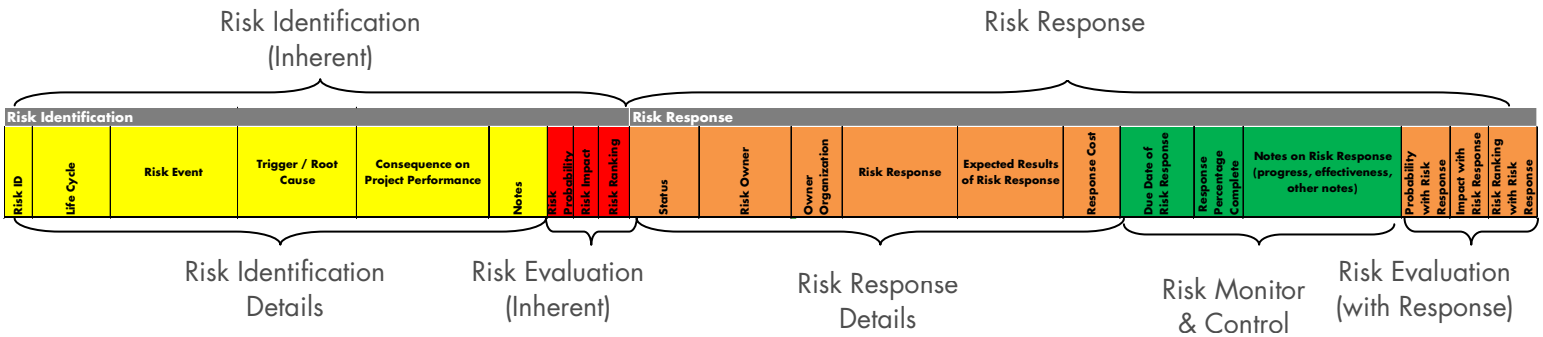


Figure 5.0: Risk Identification Section Heading Notes

Risk Identification Section Header	Notes
• Risk ID	A unique identifier of each risk
• Life Cycle	Pull down menu to record when in the project the risk is relevant
• Risk Event	A description of the risk
• Trigger/Root Cause	The event or root cause that causes the risk to be realized
• Consequence on Project Performance	Narrative descriptions of what would happen to the project's scope, schedule, and/or budget should the risk materialize
• Risk Probability	The scored result of the team's opinion on the likelihood of this risk occurring given current conditions and project management activities
• Risk Impact	The scored result of the team's opinion of the consequences of the risk when it is realized given current conditions and project management activities
• Risk Priority Number	Is the calculated result of probability x impact that determines the magnitude of this risk on the project. Results can be red (must have risk response), yellow (dictionary risk response) or green (acceptable risk response).

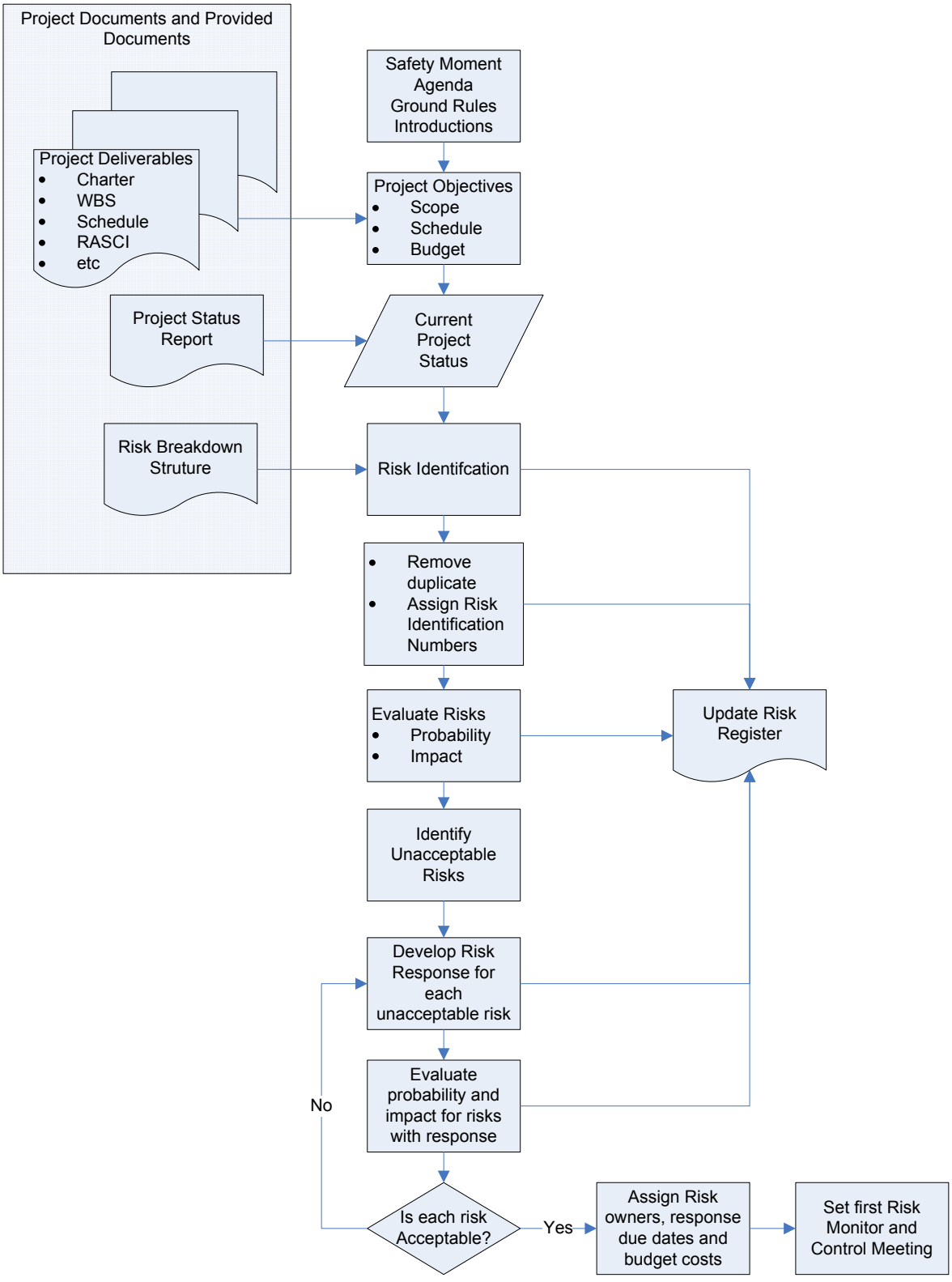
4.2 *Risk Identification Process*

4.2.1 Risk Identification Meeting

There are several methods to identify and evaluate risks; however, this guide will only describe the risk identification meeting method. Other possible risk identification processes are listed in Appendix F. A sample risk identification meeting agenda is included in Appendix G and a process overview is shown below in Figure 6.0.

Attendance for the risk identification meeting should have representation from of different functional areas and stakeholders while avoiding duplication. Ideal attendees are out-spoken and a balance of optimistic, critical, and experienced personnel. Large meetings should have unbiased professional facilitation.

Figure 6.0: Risk Work Shop Process Flow



4.2.2 Risk Description

At risk identification meetings, each risk is identified and described by completing the following phrase:

<a risk event > may happen because of *<trigger/root cause>* and result in *< consequence on project performance>.*

This sentence captures the key items for identification: the risk; its cause; and what would happen as a result. The exact phasing of the text can be modified to allow for proper English; however, it concisely captures the risk, its cause, and consequences.

Examples include:

A delay in completing foundation may happen because of *heavier than expected rains* and result in *schedule delays of 2 weeks.*

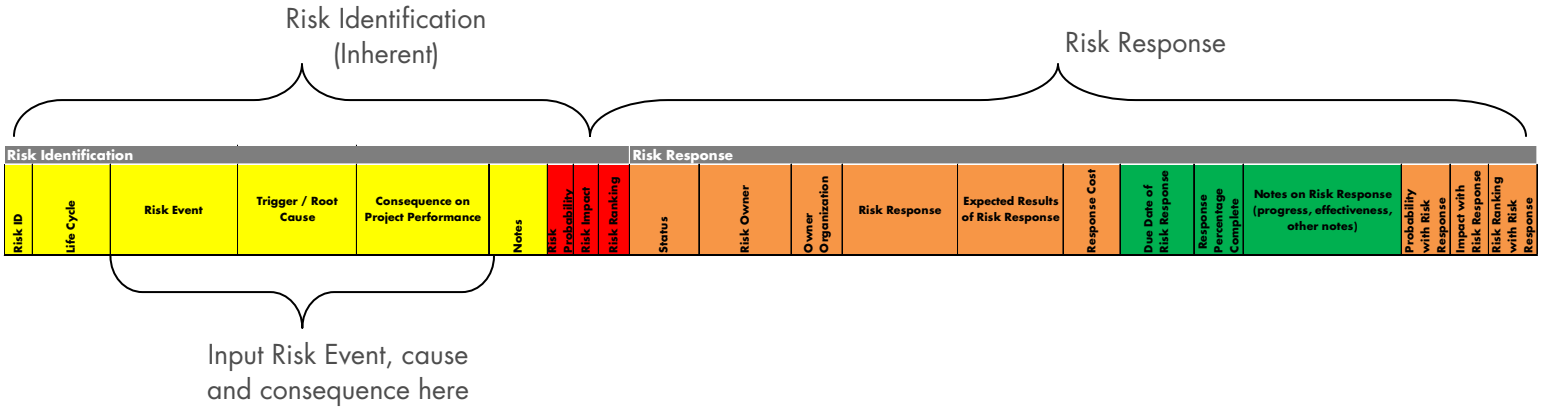
Misunderstandings on what is in scope may happen because of *incomplete user requirements* and result in *both cost and schedule overruns.*

Inappropriate trade-off decisions may happen because of *poor communication between stakeholders* and result in *a failure to meet the project's base scope objectives.*

Missing the required opening date may happen because *of the project delivery method selected* and result in *not receiving Federal grant money and missing the beginning of the school year.*

Risks are then recorded in the risk register as shown below:

Figure 7.0: Capturing Risks on the Risk Register



4.2.3 Tips on Effective Risk Identification

Suggestions for effective risk identification are:

- Focus on the project life cycle stage that is next
- Allow sufficient time for the risk identification meeting
- Do not rush the risk identification portion of the meeting
- Follow the work breakdown structure
- Return to skipped sections of the risk breakdown structure
- Pursue tangents
- There are no bad ideas
- Maintain separation between identification of risks and evaluation of risks
- A good indicator that risk identification is almost complete is that the team starts identifying duplicate risks. Continue for a while after this to ensure all risks are identified and captured
- Break the team into groups, freely mixing unrelated functional team members to allow cross pollination of ideas
- Have frequent breaks
- Allow side-bar discussions

4.3 *Risk Identification Tools*

4.3.1 Risk Breakdown Structure (RBS)

A risk breakdown structure (RBS) is a methodical and logical tool for identifying risks in a project. A RBS is provided in Appendix H. The RBS vertically uses the PESTLE risk structure (defined below) to identify risks with the five project life cycle stages across the columns. To use the RBS, start at the top of the relevant column and use the statement to prompt discussion to assess project risks in the given area. For each RBS item, ask the question, "Does this project have any risks associated with _____?" As an example:

RBS item – Communication

- Did we identify all required stakeholders?
- How are we communicating to stake holders?
  - Is there enough detail?
  - Is it frequent enough? Too frequent?
- How do we receive feedback?
- How do we share issues within the team?
- Is our planned meeting structure effective?

