A RISK IDENTIFICATION FRAMEWORK AND TOOL FOR LARGE INFRASTRUCTURE PUBLIC PRIVATE PARTNERSHIP DELIVERY

by

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Abstract

Large public sector infrastructure projects are often characterized by a broad scope and capital dollar size, dynamic stakeholder and governance network, high project risk profile, long planning and procurement timelines, and high visibility to the public and political partisans. The number and breadth of risks during the planning and procurement phases that can delay project go-ahead or cause its ultimate cancelation are significant and thus require the utmost attention for successful delivery. The goal of this research was to improve risk management as it is applied in the delivery of large civil infrastructure with particular emphasis on the planning and procurement phases of public private partnerships and risks mainly internal to the client, in this case, the public sector organizations (e.g. end user and delivery organizations) involved. The research focused on developing a risk management framework, support tools and an improved research prototype that introduces the concept of characterizing different aspects of a project to improve the identification of risks and their related drivers, and elicitation of expert opinion of risk properties.

Understanding the unique characteristics of public sector large infrastructure project delivery was central in achieving this research goal and aspects were described in each of the chapters through case studies, observations and both formal and informal interviews with senior practitioners. The objectives of the thesis are summarized under three broad research themes: (1) Risk management practices and challenges in large infrastructure public projects; (2) Approaches to support elicitation of risk information to improve risk management processes; and, (3) Developing and gauging the effectiveness of a prototype integrated risk management tool. Thesis

contributions are related to: (a) processes and risks encountered in the delivery of a public sector large infrastructure project in the planning and procurement phases; (b) strengths and weaknesses of the practitioner processes applied to carry out risk management in large infrastructure projects; (c) the multi-dimensionality of stakeholders involved in public sector project delivery; and (d) concepts and constructs developed to improve risk identification and the elicitation of expert opinion tasks applied in a prototype computer system.

Preface

A shortened and less fully developed version of the work presented in this thesis was originally written as a collection of papers (what are now chapters 6 and 7) and other chapters (chapters 3,4 and 5) have been designed to stand alone although each has been modified to fit with the thesis. The author's interest and experience in leading major public sector infrastructure projects in the planning and procurement phase of project delivery gave rise to the research topic and research questions pursued under the guidance of research supervisor Dr. Alan D. Russell. The collection of case study data modeled in the research prototype was carried out collaboratively by the author and Dr. Alan D. Russell. The programming work for implementing the research prototype was done by Mr. William Wong, a senior programmer, in the Department of Civil Engineering, UBC. The author was the lead in developing and collecting findings in the case studies presented in chapters 3, 4, 5 and 6 and collaboratively worked with Dr. Alan D. Russell on the modeling of case study information in the research prototype presented in chapter 7.

Five peer-reviewed conference papers related to this thesis have been published. The co-authors of these papers provided either guidance or contributed to the writing of these papers. I was the contact author for each of the papers and took the lead on revising the papers with suggested revisions. These conference papers include:

- Nelms, C., DeZoysa, S. and Russell, A. (2006). Features of a Risk Management Tool Applied to a Major Building Project. CD Rom Proc. of 1st Int. Construction Specialty Conference, CSCE, Calgary, Alberta, Canada, 23-26 May 2006.

- Nelms, C., De Zoysa, S., Russell, A.D. (2006). Application of an information and knowledge management methodology in analysing the risks in construction projects. The Eleventh International Conference on Computing and Decision Making in Civil and Building Engineering. (ICCCBE-XI), Montreal, Quebec, Canada, 14-16 June 2006.

- Nelms, C., Russell, A.D. (2007). Improving the risk management process using IT. ASCE Construction Research Congress, Bahamas, 2007. May 6-8, 2007, Grand Bahama Island, Bahamas.

- Russell, A.D., Nelms, C. (2007). The Application of Information Technology to Support the Elicitation of Expert Judgement in Project Risk Management. Construction Management and Economics 25th Anniversary Conference, CME25, Reading, United Kingdom, 16-18th July 2007.

- Nelms, C.E. & Russell, A. D. (2008). Identifying and responding to risks: the role of project profiling, Proc., Int. Construction Innovation Forum, CSCE 2008 Annual Conference, Quebec City June 10-13, 2008.

One peer-reviewed journal paper arose from work presented in chapter 6 of this thesis. The published paper was co-authored with Mr. William Trousdale and we worked collaboratively to write the first draft of the paper. For chapter 6, I expanded and modified this paper to fit with the dissertation as a whole. The published journal paper is:

- Trousdale, William & Nelms, Cheryl. (2009). Siting Major Public Facilities: Facts, Values and Accountability. Journal of Urban Planning and Development. 135(4), 159-165.

Versions of chapters 3, 4, and 7 of this thesis are in the process of submission for possible journal publication. A version of chapter 5 is in the process of submission as a project management guidance document for a Canadian federal public sector department and possible journal publication.

The research presented in this dissertation was carried out in accordance with the standards of the University of British Columbia Behavioral Research Ethics Board, certificate #H1-00437-A001.

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My PhD journey has taught me the value of spending time on the details and an appreciation for the time others have generously provided along the way. The opportunity to work in both industry and academia was unique and I am grateful to my key industry supporter, Alain Trepanier, who was enthusiastic about my research interests and results. To my public and private sector colleagues, thank you for your interest in my research and feedback on how we may improve current practices together. Particular thanks go to each of the participants in my research study for their time, insight, and interest in my subsequent completion. I am grateful to Ngoc Tran, Jami Koehl, Tony Guglielmin and Camila Prado for going above and beyond in providing assistance and resources.

I am sincerely grateful to my family for their love and support throughout my pursuit of my academic goals and my friends who patiently listened to me and understood in the times of writing when I rarely saw them or spoke to them. To Samir, my sounding board and partner, who always understands and wants the best for our family. Finally, I owe my gratitude to Iain, whom in the final years of this thesis volunteered so much of his time chapter by chapter and encouraged me to finish.

Dedication

To Samir, for your love and support through this journey.

Chapter 1: **Introduction**

1.1 **Chapter Overview**

This chapter provides an overview of the thesis contents and a brief synopsis of each chapter included herein. Its primary focus is:

1. To describe my frame of reference in carrying out the research;
2. To outline motivations for the research on improving risk identification and elicitation of expert opinion of risk properties to improve risk responses (mitigation, avoidance, transference and acceptance) in large major public sector infrastructure projects with reference to the front end planning and procurement phases of a project's life cycle;
3. To articulate the research questions, objectives, methodology and key assumptions followed relevant to item 2;
4. To provide a set of research test questions to assess the usefulness of the risk identification approach developed to meet the unique characteristics of the industry studied;
5. To provide an overview of the structure of the thesis chapters included herein; and
6. To provide some important definitions of terms used throughout the thesis and identify unique characteristics of large capital infrastructure project delivery and specifically those of public sector infrastructure projects in the front end planning and procurement phases of the project lifecycle that should be considered in the development of a risk identification approach.

1.2 Authors Frame of Reference and Industry Experience

I have over 10 years experience in the delivery and management of large, complex major capital public sector projects including extensive experience in the Public Private Partnership (PPP) sector. I am a Professional Engineer, and have significant experience over the course of my career advising senior Canadian federal public servants in real property transactions and alternate service delivery procurement approaches as a Director in a number of Canadian federal departments. I have had a leading role in the planning, management, and implementation of PPPs in a portfolio valued at approximately $7 billion, federal PPP guidance and approval process documents, and in the development of client relations for other Canadian federal government departments involved in PPP initiatives acting as the Canadian Director leading a National Centre of Expertise for Public Private Partnership Development & Advisory Services in the federal government of Canada. My work in industry while concurrently conducting my PhD research has given me a unique perspective. I have had first hand opportunities to consider risks and consequences at the front end planning and procurement phases of several large and diverse infrastructure projects ranging from multi-billion dollar national programs to capital investment accommodations projects in excess of 100 million dollars (Canadian). These experiences have provided me with insights into the challenges faced by public and private sector practitioners alike in performing and integrating the risk management process in a practical manner in large infrastructure projects and programs. At the same time, I have seen benefits of applying processes discussed in the academic literature, which are new to industry and may improve risk management in the front end planning of a Project.

Based on my practical experience in industry and learning in academia, I have noticed that that there are shortcomings in the discussions and practices of risk management approaches on large infrastructure projects both in academic research and in industry practices. These shortcomings are particularly apparent in the early planning and procurement phases of a project during which key decisions are made and project information is evolving. Academic research has tended to focus on the identification and treatment of risks associated with the design and construction phases and to a lesser extent the operation and maintenance phase of the project lifecycle. However, there seems to be little consideration of the risks associated with the early phases of a project when there are significant risks to starting a project and there are complex stakeholder involvements and multi-stakeholder governance requirements. Tools and techniques outlined in the academic literature range from the elaborate and resource intensive to aids and processes that may not adequately reflect the complexity of the decision or the stakeholder (internal and external)[1] and process environments required for a large infrastructure public sector project. In addition, there are few case studies and practices developed that either extract or apply lessons learned from real practice.

My observations of shortcomings in performing risk management processes are not limited to academia but also to industry practice. My experience and involvement in Canadian civil engineering industry risk management of several very large public sector projects is that there are no simple and uniform ways to conduct a risk management process. The scale, scope and

[1] Stakeholders are defined as "persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project" (PMI, 2008). . Stakeholders may be categorized as internal stakeholders as those parties from within the respective organization (e.g. employees, executive etc.) and external stakeholders as those parties outside the organization (e.g. non-profits, general public etc.).

national importance of the projects in which I have been involved in (including projects for Canadian federal departments and agencies: Royal Canadian Mounted Police, Public Health Agency of Canada, Public Works Government Services Canada and Indian and Northern Affairs) has allowed me to work alongside high caliber senior civil servants and private sector management consultants from reputable national and worldwide firms. These are some of the best and most experienced individuals from both the public and private sector assigned to plan and deliver major Canadian public sector projects of national interest. The senior public and private sector project participants in general have had experience implementing risk management on multiple large infrastructure projects or programs. Nevertheless, it appears that much risk management continues to be performed as a standalone process rather than being linked explicitly with other project management activities (such as schedule development, stakeholder management, etc.). From my experience, the risk management process, for the most part, tends to focus on performing a set of tasks that meets the reporting needs and requirements set forth by internal stakeholders who have an oversight or decision making role. In addition, there is little adoption of the elaborative tools and techniques discussed in the academic literature for the following reasons. Industry processes employed reflect the realities of the project decision making environment including challenges related to lack of time, limited training of project participants in risk management concepts, evolving project information, resource (human and financial) limits and competing priorities experienced on these large infrastructure projects. It is not uncommon for one to review a project risk report or participate in a risk identification workshop and feel that the list of the significant risks may be incomplete, and it is often not clear what may happen if the risk is realized and whether an appropriate strategic response to the risk was developed. This is despite spending significant time and resources on the risk tasks.

Despite the (practice-oriented) risk management processes adopted by industry which are at least partially successful, I have found that there are several structured processes, tools and ways of thinking that are commonly discussed in the academic literature that could assist with improving industry practice. While at the same time, it seems that academia could learn a great deal from assessing implemented practices by industry in meeting the realities of the project decision-making environment. In particular, my research seizes on the opportunity to improve on the processes and practice developed and espoused by both academia and industry towards an integrated approach that can benefit both project management tasks and industry corporate accountability and governance requirements.

My academic research goals have been and continue to be to help shape practice, shed some light on the realities of the challenges and risk management practices carried out in the Canadian context and to develop an implementable form of a structured risk management process and aid. My concurrent work in both industry and academia has given me a unique insight into both arenas.

1.3 **Research Background**

Governments worldwide are concerned with ways and means to procure infrastructure (building and civil) in a time of fiscal restraint, economic uncertainty and aging infrastructure renewal demands. This has led to the consideration of alternative approaches such as Public Private Partnerships (PPP) which embrace three or more of the functions of finance (F), design (D), build (B), operate (O), and maintain (M), often referred to by a variety of acronyms (DBFOM, DBOM, DBM, DBO and DBF). Key features of these approaches include the greater assignment of the risks to the private sector over the entire project life cycle than more traditional project delivery methods. As a result, considerable emphasis is increasingly being put onto improving the risk management process in the early phases of these PPP projects, when governments decide on how best to procure the project, whether the project should proceed, and on the best risk assignment strategy to achieve qualitative and quantitative value for money. In fact, industry has taken great interest in improving the risk management processes for these PPP projects and the allocation of resources (human and financial) to "get it right" due to the fact that the outputs of the process formulate an important input into the business case justifying the selection of the PPP delivery mechanism. My dissertation is that value for money goes beyond procurement mode selection and encompasses the transparency and accountability requirements (including financial, social, environmental and technical) that must be considered by a public sector decision maker often translated explicitly or implicitly as qualitative risks. I consider both qualitative and quantitative risks because all must be considered by both decision-making and oversight stakeholders with particular focus on the risks inherent in the front end processes associated with getting the project approved for contract award[2].

Risk management is defined to include the steps of identification, analysis, interpretation, mitigation/assignment, tracking/monitoring, communication and capturing lessons learned. Best practice recommends that this process be performed in the early phases of a project and as the project evolves the associated risks are monitored and assessed. There is no one universal

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[2] The period prior to contract award is defined in this thesis as the front end planning and procurement phases of the project life cycle.

definition of risk and in this dissertation the definition applied in the Canadian federal context by the Treasury Board Secretariat (TBS, 2012) as:

Risk is defined as the effect of uncertainty on objectives. It is important to note that risk can be characterized as a negative uncertainty, commonly referred to as a threat, as well as a positive uncertainty, commonly referred to as an opportunity.

The consideration of both positive and negative uncertainty is consistent with the definition of risk applied by Ward & Chapman (2003) and Akintoye et al. (2001) provide a summary of definitions, both similar and different than that outlined, by scholars working in the field of construction management and illustrate that there is no one definition of risk applied in the industry.

The typical life cycle of a large infrastructure project involves several phases, notably planning, procurement, design, construction, infrastructure use and end of life. The specific steps and tasks performed vary across organizations and are discussed further in chapter 2. The focus of this research is on improving the risk management processes of the client (in this case a government public sector entity) in the project front end, encompassing both the planning and procurement phases, in large infrastructure projects, with concepts transferable to other phases and stages of project delivery. I see four primary stages in the planning phase: a. Problem definition and feasibility; b. Identification and analysis of project alternatives and delivery mechanisms; c. Development of a project plan; and d. Decision and approval of whether to proceed with project. The procurement phase includes five additional steps or stages through to award of the contract: e. Procurement documentation development; f. Evaluation and selection of proponents; g. Proponent negotiation meetings; h. Recommendation of preferred proponent; and i. Decision to award contract. These processes and activities follow steps that are typically performed in the planning and delivery of a PPP (DBFM) large infrastructure project undertaken by a Canadian federal government entity which as discussed is the project delivery method applied in the case studies examined.

Large infrastructure PPPs require a substantial amount of due diligence in the front end planning and procurement phases. Approval by federal decision-making bodies to continue after the planning phase and into the procurement phase starts a resource intensive process that typically lasts for just over one year and requires substantial financial and human commitments by the public and private sector participants. The procurement phase in a PPP differs in a number of ways relative to the traditional alternative delivery approach (Design–Bid-Build) in that private sector proponents incur significant costs to develop the proposal which the public sector evaluates and participates in a series of negotiations with a short list of private sector proponents over a time span typically exceeding eight months. This direct interaction results in the private sector proponents incurring expenditures that are substantial. Costs include monies to: assemble proponent teams; pay for a project office; create submission documents for evaluation; participate in team and negotiation meetings; and create a final proposal that includes an approximately 20% to 25% complete design for evaluation. Timely and reliable outcomes of the risk management activities are critical inputs to decision makers who decide the merits of project alternatives and whether the procurement phase should proceed. Once this procurement phase is initiated and the private sector costs start to appreciate, there is considerable pressure that the public sector not waiver its commitment on whether the project should proceed or not otherwise risking adverse impacts to private sector competition, commitment to bid, and the respective negative image of the sponsoring government entity in present and future procurements.

Risk management is considered integral to modern project management and independent of the procurement mode used (PMI, 2008), although industry practitioners seem to see this function more as an art than science. The identification of risks and definition of their associated properties and values are the most difficult steps in risk management. Construction industry practitioners face several familiar challenges including, tight time lines, lack of training in risk management processes, and the somewhat ad hoc nature of current practices. This is surprising because these steps are very important early in the project to select the appropriate procurement mode (including comparison of the value for money between different project delivery approaches), to allocate risk between public or private sector, prepare procurement documentation, and develop a negotiation strategy with the private sector proponent.

An extensive review of industry and academic literature leads me to three principle observations.

1. Research efforts and industry guidance tend to focus on the risk identification process at the design and construction phases of a project life cycle.
2. There is limited use of data integration, knowledge management and information technology to support the elicitation of expert judgment in risk (events, drivers, impacts, mitigation measures) and associated project management tasks.
3. There is limited consideration by academia and industry of the risks that arise as a result of stakeholder involvement (internal and external) and their associated characteristics early in the project life cycle.

The planning and procurement phase of a public sector infrastructure project can, on average, evolve over a ten year period, sometimes longer (Flyjberg et al., 2002). Such a project cannot be completed without appropriate consideration of risks associated with the tasks, the processes and the stakeholders. Effective risk management process and support requires consideration of the unique process steps, multi-dimensional stakeholder involvement, and the accountability and transparency needs of decision makers and oversight bodies of a large public sector infrastructure project.

Based on my experience and extensive review of the literature, the challenges in conducting risk management are related to:

- the dynamic and incomplete nature of project data,
- communication of complete descriptions of the risk events identified,
- elicitation of quality qualitative and quantitative inputs as to risk event likelihoods and multidimensional outcomes (e.g. time, cost, safety, etc.),
- interpreting and understanding a project's risk profile,
- tracking and managing risks during the project's life cycle, integrating the risk management function with other project management functions, and
- managing knowledge for future re-use.

Addressing these challenges will improve these risk management steps and facilitate better quality decision-making and investment analysis for the planning and procurement phases, which has been the primary motivation of my study.

The goal of this research was to improve risk management as it is applied in the delivery of large civil infrastructure with particular emphasis on the planning and procurement phases and risks mainly internal to the client, in this case, the public sector organizations (e.g. end user and delivery organizations) involved. The research focused on developing a prototype project context characterization system that introduces the concept of *characterizing*[3] different aspects of a project to improve the identification of risks and their related drivers, and elicitation of expert opinion of risk properties. Proposed benefits of these improved processes include improvements also on the risk responses (mitigation, avoidance, transference and acceptance). Improvements to these risk management steps may be applied across all phases of the total project life cycle. I sought to identify the unique steps of the planning and procurement for a public sector infrastructure project and to improve the interpretation of project risk profiles, and the integration of knowledge management concepts in risk management. The preference of the PPP procurement approach over traditional forms of project delivery often relies on the allocation of risk from the public to private sector and hence the focus on decision makers to ensure adequate evaluation and identification of risk transferred to result in value for money (in qualitative and quantitative terms). Improving the risk identification and elicitation of expert opinion steps in the risk management process of large public infrastructure projects assists project internal stakeholders in managing a successful process i.e. understand the risks that they need to manage in the planning and procurement phases in order to contribute to a successful outcome and giving

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[3] Initially, the word '*profiling'* was used. However, sensitivities that surround that word in modern day society have led to the use of the more benign '*characterizing*'. The word profile is used to refer to the overall risk tableau of a project – i.e. the project's risk profile.

confidence to decision makers that both the project approval and procurement mode selection deliver value for money. Therefore my research has focused on the PPP procurement delivery mechanism for the planning and procurement phases of large civil infrastructure public sector projects where there is both emphasis placed on the risk management tasks and concerns by public sector decision makers in ‘getting it right’.