The provided risk breakdown structure in Appendix H follows the PESTLE acronym:

Political
Economic
Social
Technical
Legal
Environment

Risks may not be exclusive to a single PESTLE risk category and span several categories this is perfectly acceptable. The objective of the PESTLE structure is to provide a methodical springboard for the imagination and ensure that all risks are identified.

Political/Institutional refers to the risks associated the inter- and intra-organizational framework of Post-Secondary Institution. These risks range from the large "P" Political – items that interest Provincial, Federal, and Municipal governments – to small "p" political – items that interest local participants and stakeholders. The latter items could include things such as organizational structure and policies that might affect the project. An example of a political/institutional risk is:

> *Difficulty in making timely decisions* may happen because of *organizational expectations of consensus based decision making* and result in *schedule delays, cost overruns, and poor scope trade off decisions.*

Economic relates to all the factors that might affect the cash flows associated with the project. Every financial transaction that occurs during the infrastructure's life cycle is included such as construction cost escalation, decommissioning, interest and exchange rate fluctuations. The category also includes sources, timing, and funding requirements. An example of an economic risk is:

> *Insufficient funding* may happen because of *failure to complete the project on time* and result in *the Federal Government not providing the required grant money.*

Social risks deal with items where societal benefit or harm is difficult to quantify. This would include risks unique to certain stakeholders or third parties. An example of a social risk may be:

> *Failure to obtain project approval* may happen because *key scope requirements are missing* and result in *the Student Union withdrawing its support of the project.*

Technical risks address all the details that go into developing, managing, and closing a project. These range from basic project controls and project management, to technology selection and operational issues. An example of a technical risk may be:

> *Low stakeholder buy-in and engagement* may happen because *of a poorly developed and executed communication strategy* and result in *key user requirements being missed.*

Legal risks relate to codes, regulations, and contractual matters. Legal items may be directly related to the infrastructure being built by the project, or to consultants contract terms. Examples of legal risks include:

> *Construction liens placed on the building* may happen because *of subcontractors not being paid by the prime contractor* and result in *legal costs and missing the required opening date.*
>
> *Invalid design plans* may happen because *zoning requirements prevent the required two top stories on the building* and result in *not enough teaching space.*

Environment risks include not only environmental risks such as contamination, but also risks that arise from the business and natural environment that surround the project. Environment risks tend to be external with probabilities of occurrence is outside the project's control. Examples of environment risks include:

> *Lack of skilled trades* may happen because *they are all working on the Vancouver 2010 Olympics* and result in *increased costs for required trades and insufficient trades to complete construction on time.*
>
> *Rain-induced mudslides damage* may happen because *of incorrect design requirements* and result in *damage to the building during operations and a temporary closure of the infrastructure.*

4.3.2 Document Checklist

To support risk identification the following project deliverables are useful:

- Scope Statement
- Work Breakdown structure (WBS))
- Resource loaded schedule
- Project Cost (aligned to WBS)
- Project Management Plan
- Project Charter
- Project Communication Plan
- Roles and Responsibilities Matrix
- Responsible, Accountable, Supports, Consulted, Involved (RACSI)
- Quality Plan
- Health, Safety, and Environment Plan
- Change Management Plan

4.3.3 Risk Duplication and Correlation

The Risk Manager shall review the completed risk register and determine if any risks are duplicated or overlap with other risks. Risks are considered duplicates in three ways:

1. Simple duplication: the risk is explicitly captured twice
2. Impact duplication: two similar risks result in identical or overlapping impacts
3. Common-cause duplication: risks that share the same root cause or trigger

Redefine each risk or remove it from the register so each risk is unique with an independent impact.

Examples of simple duplication are:

> *Failure to achieve LEED silver accreditation* may happen because of *scope changes removing the green roof* and result in *a failure to meet a base scope requirement.*
>
> *Eliminating window glazing* may happen because of *cost overrun*s and result it *the building failing to meet LEED silver accreditation.*

In both cases the risks focus on various causes for failure to obtain LEED silver certification. Each one of these risks may be small in and of itself, but when combined create a larger risk. The risks should be consolidated to simplify the list and make risk response planning easier.

Examples of impact duplication are:

> *Complications in demolishing the annex* may happen because of *unexpected contamination* and result in *an extra $100,000 of cost.*
>
> *Complications in demolishing the annex* may happen because of *unexpectedly finding asbestos* and result in *an extra $75,000 of cost.*

To assess duplication the project must understand if the $100,000 impact includes $75,000 for removing asbestos. If so, the double counting of the first risk is corrected by reducing its impact to $25,000.

Examples of common-cause duplication are:

> *Foundations taking longer* may happen because of *unexpected heavy rains* and result in *schedule delays of 2 weeks.*

Extra work during building the foundation may happen because of *heavy rains* and result it *a cost increase because water must be pumped out.*

In this case since both risk events share a common root cause or trigger, they are different impacts of the same risk and can be combined into a single risk.

Since the risk management framework is qualitative correlation between risks, either positive or negative, can are ignored. Appendix I provides a discussion on risk correlation.

4.3.4 Assign Risk Identification Numbers

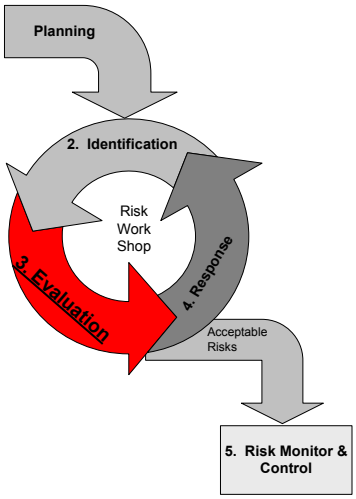
Once risk duplication is corrected, every risk is assigned a risk identification number. The unique risk identification number names and tracks a risk throughout the life of the project. This number can be sequential (1, 2, 3, etc.) or use a nomenclature to improve risk management (i.e. ##.## with the first two letters/numbers indicating the PESTLE category or project life cycle stage of the risk, and the last two number sequential). The method of assigning risk identification numbers is left to the discretion of the project team but for larger projects, a nomenclature is strongly recommended.

4.4 *Working Example of Risk Identification*

See Appendix D2 for a working example of Risk Identification.

5 Risk Evaluation

It is important to separate risk identification – an open ended exercise – with risk evaluation as it is a convergent exercise. With all risks identified, with the cause and consequence defined, then the team can assess each risk's probability and impact.



5.1 *Probability and Impact Guide*

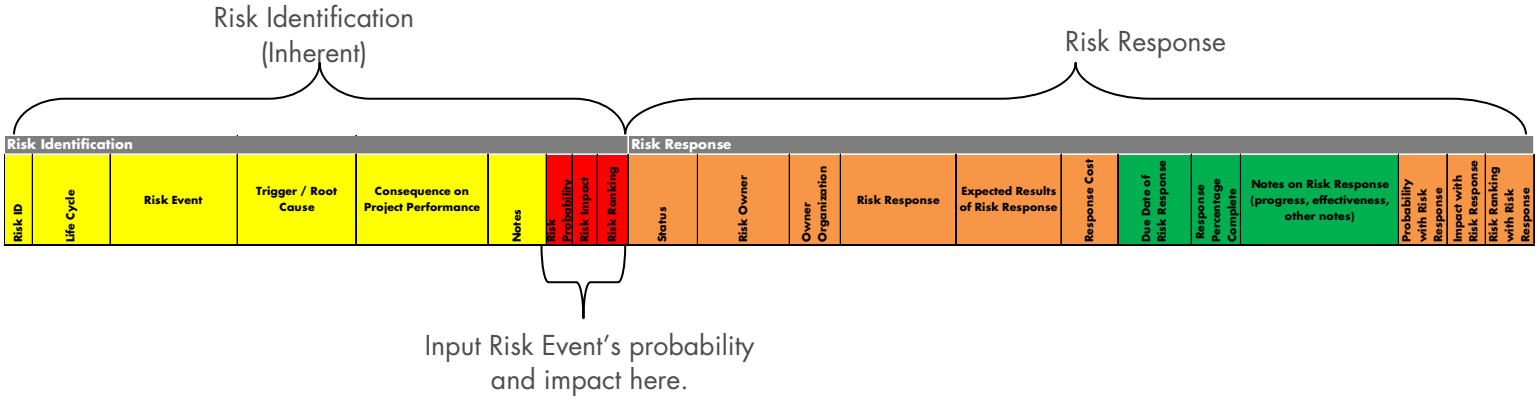
A risk's probability and impact assumes that the current and planned project controls are both in place. Reasonable assumptions can be made about the capabilities of contractors and consultants who are not present at the identification meeting.

Existing active risks are re-evaluated for probability or impact at each of the five risk identification meetings.

This risk management framework is qualitative. To determine the probability and impact of a risk, it is not imperative to have definitive, quantitative, and repeatable evaluations. If data is readily available, then it should be used, but it does not have to be sought out, researched or purchased. In determining a risk's probability and impact, use collective agreement or consensus and defer to subject matter experts. Despite the qualitative approach, the ordinal ranking of risks must still be maintained relative to each other. A good technique to calibrate the ordinal ranking is to refer to prior risks and ask the question, "Is the probably of this risk more or less likely than this other risk?"

Record a risk's probability and impact on the risk register as shown below. The risk ranking will be automatically calculated.

Figure 8.0: Recording Probabilities and Impacts in the Risk Register



5.2 *Probability Table*

Evaluate a risk's probability of occurrence using the table below in Figure 9. An electronic copy is included risk register in Appendix C. The numeric probability scales are guides. Determining a risk's specific probability is not required in a qualitative framework, only to place its probability within a given range.

A risk's probability assumes existing and planned project management activities have occurred. The probability of a risk is completely independent of its consequences.

Figure 9.0: Probability Table

Score	Description	Low end	High end	Description
5	Almost Certain	67%	99%	Event is almost expected to happen. Almost everyone has seen or heard about this happening on similar projects.
4	Likely	33%	67%	Event is common to this type of project. Most people have seen this happen before or have heard about this happening on similar projects.
3	Possible	15%	33%	Many people have seen or heard about this happening on a similar project.
2	Unlikely	5%	15%	Many would be relatively surprised if this event were to occur. Few have ever heard about this risk happening on a project.
1	Remote	1%	5%	Most have never seen this risk realized or even heard about it happening on a similar project.