Risks arise from somewhere. These are often termed the ‘sources’ or ‘drivers’, which have properties and depending on the value associated with the properties, what potentially could or could not be a risk driver is determined. In this thesis, characterizing is defined as a technique where a set of characteristics or attributes of a particular component within the various views (physical, process, participant, environment) of a project is inferred from past experience of members of an organization, the findings of researchers and/or analysis of data, to extrapolate information or improve decision making. In risk identification, of interest are those attributes, which can take on values, which are potential ‘drivers’, based on demonstrable cause-effect relationships. For example, consider the instance of project participant class stakeholder {Public Sector Client} who has a defined attribute {established practices/procedures} with values ranging from {minimal} to {established}. Where such an attribute value is identified as {minimal}, it is likely to extend the time of related client activities especially at the front end (process view). The attribute {established practices/procedures}, with a value of {minimal} becomes a potential risk driver for a number of potential risk events. The value, {minimal}, associated with it can assist with the identification of one or more related risk events, improve the clarity of the risk descriptions and add to the project’s risk profile by identifying the potential interaction of risks. I have shown how to model project context within a large infrastructure project and how one can characterize associated project attributes with particular attention to the stakeholder context and improve risk management during planning and procurement. Characterizing the components and associated attributes to represent the various views of a project can provide insights to a project team and improve the overall risk management process.

There were two key tenets in this research. The first was the assertion that the integration of risk information with key elements of the project could improve the overall risk management process (Nelms et al., 2006a,b) particularly in PPP projects (HM Treasury, 2004, p.9). The importance of context to develop the risk management process was also adopted in the AS/NZS 4360 Risk Management Standards and highlighted in the Enterprise Risk Management Guidelines (RMB, 2007), a framework for risk management in the public sector projects in British Columbia, Canada. The second tenet was that a highly structured characterization of project context and in particular stakeholders using information technology would result in a more comprehensive and accurate identification of risk and associated properties and ensure a more focused response in dealing with risks. This was based on the findings that stakeholders are a source of considerable risk particularly in the early phases of a project life. Primary benefits of risk management come from the identification stage (Bajaj et al., 1997) when it is performed early in the project (Walewski & Gibson, 2003). Characterizing stakeholder attributes and associated values as a dimension of project context modeling can give participants insight to improve the risk management process and related project management activities early in the project.

A partial prototype computer-based tool was developed to model project context (DeZoysa, 2006). This entailed identifying the environmental (both natural and man-made), organizational/

participant (project stakeholder), product scope and process views. DeZoysa's work on the architecture of the prototype tool provided few details on how best to describe the components in the various project views. I have focused on how to characterize different components, with particular emphasis on stakeholders, consideration of risks, and process and contractual steps in the public sector delivery of large infrastructure projects. Concepts have been tested and constructs added to the prototype to improve one or more risk management tasks during planning and procurement. This allowed me to test and validate the concepts in realistic settings of case studies and through semi-structured interviews with senior industry practitioners.

1.4 **Research Motivation: Challenges with Current Risk Management Approaches**

The quality of the risk management process carried out on infrastructure projects varies regardless of project delivery approach applied. A review of literature, industry experience, and discussions with construction industry professionals show that the process ranges from a project manager's spreadsheet with potential risk events (with no identification of risk sources, modes of failure or mitigation approaches) at the early stages of a project to a comprehensive risk database created by a full time risk manager responsible for its management. A major and complex challenge is to identify the many risk types, which include financial, economic, environmental, organizational, contractual, technical and political. At the start of my study, risk identification and quantification in large civil infrastructure projects was perceived as somewhat *ad hoc* (Tah, & Carr, 2000; Adams, 2006). Most often risks were considered in isolation even though in many cases they could be interrelated (Thomas et al., 2006). There was no readily available approach to synthesize data collected or apply knowledge from past projects. Hertogh & Westerveld (2010) in their study of international large infrastructure projects highlight the lack of exchange of knowledge on the management and organization of these project types. Work by Akintoye et al. (2003) summarized the results of an investigation of risk management in the U.K.'s Private Finance Initiative (analogous to a Public Private Partnership) projects, which highlighted relatively incomplete upfront project information, poor historic statistical risk data, and lack of risk information from previous projects in the form of a risk library. These deficiencies adversely affected the ability to meet value for money assessment requirements of the government sector. Tight time frames for data collection, analysis and decision-making, estimation of values for risk event likelihood and outcomes resulted in somewhat highly subjective estimates that were not easily reproducible. Following risk identification, risk events need quantification, allocation to the appropriate project stakeholder, and management such that project objectives and performance criteria (e.g. duration and cost) can be met. However, the complexity, number of risk issues and lack of a systematic, transparent and objective risk analysis approach made it difficult.

In my professional work, I have experienced firsthand the challenges of undertaking a comprehensive and transparent risk management process during the front end planning and procurement of public sector projects delivered both by traditional and PPP project delivery approaches. Stakeholder generated risks, especially those internal to the sponsoring and delivery organizations, are often rarely considered and these became a major part of my research. Management consultants were hired to assist with and monitor the project risk management process. The challenges outlined have been real and their products met the prescribed intent of performing risk management, yet leaving the feeling of opportunity to further improve and integrate the risk tasks with other project management activities.

I consider that the intent of the risk management process performed early in the project is to develop a project risk profile and manage positive and adverse risk events in subsequent phases. In many cases, it seems that attendance at risk identification/quantification workshops or receipt of a consultant's report are unsatisfactory because they have involved 'high level' general management treatment that leaves challenges unidentified and have been rushed by looming time constraints. Many risk management exercises seem to have been undertaken to achieve third party approval or auditing requirements rather than to develop a document and plan that will be useful in later phases of the project. From my experience, I consider that there is much room for improvement and that many project participants continue to worry whether or not they have identified the most significant risks, their drivers, associated properties, and appropriate responses. Both the academic and industry literature contain few cases that compare what was thought to happen with what actually happened, so learning of the success (e.g. forecast = actual) of the risk management process tends to be flat. Authors in the construction industry literature and other professionals seem to acknowledge that risk management is integral to the project management process, but many challenges remain and there are few tools to integrate risk management with project management. There are many opportunities for risk transfer in PPP projects to increase value for money over traditional procurement approaches, but both academia and industry question the degree to which they 'got it right' in carrying out the risk management. Clearly new research efforts are timely.

1.5 **Research Questions and Objectives**

My research addressed two of De Zoysa's (2006) questions in re-posed form as set out in the following subsection. In their original form, De Zoysa's questions were:

1. How should the relationship between project context and project risks be represented and how should the project context be modeled?
2. How should representations of project risks and their relationship with project context be exploited to gain insights for decision making, and in support of this, what querying, reporting and visualization functions are of use?

Arising from these questions, and aided by previous work (Russell & Udaipurwala, 2004), a multi-view representation of a project was enhanced and extended to treat the environmental (natural and man-made) and risk views of a project (De Zoysa, 2006; Wang, 2005). I have extended the usefulness of the organizational/participant view of a project by adding content, testing ideas and validating associated attributes. In addition, I have tested the concept of using risk drivers to make associations between view components and a grouping of like risks, called a risk issue, so that individual risk events could be defined that corresponded to the existence of one or more risk drivers at a particular project location or at a particular point in time. Information and its associated level of detail and format discussed in chapters 5 and 6 have been drawn upon to test the prototype for industry applications. Inputting case study information to test the prototype resulted in a number of assumptions about drivers at the event level to be restructured such as the sharing of locations at the event versus issue level. Greater refinement is now possible because one can examine attributes and their values for a risk driver to confirm risk driver status in the temporal and spatial context. The interface of the prototype has also been adjusted to improve the transparency and viewing of multiple screens and content to facilitate improved risk identification sessions. The visualization of risk data, although further enhanced in the prototype, has not been exploited in the thesis because of the focus on exploring process and stakeholder aspects of the planning and procurement phases. DeZoysa's work contributed to answering questions 1 and 2, but it was determined that much work remained to be done particularly with respect to question 2.

I have reposed De Zoysa's questions (1) and (2) and further questions were developed to provide guidance for my research. My focus was to move beyond the architecture of the prototype tool and introduce the concept of *characterizing* (as indicated previously, the word profiling was initially used, but it is not well received in the public sector) and as a way to explore how best to describe the components in the various project views, in particular the stakeholder view. *My work has provided ways to improve the risk identification and elicitation of risks and associated properties in the planning and procurement phase of large infrastructure projects by introducing support tools and approaches to elicit and gather better quality project stakeholder, process and risk data for input into an enhanced research prototype.*

1.5.1 Research Hypotheses

The research hypotheses (and reference to related chapters) guiding my research included the following:

H1. The processes of risk identification and elicitation of risk properties can be improved using specific methodologies and tools; in particular a characterized project context. {Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects; Chapter 6 – A decision support approach for the identification of project objectives and improved decision making; and Chapter 7 – An integrated risk management process: a prototype application}

H2. A risk management process in the front-end planning and procurement phases of a project is integral to contributing to the planning of other project management activities and critical decision-making. {Chapter 2 – Characterizing Canadian large infrastructure public sector projects}

H3. Characterizing the components and associated attributes used to represent the various views of a project can provide valuable insights to project managers and improve the overall risk management process. {Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects; Chapter 6 – A decision support approach for the identification of project objectives and improved decision making; and Chapter 7 – An integrated risk management process: a prototype application}

H4. Stakeholders are a major source of risk and there is a direct link between stakeholder attributes and the likelihood and impact of risk events. {Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects}

H5. The risk management tools and techniques available to project participants do not meet current practitioner needs for large infrastructure public projects. {Chapter 3 – Risk management in the front end planning phase: lessons of a large infrastructure public private partnership project; Chapter 4 – Key risks managed in the procurement of the first Canadian federal real property public private partnership project}

1.5.2 Research Questions

Three critical research questions being pursued in this thesis are:

1. How can modeling project context improve the processes of risk identification, and elicitation of risk properties for large public sector infrastructure projects in the early phases of a project?
2. What are the user objectives that must be considered in order to develop a practical workable approach to risk management in the planning and procurement phases of a large infrastructure public sector project?
3. How can one best model project context and specifically characterize stakeholders given the objectives identified in Question 2 in such a way that it is of value, succinct and addresses the time and resource constraints experienced on large infrastructure projects?

A fourth related question, not fundamental to but of importance to this thesis relates to the role of Information Technology in the risk management process is:

4. What are the potential roles for Information Technology in the design of a support tool for real time risk identification and elicitation of expert opinion sessions?

In responding to these questions, the primary goal of this research is to develop a framework/approach that will assist a user early in the project lifecycle in identifying project risk events, drivers of those risk events along with capturing and modeling risk related knowledge for current and future project use. Understanding project stakeholders, including *their role and objectives, is central to the framework/approach and tools are presented to do so for large infrastructure public sector infrastructure projects.*

1.5.3 Research Themes, Objectives and a Reader's Guide

The following section provides a guide to the reader in navigating the three research themes and nine objectives of this thesis. Each chapter is defined as either *core* or *support* in responding to the goal of the thesis.

Support chapters provide an overview of the public sector large infrastructure project delivery environment including the unique problems and aspects of interest, which drive the need for the structured risk approach and tools. *Support* chapters include:

- Chapter 2 – Characterizing Canadian large infrastructure public sector projects;
- Chapter 3 – Risk management in the front end planning phase: lessons of a large infrastructure public private partnership project; and
- Chapter 4 – Key risks managed in the procurement of the first Canadian federal real property public private partnership project.

Chapter 2 is an overview of the complexities involved in the delivery of these large infrastructure projects and Chapters 3 and 4 are project case studies further defining aspects of interest in the front end planning and procurement phases of project delivery. These case studies provide details on the rationale driving the need for the framework/approach and research prototype introduced.

Core chapters provide a description of the structured risk approach/framework, the research prototype and supporting tools. *Core* chapters include:

- Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects;
- Chapter 6 – A decision support approach for the identification of project objectives and improved decision making;
- Chapter 7 – An integrated risk management process: a prototype application; and
- Chapter 8 – Validation results.

Chapters 5 and 6 introduce tools that support the framework/approach and provide project examples on how these tools may be implemented in practice and populate aspects of the research prototype. Chapter 7 provides a description of how one may effectively address the issues identified in the *support* chapters in a structured manner using the framework/approach and research prototype introduced. The perspective of potential users, senior public and private sector executives, and their views on the potential of the research prototype to improve project risk identification and elicitation of risk properties is presented in chapter 8 and provides additional insight and validation of the research contributions.

The purpose of the research is to provide insight on: a. Processes and risks encountered in the delivery of a public sector large infrastructure project prior to project award (Chapters 2, 3, and 4) ; b. Strengths and weaknesses of state-of-the-art processes and tools available to carry out risk management and associated challenges in large infrastructure projects (Chapters 2, 3, and 4) ; c. Multi-dimensionality of stakeholders and decisions involved in public sector project delivery (Chapter 2, 5 and 6); and d. Concepts and constructs developed to improve risk management processes applied in a prototype computer system (Chapter 5, 6 and 7). The objectives of this research and motivation for their treatment are highlighted under three research themes as follows:

1.5.3.1 Research Theme 1 – Risk Management Practices and Challenges in Large Infrastructure Public Projects

Activities and stakeholders involved in the delivery of large infrastructure projects by the public sector differs from that of a project delivered by a private sector entity due to a number of factors including the political environment, legislative and compliance frameworks, and organizational complexity and multi-faceted mandates. The thesis focuses on providing insight into the characteristics, processes followed, risks and stakeholders involved in a public sector large infrastructure project in pursuit of the following objectives and research hypotheses H3, H4, and H5:

- O1. To characterize unique aspects of large infrastructure PPP delivery by a Canadian public sector entity;
- O2. To define the stakeholders and typical tasks performed in the front end-planning and procurement phases of public sector large infrastructure project delivery process;
- O3. To gain a better understanding of risk management approaches employed by industry practitioners in major public sector projects including the constraints faced, process carried out, tools/techniques employed and synergy with other project management activities.

Chapters that cover this research theme include:

- Chapter 2 – Characterizing Canadian large infrastructure public sector projects;
- Chapter 3 – Risk management in the front end planning phase: lessons of a large infrastructure public private partnership project;

- Chapter 4 – Key risks managed in the procurement of the first Canadian federal real property public private partnership project; and
- Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects.

1.5.3.2 Research Theme 2 – Approaches to Support Elicitation of Risk Information to Improve Risk Management Processes

Various sources of information are required to provide an integrated view of a project and populate the risk prototype tool discussed in Research Theme 3. Two approaches/frameworks are developed to assist users in creating quality input information specifically with respect to Project stakeholders and their objectives. Each of these aspects is critical in the management of risk – stakeholders with respect to drivers and their objectives with understanding their perspective of consequences of risk events. Stakeholders can be a significant source of risk for a project, in particular in the planning and procurement phases of a public sector large infrastructure project. The scale and scope of these large public sector projects require considerable levels of oversight and involvement of decision makers and tend to generate significant public interest. Understanding the multidimensionality of stakeholder involvement and their objectives in public sector large infrastructure projects is the focus of the following objectives in the thesis and research hypotheses H1, H2 and H4:

- O4. To characterize stakeholders involved in a Canadian federal large public sector infrastructure project, using a PPP project as a specific case;
- O5. To gain a better understanding of how stakeholders contribute to the risk profile of a project and develop attributes for classes of project participants and associated values that may be used in the approach formulated based on literature and direct observation; and

- O6. To develop and apply an approach to elicit project objectives that may be utilized in multiple stages of project delivery.

Chapters that cover this Research Theme include:

- Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects; and
- Chapter 6 – A decision support approach for the identification of project objectives and improved decision making.

A related chapter but which does not directly address the objective outlined in this research theme include:

- Chapter 7 – An integrated risk management process: A prototype application.

1.5.3.3 Research Theme 3 – Developing and Gauging the Effectiveness of a Prototype Integrated Risk Management Tool

An information technology (IT) approach and supporting tool can concurrently improve upon current risk identification processes and expert opinion elicitation tasks in the planning and procurement phases of a large infrastructure project through the modeling of project context in a structured fashion. A multi-view representation, with emphasis on the stakeholder view, of a project in terms of hierarchical structures of components to manage and reuse risk related information and knowledge is introduced and demonstrated to show how it may be used in practice. Relevant objectives are as follows and related research hypotheses are H1 and H3:

- O7. To enhance features of a project management research prototype to demonstrate the value of the ideas and concepts developed to improve the risk identification and elicitation of expert opinion approach addressing identified weaknesses and to further improves current practices;

- O8. To implement characterizing in a practical way to assist with the risk identification and elicitation of expert opinion in the early planning phases of the project lifecycle.
- O9. To demonstrate the application of the approach and its response to tests that reflect industry needs as set out at the forefront of the thesis and current practice shortcomings.

Chapters that cover this Research Theme are:

- Chapter 7 – An integrated risk management process: a prototype application}
- Chapter 8 – Validation Results

  Chapters related but which do not directly address the objectives outlined in this research theme include:
- Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects; and
- Chapter 6 – A decision support approach for the identification of project objectives and improved decision making.

1.6 **Research Scope**

Here I provide a succinct statement of the scope of my research work and as elaborated upon in the previous sections of this Chapter. The scope of work has been bounded to the following:

- The focus of the approach is on the project planning and procurement phases for a large public sector infrastructure project, prior to the award of a construction contract;

- The procurement delivery mechanism considered to provide context of the activities, process stages and stakeholders of the planning and procurement phases is for a public private partnership (PPP) delivered by a Canadian federal public sector entity;
- The primary perspective is that of a Canadian federal public sector project sponsor with signing authority for contract award for the design and construction phase;
- The approach is applicable for all project types; however, testing of the approach will be performed on large civil infrastructure project types; and
- The academic literature review that has been conducted in this research has focused on the treatment of risk management in civil engineering, specifically, civil infrastructure projects.

1.7 Research Methodology

The research methodology used in pursuing the foregoing research questions and achieving the research objectives consisted of a multi-part methodology comprised of a combination of investigation, observation, professional experience and a literature review. The components included four phases:

- Phase 1 Problem Definition/Literature Review
- Phase 2 Case Study Investigations
- Phase 3 Risk Management and Support Approach Development
- Phase 4 Research Validation

A series of research test questions were developed and informed from the findings in Phase 1 and Phase 2 and were applied in Phase 4. A description of each of the research methodology phases follows:

1.7.1 Phase 1 - Problem Definition and Literature Review.

Phase 1 involved the identification of research context and limitations (shortcomings) of current risk management processes through observations of current practice and literature review. Outputs of this phase included the identification of basic shortcomings of current processes and constraints and the realities of industry requirements and practices in performing risk management tasks in the front end phases of project delivery.