5.3 *Impact Table*

A risk can impact a project through the three project imperatives:

1. Scope
2. Schedule
3. Budget

Any risk can impact a project in more than one area. To evaluate a risk's impact, the team determines the worst reasonably-expected result that could occur if the risk materializes. A risk's impact is independent of its probability. When assessing a risk's project impact, consider existing tools, processes, and assets, etc. that are in place, or will be in place, that would reduce the expected impact. For instance, when assessing the potential impact of a fire, keep in mind that a building is built to code, has smoke detectors, fire alarms, and a sprinkler system.

Figures 10.0, 11.0, and 12.0 are the reference tables to assess a risk's impact. To evaluate an impact use the description and the numerical references as a guide only. It is tempting for some team members to debate and then assign fixed numbers. The risk framework is qualitative: precise evaluation is not required. Evaluation needs to ensure that the order of magnitude of each is correct of each risk and relative to all other risks. The impact scale is not linear and reflects the Ministry's risk tolerance.

Figure 10.0: Scope Impact Table

Score	Description	Description
11	Catastrophic	End-product is effectively useless
7	Major	Scope becomes unacceptable to sponsor or key stakeholders
5	Significant	End-product is usable but not desirable
2	Limited	End product is usable but not optimized
1	Negligible	No noticeable impact on end product

Figure 11.0: Cost Impact Table

Cost Impact			$10,000,000		Uncommitted Project Budget
Score	Description	Guide	Minimum	Maximum	Description
11	Catastrophic	10%	$1,000,000	$10,000,000	Budget can only be maintained by several major cuts to scope &or alternative funding sources
7	Major	7.5%	$750,000	$999,999	Budget can be maintained by cutting a major scope item or reducing several significant scope items
5	Significant	5%	$500,000	$749,999	Budget can be maintained by cutting a significant scope item or several limited scope items.
2	Limited	2%	$200,000	$499,999	Budget change can be accommodated by existing contingency
1	Negligible	1%	$0	$199,999	Budget change can be accommodated by existing contingency

Figure 12.0: Schedule Impact Table

Schedule Impact			100	Weeks Remaining	
Score	Description	Guide	Minimum	Maximum	Description
11	Catastrophic	10%	10	100.0	Major Milestones are un-attainable
7	Major	7.5%	7.5	9.9	Major Milestones are missed by a period of time
5	Significant	5%	5	7.4	Critical path tasks fall behind schedule
2	Limited	2%	2	4.9	Delays to non-critical path activities begin to effect milestones
1	Negligible	1%	-	1.9	Delays to non-critical path activities

When using impact tables in the risk register Excel file, enter the **remaining budget** and **remaining schedule** in weeks. This allows the team to focus on relevant issues that are imminent, while allowing them to record, but not take action, on risks that are far away. For example:

- *Ineffective facility commissioning and turnover* may happen because of *insufficient trades on site during commissioning* and result in *a schedule delay of 1 week.*

This risk has a negligible impact (1) on the project's schedule when there are 200 weeks remaining, but a critical impact on the schedule during the project's last two weeks. When this risk is identified at the business case risk identification meeting, it can be captured, but left unaddressed until later in the project. This allows the project team to focus its limited resources and energies on major issues. At the operations risk identification meeting with four weeks to project completion, this risk's one week impact will become catastrophic (11) and likely require corrective action.

The relative or remaining measure is used for two reasons:

1. It allows risk mitigation activities to focus on current activities
2. It allows for risks to be re-evaluated as the project matures

To evaluate a risk's impact consider all consequences the materialized risk might have on the project. If a risk impacts more than one project imperative (scope, schedule, budget), record the highest impact level. The risk's impact is promoted one level when:

Rule #1: The secondary impact is scored the same or one less than the primary impact
Rule #2: Secondary and tertiary impacts are both two less than the primary impact

Examples of these rules are shown in Figure 13.0 below:

Figure 13.0: Risk Impact Promotion Rules Example

Remaining Budget = $1,000,000
Remaining Schedule = 100 weeks

Risk Event	Consequence	Impact on			Total Risk Impact	Rule
		Cost	Schedule	Scope		
Heavy Rains cause delay in laying the foundation	• Rain delays of 2 weeks. • Increased cost of $2000 to pump out water	1	2	n/a	5	#1
The project is poorly scoped resulting in significant change orders	• Cost overruns due to change orders $800,000. • Change order work and processing time delay the schedule by 2 weeks • Change orders cause end product not to be optimized as planned	7	2	2	11	#2
Decision-making delays force material deliveries during seasonal load restrictions	• Increased number of lighter loads increase cost by $500,000. • Complexity of sequencing loads adds one week of time.	5	1	n/a	5	n/a
Decision making delays force missing a construction season	• Need to re-issue/modify RFPs to find available contractors $10,000. • Schedule delay of 8 weeks. • Scope objective for immediate improvement are not meet	1	7	2	7	n/a

5.4 *Working Example of Risk Evaluation*

See Appendix D3 for a working example of Risk Identification.

6 Risk Response

Once risks have been identified and evaluated, their risk ranking number is calculated as:

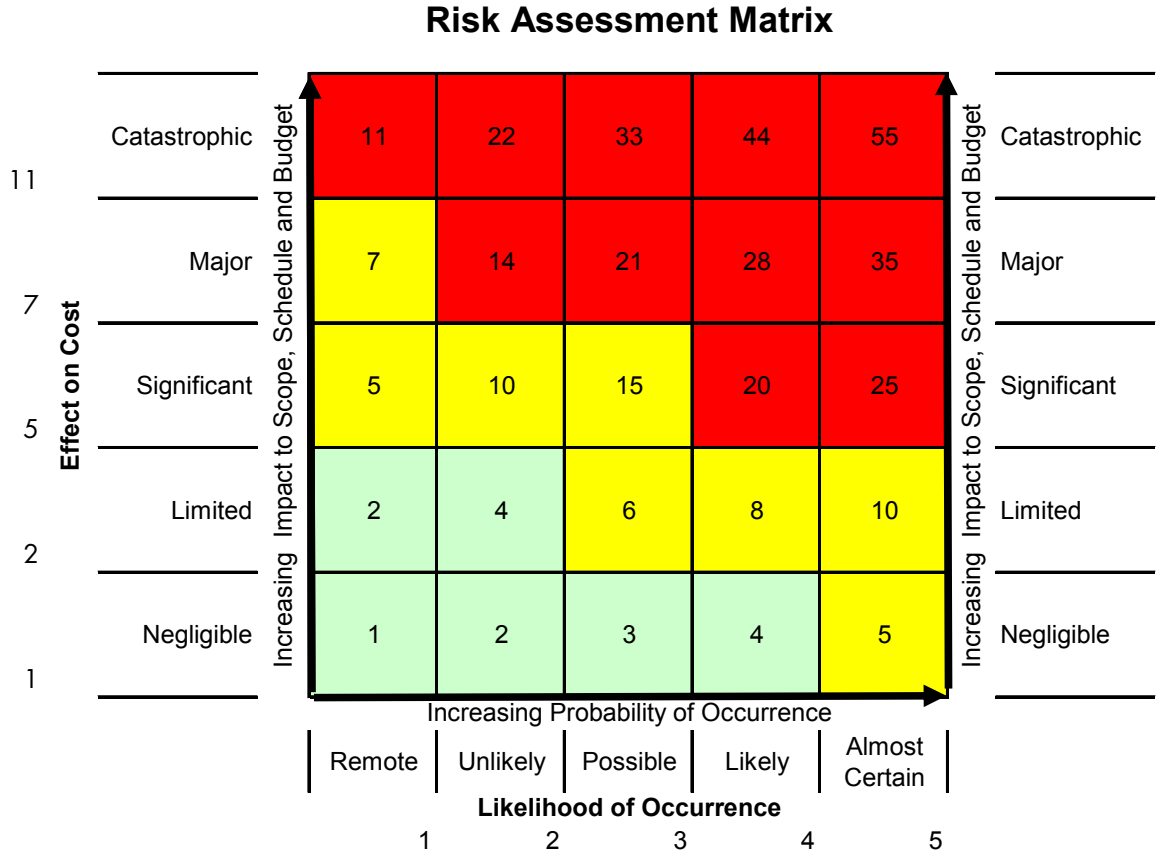
Risk Ranking = Probability x Impact

The risk ranking defines how serious a potential risk is. A higher risk ranking indicates a more serious threat to project success and a greater imperative for a risk response. Figure 14 shows the risk assessment matrix. The risk register (Appendix C) automatically calculates the risk ranking.

Any risk in the red zone must have risk responses to move into the yellow or green zone or better.

Once a risk response is developed, the risk's probability and impact are re-evaluated. If the risk ranking is still in the red zone, additional responses are required until it has moved into an acceptable zone.

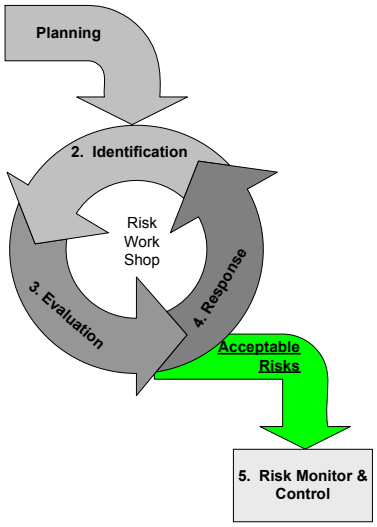
Figure 14.0: Risk Tolerance Table



6.1 *Response Strategies*

There are four basic risk responses:

1. Accept
2. Transfer
3. Mitigate
4. Avoid



Accept means that the project team simply accepts the risk and takes no additional measures to current project management practices to prevent it from occurring or to reduce its impact. The team must still take normal corrective action should the risk occur. The accept response results in carrying budget contingency and/or schedule slack to accommodate the risk. Risks in the yellow and green zone can be, but do not have to be, considered acceptable. If a risk is acceptable, change its status in the risk register to "No response required".

Mitigate is the most common form of risk response. Actions are take before the risk is triggered to reduce its probability of occurrence and/or its impact. Risk mitigation is, by definition, a pro-active risk response.