The research topic is interdisciplinary and required a comprehensive literature review that encompassed a range of fields outside engineering. Fields reviewed included risk management, project management, management sciences, and risk and decision theory areas of sociology and psychology. This broad, yet comprehensive, review of relevant industry and academic documents was used to bring solutions applied in other disciplines to an engineering problem. Practitioner literature reviewed included (1) Best practices and government guidelines, policy and regulation on public private partnership project delivery; and (2) Government and industry risk management policies and guidelines as they relate to the delivery and/or operation of large civil infrastructure. Practitioner literature extended outside of Canada to countries including the UK, Australia and India where best practices on large infrastructure delivery are well known by industry practitioners.

There is a considerable amount of academic literature treating risk management outside the field of construction such as in the fields of health, decision analysis, and environmental management. The academic literature review that has been conducted in this research focused on the treatment of risk management in civil engineering, specifically, civil infrastructure projects. The areas of the academic literature that I have focused on included: (1) categorization and aggregation of risk elements including risk response strategies and drivers; (2) tools to assist with the risk identification and elicitation of expert opinion (this has involved some study of the literature from a number of fields); (3) accommodation of a diversity of project stakeholders (financiers, planners, engineers, architects, facility maintenance providers, etc.) and associated diversity in disciplines; (4) treatment of both qualitative and quantitative data; and, (5) limited review of the application of knowledge management in civil infrastructure..

1.7.2 Phase 2 - Case Study Investigation.

Phase 2 of the research included case study investigation working closely with public sector organizations in the construction industry. Organizations involved in the research included Public Works Government Services Canada (a Canadian federal entity) and Canada Line Rapid Transit Inc (an entity related to a Canadian provincial entity). Each of these organizations has been involved in the procurement and delivery of PPP infrastructure projects representing public sector interests. In these case studies, I have performed semi-structured interviews and had direct interaction with professionals involved in the delivery of these large infrastructure projects and have carried out a careful assessment of the processes used for risk management, including the identification and elicitation techniques, tools utilized to assist in the process and knowledge management concepts applied. Outputs of this phase included the identification of the challenges which exist performing risk management in the front end planning and procurement phases of PPP projects, collection of data to formulate input for the prototype tool and supporting approaches, and confirmation of shortcomings of current approaches.

Informal and formal discussions with industry practitioners in senior executive positions (Vice President, Chief Executive Officer, Director General, etc.) with seasoned involvement in the procurement and delivery of PPP projects from a number of public and private sector organizations was used to ground the research relative to industry risk management best practices, strengths and challenges. Practitioner literature on the PPP procurement mode, and the treatment of risk, is constantly evolving as reflected in the state of flux in practitioner literature. This is particularly the case as more and more large Canadian infrastructure projects are delivered via this delivery approach and industry practitioners refine best practices and the industry norm to reflect lessons learned. Direct interaction with practitioners and first hand observations gained from over ten years of professional experience related to project planning and delivery informed the research with respect to gaining a better understanding of different stakeholder values and objectives. My specific focus was on:

- The objectives and interests of different stakeholders involved in a large infrastructure project;
- Primary risk issues of concern to multiple project participants in the front end Project planning with respect to the financing, organizational, contractual, construction and operations and maintenance process dimensions of a project;
- Current techniques and approaches used for the risk identification, communication and the monitoring and tracking of risks prior to contract award; and
- Current challenges in carrying out the risk management process in the evaluation of or delivery of large infrastructure projects with a particular emphasis on those projects delivered via a PPP.

Findings from the case study investigations assisted in providing insight into the development of new approaches outlined in Phase 3.

1.7.3 Phase 3 - Risk Management and Support Approach Development.

Phase 3 involved formulating ideas, exposing them in different forms to practicing professionals, some testing of the ideas and concepts in the form of peer reviewed conference papers and the research prototype. Output included the development of two support approaches and an enhanced prototype to support risk management tasks in the front end planning of large infrastructure projects. Concepts and processes developed were implemented into the prototype system and tested with practitioners in controlled cases to enhance it with respect to those aspects of interest. Specifically, in one project a multi-view representation of the project context and a comprehensive risk register was developed to test ideas, and for use in the validation and review stage of the research.

1.7.4 Phase 4 - Validation.

A series of semi-structured interviews with senior industry executives was performed to assess their view on the application of the prototype in their projects, issues and opportunities for knowledge management and integration with other project management tasks. Validation was tested relative to a series of research test questions developed. Feedback obtained from the testing exercise was used to refine the concepts and highlight practicality of its application in practice to improve the identification of risk events, respective values and the management of knowledge for reference in the future.

1.8 **Research Test Questions**

A series of tests, expressed as questions, have been developed to apply to the approach and enhanced prototype tool in order to test the fit with shortcomings of current industry approaches and the unique characteristics and requirements of the industry. The attributes of the research tests for assessing whether the prototype tool and approach address the identified weaknesses of current state of the art risk management aids are defined as generality, integrative, transparent and new. The research test attributes, questions and their metrics used in the validation exercise are outlined below.

1.8.1 Generality

The approach can be considered general (i.e. broadly applicable) if it has the ability to be applied across a variety of problem scenarios such as across a range of project types and project delivery mechanisms.

Questions:

- Do you see opportunity to apply this tool on your projects and across a variety of project types (Real Property, IT, other)?

Metrics:

- Subjective rating by experts about the 'generality of the approach'
- Number of project types that can apply the approach with respect to project size, delivery approach, and types.

1.8.2 Integrative

The approach can be considered integrative if it has the ability to foster the integration of data currently available to Project personnel into the approach and data entry fields are unambiguous to individuals across disciplines.

Questions:

- Are the data fields comprehensive to meet your needs? (An important issue is the willingness of project personnel to define relevant data fields and then populate them with values – e.g. ability to define attributes of interest, and then assign values as a function of project context)
- Do you feel that you can input available project data into the system?

Metrics:

- Subjective assessment by the experts about the usability of data fields for integration of current information available.

1.8.3 Transparent

The approach can be considered transparent if the approach fits with processes and practices performed by practitioners including the ability to accommodate multiple linguistic styles, values and means of expressions by individuals across disciplines.

Questions:

- Do you feel users across disciplines would be able to use the system?

Metrics:

- Subjective rating of experts about the 'fit for purpose' of the approach for practitioners across disciplines.

1.8.4 New/ Value Add

The approach can be considered new if it is assessed as adding value such as providing insights not readily available from current practice and results in improved risk management such as greater completeness in risks identified, better understanding of reasons for them, better and more complete assessment of impacts (type and value) etc..

Questions:

- Does the approach offer value or an improvement relative to current practice?

Metrics:

- Subjective rating of the experts on the 'value' and 'newness' of the approach in providing insights;
- Number of tasks or process steps assisted by the experts that are not explicitly carried out in current practice.

1.9 Thesis Structure and Overview of Contributions

The following section provides a summary of each of the chapters that comprises this dissertation.

Chapter 1 - Introduction

This chapter presents the motivation for the research, research objectives, boundaries with respect to the scope of work and research tests that will be applied. The public sector client perspective in performing the risk management steps is taken in conducting this research.

Contributions that arise from this chapter include a current perspective on industry practice and challenges in carrying out risk management tasks in large infrastructure public sector projects.

Chapter 2 - Characterizing Canadian large infrastructure public sector projects

This chapter provides an overview of the unique characteristics of the public sector and the risk management practices carried out by public sector entities in the front-end planning stage of the project lifecycle of large public infrastructure projects. An overview of the complexities of public sector large infrastructure projects including the unique characteristics of the public sector as a procurer and manager of the project delivery process relative to its private sector counterpart are discussed.

Contributions that arise from this chapter are three fold. First, characteristics to describe a large public infrastructure project in Canada. Second, a description of the PPP project delivery mechanism employed in the Canadian federal context is outlined. Thirdly, an overview of the factors that differentiate, at the operational level in the delivery and management of a project in the planning and procurement phases, the public and private sector are described to further understand the context and complexity of the public sector client environment to which the thesis framework is developed.

Chapter 3 - Risk management in the front-end planning phase: lessons of a large infrastructure public private partnership project

This chapter first summarizes the state of the art in risk management processes, including commercially available software tools, based on a review of academic and industry literature. A case study of the Canada Line Rapid Transit Public Private Partnership (PPP) project to serve as a means to describe in detail the risk management process performed on a public sector PPP project and the associated strengths and challenges identified by practitioners involved in identifying risks in large infrastructure PPP projects. Findings provide useful insight to understand the shortcomings particularly relative to industry practitioner needs.

Contributions that arise from this chapter include a fulsome description of the risk management process undertaken by a public sector entity on a Canadian large infrastructure PPP project including a description of how a risk register was developed, its content, practitioners' perspective on the strengths and weaknesses of the process and its application managing various reporting and accountability requirements at the project and organization level. This chapter informs chapters 5, 6 and 7 on the good practices that should be imbedded in processes and issues/objectives useful to address to improve risk management practices.

Chapter 4 - Key risks managed in the procurement of the first Canadian federal real property public private partnership project

Chapter 4 provides a description of risks managed in the front end planning stage by a Canadian public sector entity implementing the first federal real property PPP in Canada for the delivery of a large infrastructure project. Risk issues identified include both those explicitly identified upfront in the Project risk register in addition to those not explicitly identified but mitigation steps taken to reduce potential adverse impacts. This chapter highlights the multitude of stakeholders involved in the front end planning stage, how these stakeholders responsible for the review, implementation or approval drive risks and the consideration of both risks managed at the Project and organizational level on these large infrastructure projects.

Contributions that arise from this chapter include a description of key risk issues identified in the front end planning and procurement phases of a project, which if not dealt with due consideration could ultimately result in the failure of a Project. These risk issues tend to either not be acknowledged or identified in industry and academic literature due to the qualitative nature and early stage in which they occur.

Chapter 5 - A stakeholder management framework for application on large infrastructure public sector projects

Chapter 5 introduces a stakeholder management framework for application on large infrastructure real property projects including how this task may be integrated with the risk management process. Observations, data from a federal large infrastructure project and feedback from industry practitioners and senior federal executives served to guide the development of the framework. The framework includes templates or tools for each stage of the stakeholder management process that may assist users to identify stakeholders, their interests and relations with project objectives. The framework serves to support users involved in risk management tasks input data into the 'Participant' View of the Prototype tool and/or consider the Project risks driven by the multitude of stakeholders involved in the planning and delivery of large infrastructure projects.

Contributions that arise from this chapter are twofold. First, a standalone stakeholder management framework is developed for application to the decision making environment and reporting requirements on large infrastructure public sector Canadian projects, which is of direct benefit to practitioners. Second, the framework directs ways in which stakeholders may be characterized informing chapter 7.

Chapter 6 - A decision support approach for the identification of project objectives and improved decision making

This chapter introduces a decision support approach designed for application on large public sector infrastructure projects and provides context of the respective project delivery decision environment including a motivating example of a failed decision process. The approach focuses on the identification of stakeholder objectives including multiple decision criteria and elicitation of performance metrics. Clarification of stakeholder objectives serves in performing risk management process tasks such as information and risk identification, analysis and allocation to appropriate project participants. The multiple decision criteria and performance metrics elicited from senior executive decision makers of a public sector entity are identified for a large infrastructure project in a decision problem to illustrate the application of the approach and opportunity to improve decision making processes and associated overall project risk management.

Contributions that arise from this chapter are twofold. First, a standalone decision support process and its application on a key decision in a large infrastructure project delivery process, site selection, are illustrated. The approach improves how practitioners manage risks at key decision points over the course of project delivery. Secondly, the approach assists the user collect inputs that populate information requirements for risk management tasks outlined in chapter 7 including the identification of stakeholder objectives, differences across stakeholder objectives and the development of relevant consequences/outcomes to assess risks against.

Chapter 7 - An integrated risk management process: a prototype application

Chapter 7 introduces a process and prototype to improve the risk management and decision-making processes carried out on large infrastructure public sector projects. First, the concept of characterizing Project context as it is applied in this research is introduced followed by a detailed framework that involves characterizing the components and associated attributes used to represent the four views of a project. These four views include the physical (what will be built), process (how it will be built including schedule), participant (organizations and individuals involved) and environmental (the natural and man-made environments in which it is being built). The application of the concept of characterization in the stakeholder view of a large infrastructure public sector project is then provided in further detail, as it is the focus of the research. How this framework can provide valuable insights to project managers and improve the overall risk management process is then discussed. An example from a large infrastructure public sector PPP project is used to illustrate application of the prototype at the front-end planning stage.

Contributions that arise from this chapter include a process to elicit expert opinion using an integrated view of the project context to populate an IT prototype and improve risk management tasks including identification, assessment and response to project risk events. In addition, this chapter introduces the concept of characterizing project attributes, with specific focus on stakeholders, and how this concept may be applied to improve the quality of risk management tasks.

Chapter 8 - Validation Results

This chapter describes the results of semi-structured interviews with senior executives of both the public and private sector to assess their view on the application of the prototype, the concept of characterization of risk attributes in their projects, issues and opportunities for knowledge management and integration with other project management tasks. This chapter serves as the validation of the research performed.

Contributions that arise from this chapter include a description of senior industry practitioners thought processes, features they like and dislike with the proposed approach and risk management practices in general on large infrastructure PPP projects.

Chapter 9 - Conclusion and Contributions

This chapter outlines conclusions, contributions made from this research and recommendations for future research.

Chapter 2: **Large Public Sector Infrastructure Projects**

This chapter presents an overview of the complexities involved in the delivery of large Canadian public sector infrastructure projects and relevant descriptions of the scope of work pertaining to the thesis. The thesis case studies, methodology and approach are specific to the Canadian context. However, the approach and lessons learned to improve risk identification and elicitation of expert opinion are applicable in other jurisdictions. It is well understood that the delivery of projects across construction industry sectors, organizations and international jurisdictions differs and there is no unified terminology that is applied consistently across the field. This chapter therefore describes the following key areas that bound the thesis and establishes its context as illustrated in Figure 1:

Infrastructure Projects: The identification and management of risk is applicable for all project types ranging from small infrastructure projects to large ones. The development and testing of the approach will be performed on a large civil infrastructure project type and therefore, characteristics, or attributes, of large infrastructure projects are defined.

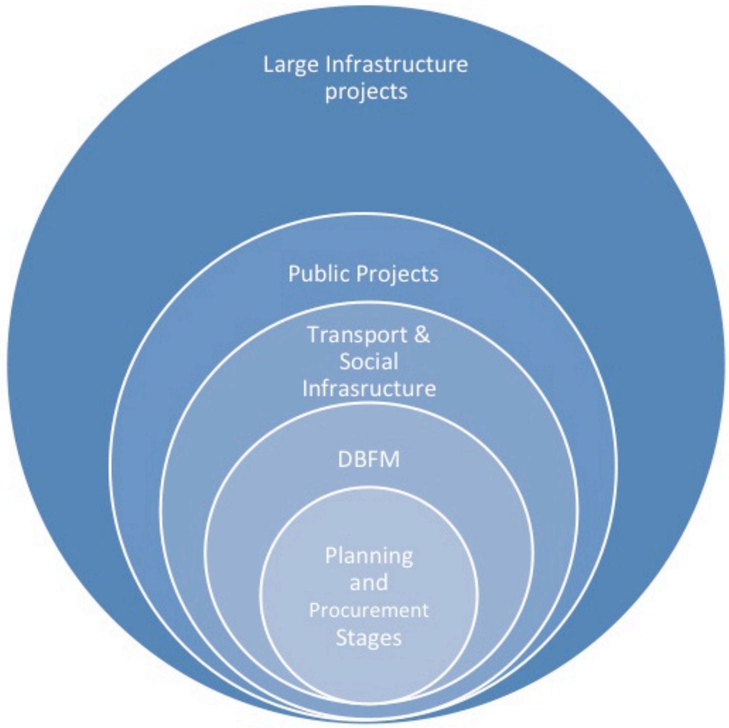
Organization: There are various perspectives in which the identification and elicitation of expert opinion of risk pertains in the delivery of large infrastructure projects, ranging from the user, Project Sponsor (Owner/Client), contractor, or the public at large among others. The primary perspective is that of a Canadian federal public sector project sponsor with signing authority for contract award for proceeding with the final design and construction phase. Differences across the decision-making, governance and project delivery environment of the public and private sector are outlined further in this chapter.

Construction Segments: The construction industry may be broadly or narrowly defined into a number of segments. Each industry segment has both similarities and differences. The construction segments for which the approach is developed is that of the Transport and Social Infrastructure segments due to frequency of project segment delivery relative to other construction segment project type by the identified public sector entity.

Delivery Mechanism: Large public sector infrastructure projects may be delivered using a number of procurement delivery mechanisms ranging from a Design Bid Build (DBB), typically identified as a traditional public sector form of delivery through to a Design Build Finance Maintain (DBFM), typically termed broadly a public private partnership (PPP). The procurement delivery mechanism considered herein, providing context for the activities, process stages and stakeholders of the planning and procurement phases, is for a public private partnership, specifically a DBFM, delivered by a Canadian federal public sector entity.

Project Life Stage: Large infrastructure projects are delivered across a number of project phases notably front end planning and procurement, design, construction, infrastructure use and end of life. The focus of the approach is on the Project front end planning and procurement phases for a large infrastructure public sector project and prior to the award of a construction contract.

Figure 1: Illustration of thesis scope context



2.1 Defining Large Public Infrastructure Projects

Characterizing or defining a Project as a certain 'type' is a difficult task as there are a myriad of characteristics, definitions and associated interpretations applied in the construction industry. Generic approaches used to characterize projects include those of Obeng (1994) and Shenhar & Dvir (2004). Obeng (1994) considers the clarity of both the stakeholders and organization on both what is required to be carried out and how to do it. Shenhar & Dvir (2004) developed a framework termed the NTCP model to help understand the nature of the project and identify gaps relative to current capabilities based on an assessment of project complexity, novelty, technology and pace. In the case of large infrastructure projects, there is a number of synonymous terms to describe large infrastructure projects used in popular media, academic and industry papers including Mega projects, Major Projects, superprojects and large-scale. Although multiple terms are used, there is no one universal definition and characteristics vary. For example, Fiori & Kovaka (2005) define mega projects as "A construction project, or aggregate of such projects, characterized by: magnified cost, extreme complexity, increased risk, lofty ideals, and high visibility, in a combination that represents a significant challenge to the stakeholders, a significant impact to the community and pushes the limits of construction experience.". Others, such as Frick (2008) characterize transportation mega-projects according to the 'Six C's' (Colossal, Captivating, Costly, Controversial, Complex, Control), characteristics that are also applicable to describing large infrastructure in other sectors. In this thesis, a large public infrastructure project may be broadly characterized by the participation of multiple stakeholders with differing value systems, technical complexity, aggressive and multi-year schedules and uncertainty in budgeting.