Transfer means that the risk will be transferred to a 3rd party to manage and bear its consequences. Transferring a risk removes the unknown impact and exchanges it with a known effect - usually a cost, either visible or hidden. Risk transference is never free; all parties will want compensation for accepting the consequences of a risk. The lower the ability for the 3rd party to respond to a risk, the greater the risk transfer price. Two examples of risk transfer are shown below:

- *Insufficient funding* may happen because of *actual costs exceeding budget costs of construction* and result in *unacceptable cost overruns.*

Transfer Risk Response (hidden cost): *Use a fixed price contract for construction.*

- *Damage to the building* may happen because of *a fire* and result in *massive cost overruns and missing the opening date.*

Transfer Risk Response (visible cost): *Obtain fire insurance for the construction site that includes a provision for space rental should the building opening date be missed due to fire.*

Avoid is a potent risk mitigation that reduces a risk's probability to zero. To avoid a risk, the project team makes a decision that eliminates the risk. An avoid risk response is shown below:

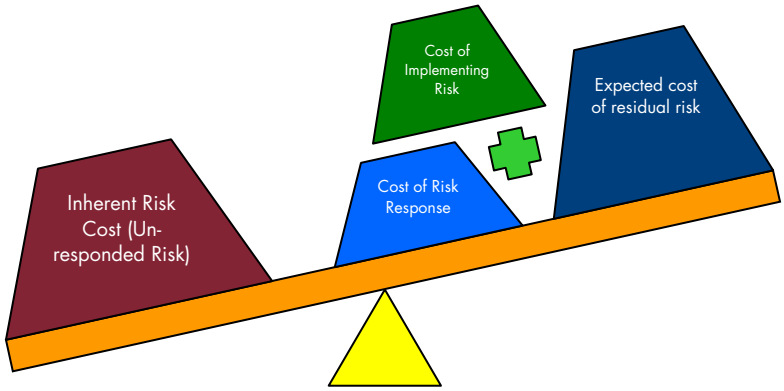
- *Raising the height of proposed plus 15' pedway connecting the new building to the old one across the street* may happen because of *city by-laws concerning street traffic* and result in *a significant cost increase.*

Avoid Risk Response: *Do not build the plus 15' pedway and instead build cross walk.*

6.2 *Risk Response Cost-Benefit Analysis*

Figure 15.0: Cost-Benefit Analysis of a Risk Response

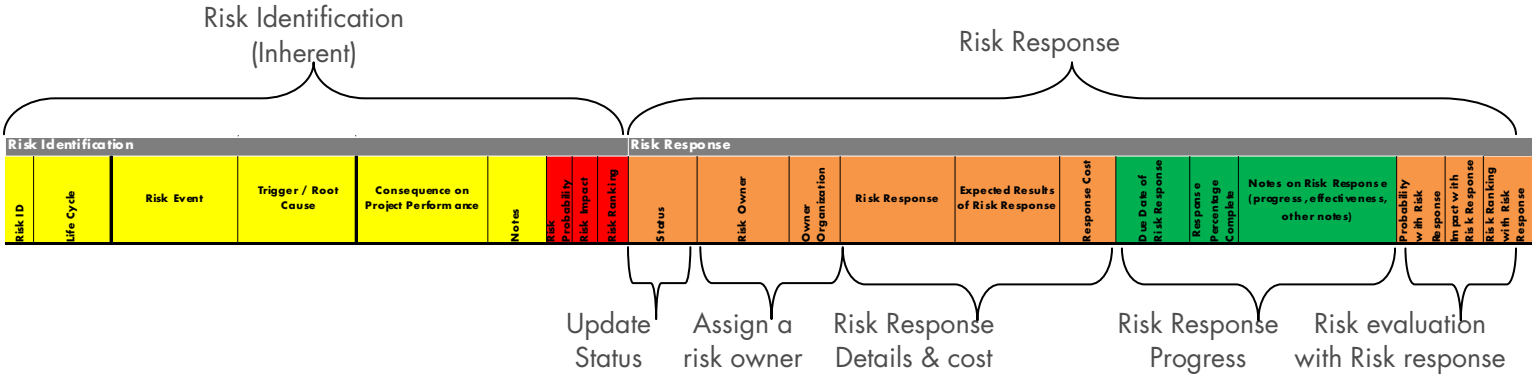
In developing a risk response, always weigh the potential cost impact of the un-responded risk against the cost of the risk response strategy and the residual impact of the risk. Many risk responses do not eliminate the risk, but rather lower the risk's probability and impact. The cost of developing the risk response, its implementation, and the residual risk must be less than that of the original risk. If this is not true, it is better to accept the risk and carry contingency or develop an alternative, more cost effective, response.



6.3 *Completing the Risk Register*

Once it is determined that a risk must be responded to, additional information is added to the risk register. If a risk is acceptable and has no risk response, no further information is required.

Figure 16.0: Adding Risk Response in the Risk Register



The risk register is essentially an action item log. It records: what will be done; who will do it; its cost; when it is due; current progress; the expected results should be; and, what the actual results are. The risk response headings in the risk register are:

Section Header	Notes
• Status	There are 5 possible risk status: • Identified: the risk has been described and given a risk priority number • No response required: the risk is not in the red zone and is acceptable by the project team • Planned Response: a risk response has been developed and may be in some stage of execution • Implemented Response: the risk response has been developed and is fully implemented • Risk Expired: this risk has either been realized or its trigger has passed without event
• Risk Owner	Is the person who is responsible for this risk implementing the risk response? There should be only one person listed here.
• Risk Owner Organization	What is the organization of the risk owner? In large projects it is possible to have multiple stakeholders involved and tracking which risk are assigned to various organizations is important. Ideally risks are borne by the organization best able to deal with them.
• Risk Response	Describes the action that will be taken to respond to this risk. Should multiple actions be required, copy, and insert additional rows. Each risk response should have a single person accountable for its implementation. It is common for a single risk to have multiple risk responses in order to cost-effectively drive the risk into the acceptable zone.
• Expect Results of Risk Response	A description of what the expected results will be of the risk response.
• Response Cost	The cost associated with implementing the risk response. Response costs are a combination of the effort required to develop and implement the response plus the cost of the response itself (i.e. for a risk response of insurance, some one has to seek out and secure the contract in addition to the insurance premium cost). In some cases the response may be more expensive than simply accepting the risk. Care must be taken to ensure each risk response has a positive cost – benefit relationship.
• Due Date of risk response	This is the date by which the risk response should be fully implemented. Failure to complete a risk response by the required date could result in in-effective risk mitigation or, worse, none at all.
• Percent Complete	The percent complete is useful to track the amount of work complete in implementing complex risk responses that take considerable effort or time. For instance a risk response may be to hire a full time Project Manager, which requires several steps to complete (creating a job description, posting the position, screening & interviewing candidates, making an offer, etc.). This section is updated in the risk monitoring and control stage.
• Notes	In the course of completing action items, information may be discovered that needs to be captured or may change the nature of the response. This section is to capture these pieces of information and record a history of the progress of the risk response.

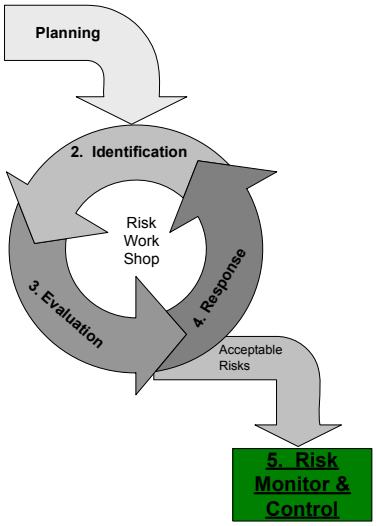
Section Header	Notes
• Probability with Risk Response	Once the risk response is fully defined and developed, the risk is re-evaluated to determine if the risk response will lower the probability of this risk occurring.
• Impact with Risk Response	Once the risk response is fully defined and developed, the risk is re-evaluated to determine if the risk response will lower the impact of the risk should it occur.
• Risk Priority Number with Risk Response	Once the risk is re-evaluated based on its planned response, new probability and impact scores are assessed. This will calculated a revised risk priority number for the risk. If this number still places the risk in the red zone, additional risk responses are required. If the risk is out of the red zone, the project team may still desire to continue to add risk responses.

6.4 *Working Example of Risk Response*

See Appendix D4 for a working example of Risk Identification.

7 Risk Monitor and Control

Risk planning, identification, evaluation and response are the foundation of risk management. No amount of detailed planning, robust identification, calibrated evaluation, or inspired risk responses will result in improved project performance unless responses are enacted.



7.1 *Risk Response Tracking and Evaluation*

As defined in the risk management plan, the project team will periodically review the progress of risk response activities. Risk reviews should be incorporated into regular project management meetings.

At risk review meetings, the team will evaluate the progress and performance of risk responses, and update the risk register and:

1. Update the risk status. If a risk's trigger has passed, change the status to "risk expired"
2. Update percent complete
3. Add notes on risk response progress
4. Take action to complete risk responses that are, or are in danger of being, past due
5. Evaluate the effectiveness of completed risk responses against the expected results.
    a. If the response is less effective than planned, re-evaluate the risk's new probability and impact given the current response. Should the risk ranking be in the red zone or be unacceptable, additional risk responses must developed.

If the risk owner feels that a risk response cannot be completed on time additional support should be requested.

7.2 *Working Example of Tracking and Control*

See Appendix D5 for a working example of Risk Identification.

8 Advanced Risk Management

8.1 *Common Root Cause of Project Failure*

The most common root cause for project failure to meet scope, schedule and budget is the lack of initial project scoping and planning. Project Managers and Institutions need to spend enough time and money during the strategic option analysis and business case to:

- Properly determine and define stakeholder requirements and expectations
- Document not just the project scope, but the reasons for the project's scope
- Determine the viability of various alternatives that solve the problem
- Assess existing assets and background conditions
- Define and verify base assumptions

8.2 *Second Line of Risk Management Defence*

The first and best risk response for any project is robust, well defined, and vigorously implemented project controls. A definition of project management is the discipline of planning, organizing, and managing resources to bring about the successful completion of specific project goals and objectives[5]. In addition to this definition, project controls are the processes and tools used to facilitate project management. If project management is about making decisions, then project controls are about collecting and analyzing information to support decision making. As a rule of thumb, a project should spend about 1% of its total cost on project management and 2% on project controls. On an infrastructure construction project, there are the following areas of knowledge are all required:

1. Project Integration Management
2. Project Scope Management
3. Project Schedule Management
4. Project Budget Management
5. Project Quality management
6. Project Human Resource Management
7. Project Communications Management
8. Project Risk Management
9. Project Procurement and Claims Management
10. Project Health, Safety and Environmental Management
11. Project Legal and Regulatory Management
12. Project Financial Management

One of the key differences between strong project management teams and poorly performing teams is their ability to identify problems early and take corrective action before the problem compounds and causes other problems. Risk management is an excellent early warning system to identify issues and develop appropriate responses before they occur. This allows problem solving to take place in a deliberate, controlled manner rather than in a reactive, crisis mode.