Characteristics to describe a large public infrastructure project in Canada are stated below for purpose of the thesis. Understanding the attributes of these large projects provides context of the complexity and scope relative to their smaller cousins. These attributes have been drawn from observations based on my professional experience executing these projects for public sector entities and a combination of attributes identified by a number of authors researching the field (Merrow, 1988; Miller & Hobbs, 2005; Bruijin & Leijten, 2008; Frick, 2008; Flyjberg et al., 2009). A range of attributes may characterize large infrastructure public sector projects; however, in this thesis the following seven attributes are selected as being pertinent and reflective of large infrastructure projects in Canada:

1) Unique

2) Broad Scope and Capital Dollar Size
3) Dynamic Stakeholder and Governance Network
4) Project Risk Profile
5) Long Front End Planning Timeline
6) High Political Partisan Participation
7) Highly Visible and Iconic

Unique: Large infrastructure projects are generally one-off projects in which the public sector organization and in many cases local industry professionals have limited experience. Participating in an individual large infrastructure project often occurs only once in a career for both public and private sector participants (Flyvbjerg et al., 2009). These projects may involve the consideration (by both the public sector and their private sector consultants) of new innovative technologies, design, materials or construction practices.

Broad Scope and Capital Dollar Size: The nature of large infrastructure projects tends to involve complex phasing, design solutions and financial scope. The project may be a bundling or aggregation of a number of projects of sufficient scope, typically in the order of capital costs that exceed $100 million in the Canadian context. Dollar values in the order of $500 million have been used to characterize mega-projects (Merrow, 1988); however, the lower dollar value is deemed appropriate to represent what Canadian public and private sector practitioners discuss as 'large'. This value is not inclusive of the related budget required to cover the project front end planning that may evolve over a period of a decade resulting in costs rising considerably. A study of over 60 large infrastructure projects found that the cost of the development phase to fund consultants, preliminary investigative and design work, project management and administration can reach 33% of the total budget (Miller & Hobbs, 2005). Large infrastructure projects are consistently underestimated and delays and exaggerated benefits are the norm due to a number of factors including for strategic and tactical reasons to improve business or political position or pleasing the hiring or proposing organization (Flyvbjerg et al., 2009). Overall, these large projects require considerable financial investments and related due diligence to ensure appropriate accountability and performance monitoring relevant to the broad scope and size.

Dynamic Stakeholder and Governance Network: Large infrastructure projects involve a complex network of public and private sector project participants often from multiple national, international, public and private sector organizations. The stakeholder list is often long and complex including the public at large and professionals representing sponsors, financiers, contractors, designers and developers across professional disciplines. It is common that the cross cultural and multi discipline project team members differ in their values such as how they make work-related and communication related decisions and practices including the level of centralization of authority, level of formalization of communication and the depth of the organizational hierarchy (Horii et al., 2005). In addition, different oversight parties providing infrastructure funding and governing project sponsors create a web of decision makers with differences in their interests and communication requirements. Within each of these participant organizations there are often participants (both groups or individuals) involved who have different, sometimes competing agendas both across and internal to an organization. Particular governance challenges arise where the multiple organizations serve as project sponsors or share the accountability for key project aspects such as joint funding (Ward and Chapman, 2008).

Differences in the organizational and cultural environment, project experience at the organization and assigned personnel level create a challenging environment for efficient, effective project controls and governance.

Project Risk Profile: Long time lines, diverse stakeholder involvement, broad financial and technical scope in the development, design, construction and operation phases expose a large infrastructure project to a series of risks that would not typically be seen in combination in smaller scale projects. In addition, large infrastructure projects typically monopolize considerable resources (human and financial) of the sponsoring organization and at an enterprise level require both tactical and strategic level consideration of the project on the organizational mission. For example, Miller & Hobbs (2005) found that regulatory or institutional changes were a critical part of the development process in 63% of the 60 large infrastructure projects studied.

Long Planning and Procurement Timeline: The front end planning stage of the project may develop over a long period of time, on average 7 years based on a research study by Miller & Hobbs (2005) and over a decade by Flyjberg el al. (2002). Based on my experience as a senior infrastructure director to a number of Canadian federal departments, large infrastructure projects can be in the planning stage for a decade, sometimes longer. For example, the case discussed in chapter 3 involving the delivery of a large transportation project, the Canada Line Rapid Transit Project, the project was identified as a solution to the regional transportation requirements over ten years prior to the construction start date (CEACA, 2004). Further, the case discussed in chapter 4 involving the first Canadian federal PPP large infrastructure real property project the front end planning stage was initiated over 20 years prior to the procurement. Large infrastructure projects can monopolize a significant portion of an organization's budget and present political challenges as the agenda of the leading political champion may change. In addition, over this long time period, the mandate of the organization leading or being the ultimate user may itself evolve in the front end planning phase resulting in changes in problem definition and appropriate strategy selection.

High Political Partisan Participation: The scale and scope of large infrastructure projects tend to have broad financial, social and environmental impacts at the local and national levels and often a high profile within the sponsoring organization and governing authorities. These projects therefore tend to be highly notable and attract political attention. The impact of the project is under scrutiny from various perspectives including financial, environmental, technical and social acceptability including for example potential to disrupt operations of nearby businesses, impact on the physical and built environment and economic development to a region. Political representatives from multi-levels of government (federal, provincial, territorial, First Nations and municipal) representing citizens become key participants depending on the reach of the Project as representatives of their constituents and/or in combination as project funders with public monies. The support of a political champion is identified as a condition essential to success specifically the tenure of the political sponsor and that there is no change in political will (NAP, 2000). Lack of support or alignment can result in extended time lines and inadequate financial resources to respond to concerns, perform necessary consultation, and communicate requirements and feasible technical/financial options under consideration. In some cases, lack of political support may result ultimately in the termination of the project.

Highly visible and iconic: Large infrastructure projects are typically under scrutiny with respect to both the technical and financial solution proposed. Aesthetics and 'fit' with the surrounding built environment become issues of interest by various project stakeholders. The scale and impact of these large projects also attract desires to use the project to symbolize the values (such as environment sustainability or design ingenuity) of the nation or region of impact. There is a tendency for a range of project participants, including those reviewing the project need, to desire to shape the infrastructure project as a public landmark or 'history in the making' demanding 'extras' in design, construction and operation/maintenance elements that push the project complexity and base budget and schedule in ways blind to the impact on the mantra 'on time, on budget' (Frick, 2008).

2.1.1 Factors Influencing Large Infrastructure Cost and Schedule Growth

The complexity, size and multi-year nature of the planning and delivery of large infrastructure projects makes it difficult to point to any one or combination of drivers for cost and schedule growth. Flyvbjerg et al. (2009) highlight a number of studies by authors that illustrate the commonality of major projects having cost overruns and that executives typically attribute underperformance to "numerous uncertainties such as project complexity, technological uncertainty, demand uncertainty, lack of scope clarity, unexpected geological features and opposing stakeholder voices". Flyvbjerg et al. (2009 p. 172) in turn categorizes the reasons behind systematic forecasting errors into: delusions or honest mistakes; deceptions or strategic manipulation of information and processes; and, bad luck.

One of the factors identified to characterize large infrastructure projects is *Broad Scope and Size* in which the financial factor is identified as a large component. There are a number of ‘engineering’ factors which should be considered in ‘getting it right’ to complement the issues identified by Flyvbjerg et al. (2009). These factors developed to the Canadian context, identified in Table 1, contribute to cost escalation and schedule deviance and illustrate how it would be difficult for both those developing the numbers and those performing a due diligence review to highlight problems with cost estimates assigned in the front end planning phase.

Table 1: Factors contributing to cost and schedule growth in the front end planning stage of Canadian large infrastructure public sector projects (Adapted from Merrow, 1988)

Factor Contributing to Cost and/or Schedule Growth	**Comments**
Project Definition/Planning	• Multiple parties involved with often competing objectives and needs requires engagement and communication to ensure project definition is scoped appropriately and 'extras' or 'nice to haves' (which escalate costs) are minimized; • Difficulties in consolidating project information sourced from multiple stakeholders to define requirements, budget and anticipated schedule allowances and overlapping project phases.
Cost Estimating	• Complexity in modeling correlation across components and difficulty to identify base cost components, monitor cost changes relative to evolution of scope and forecasting over long time periods with confidence.
Economic Assumptions	• Long time periods in project delivery present challenges in modeling currency, inflation and interest rate fluctuations in addition to commodity prices.
Technological Innovation	• Lack of precedence in the implementation of new design, materials, technologies or construction methods and/or limited experience of working professionals applied or integrating the project solution present challenges in both estimating anticipated costs and time requirements in performing work; • Large infrastructure project often involve new Information Technology components, which also present challenges as outlined above.
Project Execution	• Multiple projects within the overall project requiring implementation and monitoring resulting in increased resource requirements, consideration of overlapping activities and correlation of risk events.
Project Changes	• Projects planned, designed and constructed over long times over which regulatory or client requirements may change likely impacting budget and schedule allowances.
Resource Requirements for Due Diligence	• High resource uptake in select periods of planning, procurement, design and construction; • Specialty resources required to plan and procure project, perform design or construction work due to one-off nature and/or broad size/scope of the project.
Project Team	• Projects often involve project team members across cultures and countries of origin over extended time lines. Continuity of project team members over project phases, work style and communication approaches may differ resulting in miscommunication, interpretation or integration challenges.

Each of these factors identified in Table 1 highlight the importance to consider the project context when assessing risks, and developing, monitoring and reviewing project costs and schedules. Specific risk issues identified in a large public sector infrastructure project being procured using a PPP are highlighted in chapter 4. They illustrate other process and stakeholder factors that are drivers of cost and schedule growth in the front end planning phase of a project life cycle.