[5] PMBOK 4th Edition

APPENDIX A: Assumptions and Steps to Transform Qualitative Framework to Quantitative

Assumptions:

This framework assumes:

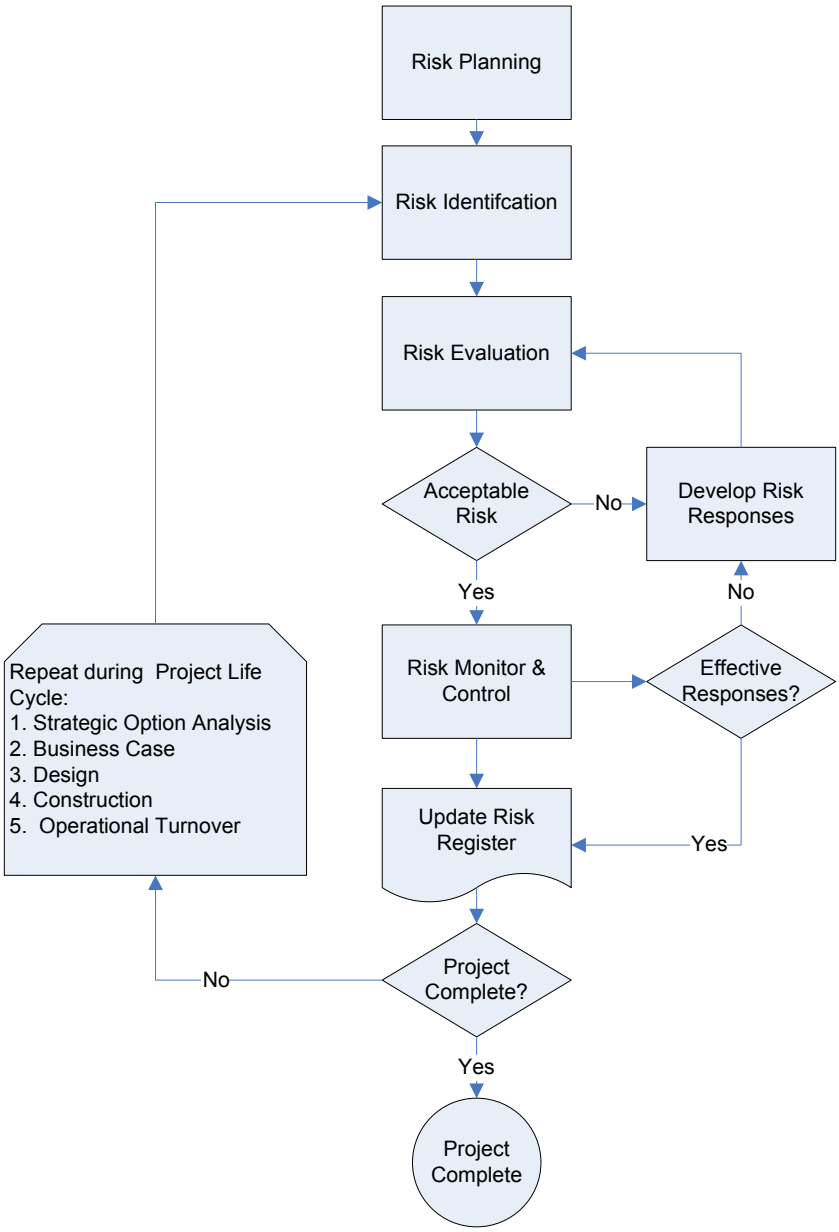
- Project leadership has a minimum basic formal understanding of project management
- Project leadership has at least a cursory understanding of risk management
- Projects over $50 million will be supported by an individual or firm that has risk management expertise beyond this framework
- The project team has a good understanding of the scope, schedule, and budget expectations of the project
- The project team has a tacit understanding of the potential risks and impacts facing the project

Qualitative to Quantitative Risk Management

This guide provides a qualitative or basic approach to risk management suitable for small to medium sized projects. As the project increases in size, scope, complexity, and cost, a more sophisticated approach is warranted. Changes would include:

1. Exploration of opportunities (beneficial risks) and development of responses to increase the probability and impact of things going right
2. Monte Carlo modeling for risk probabilities and impacts
3. Probabilistic budgets and schedules
4. Development of risk-based cost contingency and schedule slack
5. Documented, defendable values for risk probability and impacts
6. Quantitative analysis of the cost-benefit effectiveness of risk responses
7. Correlation coefficients are developed for risks
8. Integration of risk management into contingency management
9. Integration of risk management into scope management
10. Integration of risk management into change management
11. Integration of risk management into schedule management

APPENDIX B: Detailed Work Flow



APPENDIX C: Risk Register

Risk Register

Institution <Enter Institution name>

Project: <Enter Project Name>

Revision Date <enter revision date>

Date Wednesday, May 26, 2010

Risk Identification									Risk Response											
Risk ID	**Life Cycle**	**Risk Event**	**Trigger / Root Cause**	**Consequence on Project Performance**	**Notes**	**Risk Probability**	**Risk Impact**	**Risk Ranking**	**Status**	**Risk Owner**	**Owner Organization**	**Risk Response**	**Expected Results of Risk Response**	**Response Cost**	**Due Date of Risk Response**	**Response Percentage Complete**	**Notes on Risk Response (progress, effectiveness, other notes)**	**Probability with Risk Response**	**Impact with Risk Response**	**Risk Ranking with Risk Response**
								0			#N/A									0
								0			#N/A									0
								0			#N/A									0
								0			#N/A									0
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APPENDIX D: Working Examples

The following working examples are designed to walk the reader through the five steps of risk management with sufficient detail that they could apply the learning to their own project.

APPENDIX D1: Working Example of Risk Planning

The project's scope of work is to upgrade the information network backbone in the Life Sciences building. The Director of IT Services and the project manager is familiar with the technology. Last year, the same project manager completed the same project in the Engineering Building and plans on using the same contractor. The anticipated budget for the entire project is $4 million. At the beginning of the strategic options analysis stage, the project manager made and documented the following decisions:

- Project Manager will act as Risk Manager and Functional Lead
- Project Sponsor will be the Director of IT Services
- An IT Manager has been nominated by the department as the Operations Stakeholder
- Risk monitoring and control will be completed every four weeks
- Reporting will be included in meetings with the Project Sponsor every four weeks
- Budget for risk management implementation activities will be $10,000
- Budget for risk responses will be funded from generated savings
- The proposed schedule is as follows:

Event	Date	Participants	Notes
Risk Identification Meeting #1: Strategic Options Analysis	Dec 1	Project Manager Project Sponsor	2 hour scheduled
Risk Identification Meeting #2: Business Case	Jan 15	Project Manager Project Sponsor IT Manager	3 hours schedule
Formal documentation of Risk Management Plan	Jan 30	Project Manager	Submission includes Risk plan and current risk register
Risk Identification Meeting #3: Design	March 1	Project Manager Project Sponsor IT Manager Design Consultant	2 hours schedule Meeting coincides with design kick off meeting
Risk Identification Meeting #4: Construction	May 1	Project Manager IT Manager Design Consultant Contractor	2 hours scheduled Meeting coincides with construction kick off meeting
Risk Identification Meeting #5: Operations	July 30	Project Manager IT Manager Contractor	1 hour scheduled

APPENDIX D2: Working Example of Risk Identification

The project is completing the risk identification meeting for the design phase. In using the risk breakdown structure, the team reviews the item of decision making and trade offs. The following questions were asked:

- Does the project have any risk associated with decision making?
- What risks might the project have due to poor trade off decisions?
- How might trade off decisions impact the design schedule and cost?

Based on the question asked, the team identified the following risks:

Incorrect trade off decisions for budgetary reasons may happen because of *poor scope prioritization and constantly changing decisions* and result in *schedule delays and cost overruns during design.*

Lack of a clear decision making method may happen because of *poor project planning* and result in *schedule delays and cost overruns during design.*

Lack of user input into design decisions may happen because of *low stakeholder engagement* and result in *schedule delays, cost overruns, and missing scope items during design.*

These risks are recorded in the risk register as:

Figure 17.0: Sample Risk Identification

Risk ID	Life Cycle	Risk Event	Trigger / Root Cause	Consequence on Project Performance	Notes
1	Design	Incorrect trade off decisions for budgetary	Poor scope prioritization and constantly changing decisions	Schedule delays and cost overruns during design.	
2	Design	Lack of a clear decision making method	Poor project planning	Schedule delays and cost overruns during design.	
3	Design	Lack of user input into design decisions	Low stakeholder engagement	schedule delays, cost overruns, and missing scope items during design	

APPENDIX D3: Working Example of Risk Evaluation

The project had identified the following risk from the RBS item, "Interfaces with existing facilities":

> *Insufficient steam may be provided to the new administration building* may happen because *central plant does not having enough capacity* and result in *inability to properly heat the new building (scope requirement).*

The team has never encountered this problem before, but a few have heard of this happening on similar projects at other Institution's campuses. Although the team assumes that the central plant has sufficient capacity, making the risk a very low probability, no one really knows for certain. The team agrees to give this a probability of "Possible" with a score of "3". The impact of this risk is scope-related as the building must be heated. Should this risk materialize, the building would be effectively useless. The team ranks this risk's impact of catastrophic with a score of 11. The combined risk priority level is then 33, putting it in the red zone and requiring a risk response.

Figure 18.0: Sample Risk Identification

Risk Event	Trigger / Root Cause	Consequence on Project Performance	Notes	Risk Probability	Risk Impact	Risk Ranking
Insufficient steam may be provided to the new administration building	Central plant does not having enough capacity	Inability to properly heat the new building (scope requirement).		3	11	**33**

APPENDIX D4: Working Example of Risk Response

As previously stated the most common form of risk response is risk mitigation. Risk mitigation responses are actions that are taken before the risk is triggered to reduce the likelihood of occurrence, and/or its impact should the event occur. The following is an example of risk response iteration:

- An initial attempt to "avoid" the risk
- Followed by subsequent "transferring" of the risk
- Effective risk "mitigation"
- Finally risk "acceptance"

The sample project charter has the objectives of: "build three additional teaching spaces capable of accommodating up to 100 students with supporting class lecture equipment. The teaching space must be in usable condition for the beginning of the fall semester. A budget has been approved of $5 million."

A risk for this project is:

> *Failure to complete the project for the beginning of fall classes* may happen because of *poor contractor performance* and result in *increased costs, missed key deliver date and disruptions to class schedules (scope).*

On this project, schedule overruns due to contractor performance are common, occurring between 33% and 67% of the time, giving it a probability of "likely", with a score of "4". The consequences of this risk are several. First, the objective of the project is to provide the teaching space by a certain date (schedule). One must assume that the space would eventually be completed, so this risk would constitute missing a major milestone by a period of time, or a "major" schedule risk which would score a "7". Regardless of the opening date, classes must be held and so it is expected the project would have to source alternative space to host classes until the space is available. It is assumed that the cost of arranging, equipping, and renting this space would be about 2% of the total project's remaining budget, which would merit a "negligible" rating and a score of "2". Finally, missing the opening date makes the end product usable but not optimized which is a "limited" scope risk, with a score of "2". Since this risk has multiple impacts, to record the risk's impact one would take the highest score of "7", and advance it one level to a score of "11"[6]. The risk would be recorded in the risk register as:

[6] Rule #2 on evaluating risk as discussed in Section 4.3

Figure 19.0: Sample Risk Recorded

Risk ID	Life Cycle	Risk Event	Trigger/ Root Cause	Consequence on Project Performance	Notes	Risk Probability	Risk Impact	Risk Ranking
1	Construction	Failure to complete the project for the beginning of fall classes.	Poor contractor performance	Increased costs and missed key deliver date.		4	11	**44**

With a risk priority number of "44", this risk is in the red zone and must have a response. It is suggested that this risk could be avoided by delaying the opening date by one full year. However, the project charter requires this opening date so this avoid risk response is not valid. Another team member suggested having regular progress meetings with the contractor. Since this is already part of the project plan, it is not considered a valid risk response, as it is part of the status quo.[7] One of the most common methods of treating this risk is the use of a fixed price contract is to adjust the contract language. A possible risk response might be:

1. Specify "liquidated damages" in the contract so that the contractor must cover costs incurred by the owner to host classes in alternative accommodations until the project is complete.

This response might be recorded in the risk register as:

Figure 20.0: Sample Risk Response #1

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Planned Response	PM	Internal	Include Liquidated Damages clause in the contract	Cost of alternative accommodation due to late completion will be covered by the contractor if it is their fault.	$500	Jan 1, 2010	0%		4	7	**28**

[7] Often team members may suggest risk responses that are actions already in place. This can occur for several reasons. A prime reason is that the team member implicitly does not agree with the evaluation of the risk's probability or impact. This could signal a poorly calibrated evaluation.

This response reduces the impact of the risk as it transfers the responsibility of the risk materializing from the owner to the contractor. This eliminates the cost impact of this risk, shifting it from a score of "2" to a score of "0". With the cost impact removed the effect of rule #2 promoting the risk impact is avoided, lowering its impact score to "7". Since the response has no affect on probability, the risk ranking remains in the red zone and requires additional responses. An additional response is added:

1. Develop performance expectations in the contract with corresponding penalty clauses tied to delivery dates to increase the likelihood of positive contractor performance. These penalties are in addition to liquated damages.

This would be recorded in the risk register as:

Figure 21.0: Sample Risk Response #2

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Planned Response	PM	Internal	Include Liquidated Damages clause in the contract	Cost of alternative accommodation due to late completion will be covered by the contractor if it is their fault.	$500	Jan 1, 2010	0%		4	7	**28**
Planned Response	PM	Internal	Include punitive late deliver penalties in the contract over and above liquated damages	Increased consequences of late delivery for the contractor increase the likelihood of on time delivery	$500	Jan 1, 2010	0%	Try and determine the cost premium of a bonus / penalty	3	7	**21**

The risk probability after the risk response is implemented drops from possible to unlikely. The $500 recorded in the cost column reflects work to change the standard contract. It is likely that the contractor would increase its prices to reflect its increased financial risk, but this amount cannot be determined without negotiations. Risk transference is never free. By tying the contractor's objective (profit) closely with the institution's objective (schedule delivery), the project is more likely to succeed. However, the final score of "21" is still in the red zone, therefore, more risk responses are required.

A risk mitigation response to take seven weeks out of the schedule is developed by including the contractor during the design phase to help with constructability design reviews and starting phased construction early under a construction management contract. This would result in a time and

material construction management contract that would be turned into a fixed fee contract once all the design drawings are issued for construction. This would be recorded in the risk register as:

Figure 22.0: Sample Risk Response #3

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Planned Response	PM	Internal	Include Liquidated Damages clause in the contract	Cost of alternative accommodation due to late completion will be covered by the contractor if it is their fault.	$500	Jan 1, 2010	0%		4	7	**28**
Planned Response	PM	Internal	Include punitive late deliver penalties in the contract over and above liquated damages	Increased consequences of late delivery for the contractor increase the likelihood of on time delivery	$500	Jan 1, 2010	0%	Try and determine the cost premium of a bonus / penalty	3	7	**21**
Planned Response	PM	Internal	Retain contractor during the design phase under a construction management contract	Reduce planned schedule by seven weeks.	$35,000	1-Jan-10	0%		1	7	**7**

In this example, the contractor is happy with this solution and reduces the premium required for the liquidated damages and performance penalty clauses.

The response further reduces the probability of late deliver from "possible" to "remote", dropping the risk priority from "21" in the red zone to "7" in the yellow zone. The impact of late delivery remains unchanged. At this point, there is not a requirement to develop any additional risk responses as the risk probability has been reduced to its lowest level barring complete avoidance. However, the project team still considers this as an unacceptable risk and addresses the residual impact of a late completion. The project team develops a mitigation strategy triggered during construction if it is apparent that the project will not finish on time. The mitigation strategy actions will include:

- Locate and secure alternative accommodations
- Ensure that appropriate technology and equipment are available with effective connectivity
- Adjust classroom scheduling to reflect the new accommodations

- Determine transportation and safety implications of using the new temporary location
- Develop a communication plan for faculty and staff regarding the individual impacts of the change

While these actions will not eliminate the impact of late delivery, it will reduce the scope consequences of late delivery. Risk mitigation may include activities that are coupled with other actions once the risk has been triggered. This response would be recorded in the risk register as:

Figure 23.0: Sample Risk Response #4

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Planned Response	PM	Internal	Include Liquidated Damages clause in the contract	Cost of alternative accommodation due to late completion will be covered by the contractor if it is their fault.	$500	Jan 1, 2010	0%		4	7	**28**
Planned Response	PM	Internal	Include punitive late deliver penalties in the contract over and above liquated damages	Increased consequences of late delivery for the contractor increase the likelihood of on time delivery	$500	Jan 1, 2010	0%	Try and determine the cost premium of a bonus / penalty	3	7	**21**
Planned Response	PM	Internal	Retain contractor during the design phase under a construction management contract	Reduce planned schedule by seven weeks.	$35,000	1-Jan-2010	0%		1	7	**7**
Planned Response	PM	Internal	Determine a schedule trigger that launches the mitigation plan of securing additional temporary class room space and effective communication to students and faculty	Reduce planned schedule by seven weeks.	$2,500	1-Jan-2010	0%		1	2	**2**

APPENDIX D5: Working Example of Risk Monitor and Control

A project has the following excerpt from its project charter:

> "Replace the major components of the Chemistry buildings HVAC system including: chillers for air conditioning, and the associated blowers and rebalance system. Installation must not dramatically impact normal building operations. "

The identified risk was:

- *Unexpected disruptions to normal operations during HVAC replacement* may happen because of *poor coordination of installations with faculty and operations* and result in *failing to meet scope objectives to avoid dramatic impacts to building operations.*

This was recorded in the risk register as:

Figure 24.0: Risk Monitor & Control Example #1

Risk ID	Life Cycle	Risk Event	Trigger / Root Cause	Consequence on Project Performance	Notes	Risk Probability	Risk Impact	Risk Ranking
2	Construction	Unexpected disruptions to normal operations during HVAC replacement.	Poor coordination of installations with faculty and operations	Failing to meet scope objectives to avoid dramatic impacts to building operations.		4	11	**44**

In response to this risk a plan was developed and recorded in the risk response register as:

Figure 25.0: Risk Monitor & Control Example #2

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Implemented Response	PM	Internal	Setup regularly scheduled meetings with operations and faculty to share planned HVAC installation.	No unplanned or excessive disruptions to normal building operations.	$2,500	Jan 1, 2010	0%		1	2	**2**

The plan was implemented; however, while operations regularly attended this meeting, teaching faculty representation did not. Work on the HVAC system was planned for the winter so the lack of air conditioning would not be a problem, and balancing was scheduled for a weekend. Furthermore, during preliminary work it was determined that certain fume hoods must be replaced. This replacement was expected to take one day per room and during this time the lab would not be functional due to construction. While the budget could accommodate the increased cost of the fume hoods, the budget contingency and schedule precluded all of the fume hood work from taking place on weekends. As a result, at regular risk monitor and control sessions, the risk was re-evaluated as:

Figure 26.0: Risk Monitor & Control Example #3

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Implemented Response	PM	Internal	Setup regularly scheduled meetings with operations and faculty to share planned HVAC installation.	No unplanned or excessive disruptions to normal building operations.	$2,500	Jan 1, 2010	0%		3	11	**33**

The review meeting identified that the planned response was not having the desired effect and that additional actions items were required. The team developed the following additional risk responses:

Figure 27.0: Risk Monitor & Control Example #4

Status	Risk Owner	Owner Organization	Risk Response	Expected Results of Risk Response	Response Cost	Due Date of Risk Response	Response Percentage Complete	Notes on Risk Response	Probability with Risk Response	Impact with Risk Response	Risk Ranking with Risk Response
Implemented Response	PM	Internal	Setup regularly scheduled meetings with operations and faculty to share planned HVAC installation.	No unplanned or excessive disruptions to normal building operations.	$2,500	Jan 1, 2010	0%		3	11	**33**
Planned Response	PM	Internal	Immediately email faculty and graduate students with offices in the building the planned date of weekend HVAC commissioning. Repeat email two weeks ahead of the actual date and remind them of the possible impacts of commissioning.	No unplanned or excessive disruptions to normal building operations.	$250	Jan 1, 2010	0%		3	5	**15**
Planned Response	PM	Internal	Identify and individually meet with all faculty who are have labs with fume hoods that need replacement and schedule a mutually acceptable day for construction	No unplanned or excessive disruptions to normal building operations.	$5,000	Jan 1, 2010	0%		1	2	**2**

APPENDIX E: Risk Register Instructions

Risk Register Section Header	Notes	Section
• Risk ID	A unique identified of each risk	4.7
• Life Cycle	Pull down menu to record when in the project the risk is relevant	3.3
• Risk Event	A description of the risk	4.3
• Trigger / Root Cause	The event or root cause that causes the risk to be realized	4.3
• Consequence on Project Performance	Narrative descriptions of what would happen to the project's scope, schedule and / or budget should the risk materialize.	4.3
• Risk Probability	The scored result of the team's opinion on the likelihood of this risk occurring given current conditions and project management activities	5.2
• Risk Impact	The scored result of the team's opinion of the consequences of the risk when it is realized given current conditions and project management activities	5.3
• Risk Priority Number	Is the calculated result of probability x impact that determines the magnitude of this risk on the project. Results can be red (must have risk response), yellow (dictionary risk response) or green (acceptable risk response).	6
• Status	There are 5 possible risk status: • Identified: the risk has been described and given a risk priority number • No response required: the risk is not in the red zone and is acceptable by the project team • Planned Response: a risk response has been developed and may be in some stage of execution • Implemented Response: the risk response has been developed and is fully implemented • Risk Expired: this risk has either been realized or its trigger has passed without event	
• Risk Owner	Is the person who is responsible for this risk implementing the risk response? There should be only one person listed here.	
• Risk Owner Organization	What is the organization of the risk owner? In large projects it is possible to have multiple stakeholders involved and tracking which risk are assigned to various organizations is important. Ideally risks are borne by the organization best able to deal with them.	
• Risk Response	Describes the action that will be taken to respond to this risk. Should multiple actions be required, copy, and insert additional rows. Each risk response should have a single person accountable for its implementation. It is common for a single risk to have multiple risk responses in order to cost-effectively drive the risk into the acceptable zone.	6

Risk Register Section Header	Notes	Section
• Expect Results of Risk Response	A description of what the expected results will be of the risk response.	
• Response Cost	The cost associated with implementing the risk response. Response costs are a combination of the effort required to develop and implement the response plus the cost of the response itself (i.e. for a risk response of insurance, some one has to seek out and secure the contract in addition to the insurance premium cost). In some cases the response may be more expensive than simply accepting the risk. Care must be taken to ensure each risk response has a positive cost – benefit relationship.	6.2
• Due Date of risk response	This is the date by which the risk response should be fully implemented. Failure to complete a risk response by the required date could result in in-effective risk mitigation or, worse, none at all.	7
• Percent Complete	The percent complete is useful to track the amount of work complete in implementing complex risk responses that take considerable effort or time. For instance a risk response may be to hire a full time Project Manager, which requires several steps to complete (creating a job description, posting the position, screening & interviewing candidates, making an offer, etc.). This section is updated in the risk monitoring and control stage.	7
• Notes	In the course of completing action items, information may be discovered that needs to be captured or may change the nature of the response. This section is to capture these pieces of information and record a history of the progress of the risk response.	7
• Probability with Risk Response	Once the risk response is fully defined and developed, the risk is re-evaluated to determine if the risk response will lower the probability of this risk occurring.	6.1
• Impact with Risk Response	Once the risk response is fully defined and developed, the risk is re-evaluated to determine if the risk response will lower the impact of the risk should it occur.	6.1
• Risk Priority Number with Risk Response	Once the risk is re-evaluated based on its planned response, new probability and impact scores are assessed. This will calculated a revised risk priority number for the risk. If this number still places the risk in the red zone, additional risk responses are required. If the risk is out of the red zone, the project team may still desire to continue to add risk responses.	6.1

APPENDIX F: Alternative methods of risk identification

1. Brainstorming
2. Delphi Technique
3. Interviews
4. Root Cause Analysis
5. Lessons Learned
6. SWOT Analysis
7. Expert Judgement
8. Fishbone / Cause & Effect / Ishikawa Diagrams
    - Machines
    - Methods
    - Materials
    - Measurements
    - Environment (Mother Nature)
    - People (Manpower)
9. Force Field/Influence Diagrams
10. Process Flow Charts
11. Challenge Constraints & Assumptions
12. Critical path Analysis

APPENDIX G: Sample Risk Identification Meeting Agenda

Location:			
Time:			
Invited Attendees	**Person**	**Organization**	**Contact**

Preparation	Person	Activity
All invites	Think about their role in the project and what concerns they have concerning the success of the project Develop mental list of project risks that they are concerned about or have responsibility for	
Purpose	To develop a risk register for the project including description of the risk, causes, impact, likelihood, priority and assign owners to develop mitigation tactics, costs and benefits.	
Payoff/Product	Completed risk register	

Process

Start	What	How	Who
Time:	**Item:**	**Action:**	
8:30	Safety Moment	Discussion	
8:35	Agenda, process, ground rules	Discussion	
8:40	Introductions and personal objectives of meeting	Discussions	
8:50	Review project scope, schedule and budget objectives	Open forum, Review of documents	
9:10	Review current status of project		
9:15	Review of what is a Risk	Presentation	
9:30	Practice risk identification	Demonstration	
9:35	Hot button items (risks)	Self directed	
9:45	Break		
10:00	Identify Risks using Risk Break Down Structure	Breakout groups	
12:00	Lunch		
1:00	Rationalize risks to eliminate duplicates. Assign risk identification numbers	Discussion	
1:15	Risk Evaluation – probability and impact	Discussion	
2:30	Break		
2:45	Sort risks by risk priority number, identify unacceptable risks	Discussion	
2:50	Develop risk response plans for each unacceptable risk. Re-evaluate risks assuming response plan is effective. Continue developing response plans until each risk is acceptable.	Discussion & Example	
4:45	Set first date and time for first risk monitor and control meeting	Discussion	
4:50	Plus / Delta	Discussion	
5:00	Adjourn		

APPENDIX H: Risk Breakdown Structure

To use ask the question: Do we have any risks associated with _____?

Risk Breakdown Structure

- 1.Strategic Options Analysis
  - 1.1.Political / Institutional
    - 1.1.1.Politcal / Ministry
      - 1.1.1.1.Expectations Management
      - 1.1.1.2.Policy alignment / change
      - 1.1.1.3.Inter & Intra Governmental Relations
      - 1.1.1.4.Project alignment
      - 1.1.1.5.Reviews & Approvals
      - 1.1.1.6.Adherance to Goverment Policy & Guides (CAMF)
    - 1.1.2.Organizational (Post Secondary Instition)
      - 1.1.2.1.Project Sponsorship
      - 1.1.2.2.Business Model
      - 1.1.2.3.Business Objectives
      - 1.1.2.4.Budgetary Pressures
      - 1.1.2.5.Organization Structure
      - 1.1.2.6.Program & Portfolio Impacts
        - 1.1.2.6.1.Prioritization
        - 1.1.2.6.2.Project Dependencies
        - 1.1.2.6.3.Sequencing of Project
        - 1.1.2.6.4.Relations to other Projects
      - 1.1.2.7.Faculty, Students and Staff
  - 1.2.Economic
    - 1.2.1.Funding Sources
      - 1.2.1.1.Fiscal timing
      - 1.2.1.2.Capital Donations
      - 1.2.1.3.Institution Budget
      - 1.2.1.4.Treasury Board
      - 1.2.1.5.Other Private & General Public sources
    - 1.2.2.Investment
      - 1.2.2.1.Project Delivery Model
      - 1.2.2.2.Variability in Projected Cash flow
      - 1.2.2.3.Uncertain / variable demand
      - 1.2.2.4.Value for Money
      - 1.2.2.5.Return on Investment, Net Present Value /Cost
  - 1.3.Social
    - 1.3.1.Stakeholders
    - 1.3.2.Media
    - 1.3.3.Public
    - 1.3.4.Stakeholder Performance gap
    - 1.3.5.Public Perception
    - 1.3.6.Institutional Image
  - 1.4.Technical
    - 1.4.1.Project Management
      - 1.4.1.1.Intergration
      - 1.4.1.2.Scope
        - 1.4.1.2.1.Requirements
        - 1.4.1.2.2.Scope definition
      - 1.4.1.3.Schedule
        - 1.4.1.3.1.Schedule Targets
        - 1.4.1.3.2.Milestone requirements
      - 1.4.1.4.Budget
      - 1.4.1.5.Comminications
        - 1.4.1.5.1.Strategy
        - 1.4.1.5.2.Stakeholders
      - 1.4.1.6.Procurement
        - 1.4.1.6.1.Cost of Risk Transferance
        - 1.4.1.6.2.Make vs Buy / In-source vs outsouce
      - 1.4.1.7.Health, Safety, Environment
      - 1.4.1.8.Human Resources
        - 1.4.1.8.1.Resource Availablity
        - 1.4.1.8.2.Resource Skill Sets
    - 1.4.2.Requirements Definition
      - 1.4.2.1.Requirements of Stakeholders
      - 1.4.2.2.Assumptions
      - 1.4.2.3.Constraints
    - 1.4.3.Site
      - 1.4.3.1.Selection
      - 1.4.3.2.Acquisition
    - 1.4.4.Success / Performance Measurement
    - 1.4.5.Effectiveness & Efficiency
  - 1.5.Legal
    - 1.5.1.Regulatory
    - 1.5.2.Legislation
    - 1.5.3.Zoning
  - 1.6.Environment
    - 1.6.1.Operating Environment
      - 1.6.1.1.Demand
      - 1.6.1.2.Competition
    - 1.6.2.Natural Environment
      - 1.6.2.1.Seasonal conditions
- 2.Business Case
  - 2.1.Political / Institutional
    - 2.1.1.Political / Ministry
      - 2.1.1.1.Inter & Intra Governmental Relations
      - 2.1.1.2.Expectations Management
      - 2.1.1.3.Policy alignment / change
      - 2.1.1.4.Reviews & Approvals
      - 2.1.1.5.Adherance to Goverment Policy & Guides (CAMF)
    - 2.1.2.Organizational (Post Secondary Instition)
      - 2.1.2.1.Project alignment
      - 2.1.2.2.Prioritization
      - 2.1.2.3.Program / Portfolio
      - 2.1.2.4.Business Model
      - 2.1.2.5.Budgetary Pressures
      - 2.1.2.6.Organization Structure
      - 2.1.2.7.Reviews & Approvals
      - 2.1.2.8.Business Objectives
      - 2.1.2.9.Faculty, Students and Staff
  - 2.2.Economic
    - 2.2.1.Funding Sources
      - 2.2.1.1.Fiscal timing
      - 2.2.1.2.Capital Donations
      - 2.2.1.3.Institution Budget
      - 2.2.1.4.Treasury Board
      - 2.2.1.5.Other Private & General Public sources
    - 2.2.2.Budget
      - 2.2.2.1.Cost Escalation
        - 2.2.2.1.1.Labour
        - 2.2.2.1.2.Materials
      - 2.2.2.2.Interest Rates
      - 2.2.2.3.Exchange Rates
    - 2.2.3.Investment
      - 2.2.3.1.Project Delivery Model
      - 2.2.3.2.Variability in Projected Cash flow
      - 2.2.3.3.Opportunity costs
      - 2.2.3.4.Uncertain / variable demand
      - 2.2.3.5.Value for Money
      - 2.2.3.6.Return on Investment, Net Present Value /Cost
  - 2.3.Social
    - 2.3.1.Stakeholders
    - 2.3.2.Media
    - 2.3.3.Public
    - 2.3.4.Public Perception
    - 2.3.5.Institutional Image
  - 2.4.Technical
    - 2.4.1.Project Management
      - 2.4.1.1.Project Controls
      - 2.4.1.2.Client Operations Team
      - 2.4.1.3.Human Resources
        - 2.4.1.3.1.Resource Availablity
        - 2.4.1.3.2.Resource Skill Sets
      - 2.4.1.4.Intergration
      - 2.4.1.5.Scope
        - 2.4.1.5.1.Project Dependencies
        - 2.4.1.5.2.Scope Development
      - 2.4.1.6.Schedule
      - 2.4.1.7.Budget
      - 2.4.1.8.Comminications
      - 2.4.1.9.Procurement
        - 2.4.1.9.1.Cost of Risk Transferance
        - 2.4.1.9.2.Make vs Buy / In-source vs outsouce
      - 2.4.1.10.Health, Safety, Environment
      - 2.4.1.11.Quality Control / Quality Assurance
    - 2.4.2.Technology Selection
    - 2.4.3.Site
      - 2.4.3.1.Selection
      - 2.4.3.2.Acquisition
    - 2.4.4.Safety
    - 2.4.5.Procurement
      - 2.4.5.1.Suppliers
      - 2.4.5.2.Sub Contractors
      - 2.4.5.3.Materials
      - 2.4.5.4.Equipment
      - 2.4.5.5.Labour
      - 2.4.5.6.Contractors
      - 2.4.5.7.Consultants
      - 2.4.5.8.Cost of Risk Transferance
    - 2.4.6.Assumptions
    - 2.4.7.Constraints
    - 2.4.8.Site
      - 2.4.8.1.Selection
      - 2.4.8.2.Acquisition
    - 2.4.9.Operations / Faculty / Students
      - 2.4.9.1.Internal Stakeholder
      - 2.4.9.2.Asset Intergration
    - 2.4.10.Effectiveness & Efficiency
    - 2.4.11.Success / Performance Measurement
    - 2.4.12.Site Contamination
  - 2.5.Legal
    - 2.5.1.Contract Arrangement
    - 2.5.2.Legislation
    - 2.5.3.Regulatory
    - 2.5.4.Contractual Terms & conditions
    - 2.5.5.Zoning
    - 2.5.6.Environmental abatement
    - 2.5.7.Funding Compliance
  - 2.6.Environment
    - 2.6.1.Operating Environment
      - 2.6.1.1.Force Majeure
      - 2.6.1.2.Competition
      - 2.6.1.3.Demand
    - 2.6.2.Natural Environment
      - 2.6.2.1.Weather
      - 2.6.2.2.Natural Disasters
      - 2.6.2.3.Fire
      - 2.6.2.4.Seasonal conditions
- 3.Design
  - 3.1.Political / Institutional
    - 3.1.1.Political / Ministry
    - 3.1.2.Organizational (Post Secondary Institution)
      - 3.1.2.1.Descions Making
      - 3.1.2.2.Trade offs
      - 3.1.2.3.Change management Leadership
      - 3.1.2.4.Faculty, Students and Staff
  - 3.2.Economic
    - 3.2.1.Cost Escalation
    - 3.2.2.Default
    - 3.2.3.Exchange Rates
  - 3.3.Social
    - 3.3.1.Media
    - 3.3.2.Stakeholders
    - 3.3.3.Public
    - 3.3.4.Public Perception
    - 3.3.5.Institutional Image
  - 3.4.Technical
    - 3.4.1.Project Management
      - 3.4.1.1.Project Controls
      - 3.4.1.2.Work processes
      - 3.4.1.3.Quality Control / Quality Assurance
      - 3.4.1.4.Resources
      - 3.4.1.5.Intergration
      - 3.4.1.6.Scope
        - 3.4.1.6.1.Technology Selection
        - 3.4.1.6.2.Interface with Existing Facilities
        - 3.4.1.6.3.Physical Interfaces
        - 3.4.1.6.4.Functional Programming
      - 3.4.1.7.Schedule
      - 3.4.1.8.Budget
      - 3.4.1.9.Quality
      - 3.4.1.10.Human Resources
      - 3.4.1.11.Comminications
      - 3.4.1.12.Procurement
      - 3.4.1.13.Health, Safety and Environmental Management
    - 3.4.2.Site Work
    - 3.4.3.Safety
    - 3.4.4.Procurement
      - 3.4.4.1.Logistics
      - 3.4.4.2.Suppliers
      - 3.4.4.3.Sub Contractors
      - 3.4.4.4.Materials
      - 3.4.4.5.Equipment
      - 3.4.4.6.Labour
      - 3.4.4.7.Contractors
      - 3.4.4.8.Consultants
    - 3.4.5.Operational Requirements
      - 3.4.5.1.Building Operatons requiements
      - 3.4.5.2.Faculty requirements
      - 3.4.5.3.Students requirements
    - 3.4.6.Resources
    - 3.4.7.Performance Measurement
  - 3.5.Legal
    - 3.5.1.Contract Arrangement
    - 3.5.2.Legislation
    - 3.5.3.Regulatory
    - 3.5.4.Contractual Terms & conditions
    - 3.5.5.Codes
  - 3.6.Environment
    - 3.6.1.Operating Environment
      - 3.6.1.1.Force Majeure
      - 3.6.1.2.Market vendor Capacity
      - 3.6.1.3.Theft / Vandalism
      - 3.6.1.4.Security
    - 3.6.2.Natural Environment
      - 3.6.2.1.Weather
      - 3.6.2.2.Natural Disasters
      - 3.6.2.3.Fire
- 4.Construction
  - 4.1.Political / Institutional
    - 4.1.1.Political / Ministry
    - 4.1.2.Organizatation (Post Secondary Institution)
      - 4.1.2.1.Descions Making
      - 4.1.2.2.Trade offs
      - 4.1.2.3.Change management Leadership
      - 4.1.2.4.Faculty, Students and Staff
  - 4.2.Economic
    - 4.2.1.Cost Escalation
    - 4.2.2.Default
    - 4.2.3.Interest Rates
    - 4.2.4.Exchange Rates
  - 4.3.Social
    - 4.3.1.Media
    - 4.3.2.Stakeholders
    - 4.3.3.Public
    - 4.3.4.Public Perception
    - 4.3.5.Institutional Image
  - 4.4.Technical
    - 4.4.1.Project Management
      - 4.4.1.1.Project Controls
      - 4.4.1.2.Work processes
      - 4.4.1.3.Quality Control / Quality Assurance
      - 4.4.1.4.Resources
      - 4.4.1.5.Intergration
      - 4.4.1.6.Scope
        - 4.4.1.6.1.Existing Facilities
        - 4.4.1.6.2.Physical Interfaces
      - 4.4.1.7.Schedule
        - 4.4.1.7.1.Construction Hours / Days / Seasons
      - 4.4.1.8.Budget
      - 4.4.1.9.Quality
      - 4.4.1.10.Human Resources
      - 4.4.1.11.Comminications
      - 4.4.1.12.Procurement
      - 4.4.1.13.Health, Safety and Environmental Management
    - 4.4.2.Site Work
    - 4.4.3.Safety
    - 4.4.4.Procurement
      - 4.4.4.1.Suppliers
      - 4.4.4.2.Sub Contractors
      - 4.4.4.3.Materials
        - 4.4.4.3.1.Logistics
        - 4.4.4.3.2.Delvieries
        - 4.4.4.3.3.Sequencing
      - 4.4.4.4.Equipment
      - 4.4.4.5.Labour
      - 4.4.4.6.Contractors
      - 4.4.4.7.Consultants
    - 4.4.5.Performance Measurement
    - 4.4.6.Operational Requirements
      - 4.4.6.1.Building Operatons requiements
      - 4.4.6.2.Faculty requirements
      - 4.4.6.3.Students requirements
  - 4.5.Legal
    - 4.5.1.Contractual Terms & conditions
    - 4.5.2.Codes
    - 4.5.3.Permitting
    - 4.5.4.Inspection
  - 4.6.Environment
    - 4.6.1.Operating Environment
      - 4.6.1.1.Force Majeure
      - 4.6.1.2.Market vendor Capacity
      - 4.6.1.3.Theft / Vandalism
      - 4.6.1.4.Security
    - 4.6.2.Natural Environment
      - 4.6.2.1.Weather
      - 4.6.2.2.Natural Disasters
      - 4.6.2.3.Fire
      - 4.6.2.4.Freight load restrictions
- 5.Commissioning & Operations
  - 5.1.Political / Institutional
    - 5.1.1.Political / Ministry
    - 5.1.2.Organizational (Post Secondary Institution)
      - 5.1.2.1.Change management Leadership
      - 5.1.2.2.Faculty, Students and Staff
  - 5.2.Economic
    - 5.2.1.Cost Escalation
    - 5.2.2.Default
    - 5.2.3.Interest Rates
  - 5.3.Social
    - 5.3.1.Media
    - 5.3.2.Stakeholders
    - 5.3.3.Public
    - 5.3.4.Public Perception
    - 5.3.5.Institutional Image
  - 5.4.Technical
    - 5.4.1.Project Management
      - 5.4.1.1.Intergration
      - 5.4.1.2.Scope
      - 5.4.1.3.Schedule
      - 5.4.1.4.Budget
      - 5.4.1.5.Human Resources
      - 5.4.1.6.Comminications
      - 5.4.1.7.Procurement
      - 5.4.1.8.Regulatory
      - 5.4.1.9.Quality Control / Quality Assurance
      - 5.4.1.10.Health, Safety and Environmental Management
    - 5.4.2.Asset Performance
    - 5.4.3.Procurement
      - 5.4.3.1.On going support
      - 5.4.3.2.Suppliers
      - 5.4.3.3.Sub Contractors
      - 5.4.3.4.Materials
      - 5.4.3.5.Equipment
      - 5.4.3.6.Labour
      - 5.4.3.7.Contractors
      - 5.4.3.8.Consultants
    - 5.4.4.Operations
      - 5.4.4.1.Labour Relations
      - 5.4.4.2.Reliability
      - 5.4.4.3.Safety
      - 5.4.4.4.Maintenance
      - 5.4.4.5.Capital Renewal
      - 5.4.4.6.Obsolescence
      - 5.4.4.7.Decommissioning
      - 5.4.4.8.Technical Requirements
      - 5.4.4.9.Health, Safety and Environmental Management
    - 5.4.5.Performance Measurement
    - 5.4.6.Operational Requirements
      - 5.4.6.1.Building Operatons requiements
      - 5.4.6.2.Faculty requirements
      - 5.4.6.3.Students requirements
  - 5.5.Legal
    - 5.5.1.Contract Enforcement / Verification
    - 5.5.2.Contractual Terms & conditions
    - 5.5.3.Occupancy / Operational Permits
    - 5.5.4.Testing & Inspection
  - 5.6.Environmental
    - 5.6.1.Operating Environment
      - 5.6.1.1.Force Majeure
      - 5.6.1.2.Market vendor Capacity
    - 5.6.2.Natural Environment

APPENDIX I: Risk Correlation

Certain risks are related to other risks by either positive or negative correlation. Positive correlation means that should the first risk occur, the second is more likely to occur or have a greater impact if does occur. Negative correlation means that should the first risk occur, the second risk is less likely to occur or to have a lesser impact. An example of positively correlated risk probability is:

- *Insufficient funds to provide all the space required by stakeholders* may happen because the *project did not complete a feasibility study* and result in *failure to meet scope requirements.*
- *Delays in picking building finishes* may happen because of *poor stakeholder communication and engagement* and result in *schedule delays of 2 weeks.*
- *Misunderstandings on what is in scope* may happen because of *incomplete user requirements* and result it *both cost and schedule overruns.*

The lack of a feasibility study or needs assessment could indicate that stakeholders were not engaged early in the process, leading to participation during design and confusion over what is included in base scope.

Examples of negatively correlated risks are:

- *Damage to the institution's reputation* may happen because of *the project is not completed on time* and result in *lower enrolment of foreign students.*
- *Less than planned foreign student enrolment* may happen because of *the new foreign students' residence is cut from the project scope* and result in *decreased operating revenue.*

In this case, while neither outcome is desirable, if the late project decreases the school's international reputation and lowers its foreign student enrolment, the impact of not having enough foreign students' residence space is lessened as there is less demand for this space.

The risk management framework is qualitative and while duplication among risks must be addressed, correlation between risks, either positive or negative, can be ignored.