2.2 **Public Private Partnership Delivery Methodology**

Governments worldwide have been rethinking how public assets are procured and operated driven by their infrastructure deficit and the need to achieve value for money. This has led to the consideration of alternative procurement approaches such as Public Private Partnerships (PPP), in particular for the large infrastructure projects (Koppenjan, 2008). The Government of Canada has identified the intent to expand the use of PPPs in Budget 2011 (Canada, 2011), which states:

> *Federal departments will be required to evaluate the potential for using a P3 for large federal capital projects. All infrastructure projects creating an asset with a lifespan of at least 20 years, and having capital costs of $100 million or more, will be subjected to a P3 screen to determine whether a P3 may be a suitable procurement option.*

The Government of Canada support for the delivery of infrastructure programs and projects in Budget 2011 follows previous announcements, including Budget 2007 (Canada, 2007), where funds were allocated for the creation of a dedicated national PPP office and national projects. The unique and complex governance and contractual terms of a PPP, a focus on risk management in the front end planning and procurement phases, and the interest of the Canadian government to further apply PPP as an asset delivery methodology were drivers to focus this thesis on large public infrastructure projects delivered through the PPP mechanism. PPPs are seen to result in cost certainty, an effective approach to transfer risks to the private sector, improved efficiencies, innovation, and timely delivery of projects (Joyner, 2008). Since there is no universal definition of a public private partnership (UN, 2004) the definition adopted in this thesis is that of PPP Canada Inc. (P3 Canada Fund: Round Three Application Guide) which incorporates the definition by the Canadian Council of Public Private Partnerships (CCPPP, 2011) as:

> *A cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards. The "partnership" is a contractual relationship that spells out the roles, responsibilities and accountabilities of both the public and private sector parties to the contract. The contract sets out the allocation of project risks between the parties. The typical length of the PPP contract term is known as the concession period, which ranges between 15 to 30+ years in the Canadian market.*

Broadly speaking, PPPs are characterized by the integration of two or more phases of a project, performance based contracts, a completion payment upon delivery of asset (for some projects), financing in part or whole by the private sector and project delivery stewardship by private sector professionals. The contractual arrangement of a PPP assigns co-responsibilities for the delivery of an infrastructure asset and associated services between a public and private sector entity and typically involves the private sector party responsible for the design, build, finance and maintenance (DBFM) of a project over a specified term at the end of which the asset is transferred back to the public sector partner. The contractual agreement between the public and private entities typically outlines a performance payment mechanism, performance standards and delegation of power to collect user charges over the contract duration. A traditional approach to infrastructure delivery involves contracts with multiple parties such that there is no integration of private sector contracts over the project life cycle. For example, a private sector entity involved in the design of the infrastructure is not involved in the operations or maintenance stage. It is believed that through PPPs the private sector has a greater incentive to meet cost and schedule goals and provide a reliable well operated/maintained infrastructure over the long term since it has a financial stake in the project and is profit driven. Value for money is anticipated based on the transfer of risk from the public to private sector and opportunities for private sector innovation, management efficiency and integrated whole life design efficiencies.

Key to the evaluation of whether a PPP offers better value for money than a traditionally procured project is the identification and optimal transfer of risk from public to private sector. Optimal risk allocation is considered to occur where "identifiable risks are allocated to whomever is best able to manage them at the lowest cost to government, taking into account public interest considerations" (ACT, 2003). In a PPP, some risks once covered by the public treasury in projects delivered via a traditional delivery mechanism are identified and quantified explicitly and may be transferred to the private sector. In general, there appears to be a greater attention placed on the risk management process in PPPs by both the public and private sector relative to the level of effort in traditional projects. The private sector tends to be interested in taking risks which can be appropriately priced, managed and mitigated from their perspective and the public sector tends to be interested in governance issues such as ensuring that 'it got it right' at the procurement method selection stage and achieved value for money overall to the taxpayer.

2.2.1 Public Sector Drivers For PPP Methodology Adoption

The trend to increase infrastructure spending to meet these growing concerns of infrastructure deficit communicated by public citizens and representatives has resulted in increased consideration of alternative project delivery mechanisms that leverage private sector investments termed public private partnerships. As required investments in infrastructure are large, many governments are increasingly looking to private sector investment and expertise through public private partnerships to assist in addressing the infrastructure deficit and realize gains in economic development. This trend is not unique to the United States and Canada but also in developing countries such as India where the role for public private partnerships is larger than past infrastructure development to improve efficiencies in a competitive environment, lower costs and provides capital (GoI, 2011). Joyner (2007) summarizes ideological and pragmatic motivations driving public sector entities to consider public private partnerships to meet the increasing demand for new infrastructure. Drivers included: demand exceeding capability of public sector to deliver; access to private sector capital, skills and risk bearing capabilities; improved quality, accountability and speed in delivery of capital needs; and opportunity for public sector entity to focus on core capability.

In Canada, based on my industry experience in the public sector, drivers for consideration of alternative procurement modes (such as a PPP) in the context of delivery of large federal public sector projects arise from a number of objectives of the lead public sector entity delivering the project. Presented are those objectives typically identified by Canadian federal entities and associated attributes of a PPP:

Alignment with Government of Canada Direction

- Reviewing opportunities for alternative delivery mechanisms on a portfolio basis is in line with Corporate and Central Agency Objectives;
- Canadian federal departments and agencies focus on 'core' public sector activities by applying alternative procurement mechanisms such as a PPP.

Efficient and Effective Project Delivery

- Private sector project delivery capacity, expertise and innovation mobilized in public sector projects;
- Synergies of integration of design/construction/operation and maintenance across project phases;
- Increasing scope of work drives opportunity for comprehensive market competition across projects.

Consistent Project and Program Delivery

- Contract documents focus on outputs and outcomes in the development of the design and maintenance protocols over long time lines.

Decreased Cost and Time Variances

- Performance based contracts are found to result in *on-time*, *on-budget* projects;
- Reduce risk of lapsing department or agency funds over fiscal periods enables improved budget projections;
- Service delivered to public within anticipated schedule.

Increased Effectiveness of Public Service Management and Delivery

- Contract structure drives private sector to complete to required performance standards;
- No payment made until Asset complete and/or to standards;

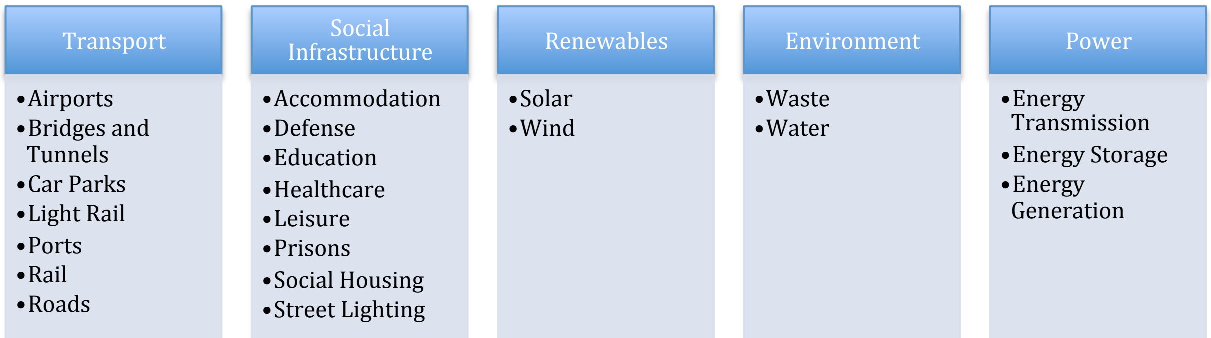
- Contract clauses automatically force actions for non-performance including deductions for not meeting Key Performance Indicators (KPI) and or space unavailability.

2.3 Defining Large Infrastructure Sectors

The infrastructure sector is broad and diverse in asset type membership and there are a number of approaches used in industry to categorize the sector from broad (Sunke, 2010) to inclusive (PPP Canada, 2011). The breakdown adopted by InfraDeals, an international industry publication focused on public private partnership deals with a public and private sector target audience, is identified as representative and applicable in this thesis. InfraDeals broadly divides the infrastructure sector into five categories: transport, social infrastructure, renewables, environment and power (InfraDeals, 2011) illustrated in Figure 2 and into subcategories of similar asset types. Sunke (2010) introduces a generic representation of the construction industry segments with the construction industry broadly segmented into general building construction and engineered works. Sectors included in this broad categorization include commercial buildings (retail stores, private sector office buildings and shopping malls) and industrial buildings (power generation plants, refineries), which are asset types not explicitly included in the broad segments illustrated in Figure 1 due to the public sector involvement in PPPs.

In this thesis the Canadian infrastructure segments applicable to public private partnerships are included where the public sector performs the function as the Project Sponsor. Broadly, these public sector projects are typically divided into horizontal (social infrastructure) and vertical infrastructure (transport) projects. The framework and case studies conducted in this thesis consider the risk management approach applied on both public sector social and transport infrastructure. Although aspects of the framework introduced are applicable in all infrastructure sectors, the nature of engineered works for Power, Environment and Renewables sectors are considered unique with some attributes not considered in this thesis.

Figure 2: PPP construction industry sectors (Source: InfraDeals (2011))



2.4 Characteristics of the Public Sector

The public sector is often described to operate at an institutional and project level much differently than the private sector. Relative to their private sector counterparts, the operating environment is one in which objectives and/or mission statements tend to change as per the changes in the governing political agenda and departmental funding decisions are often influenced by competition for funding, lack of available resources and compromises across departments. Also, the public sector is often seen as slow moving, rigid, operating in an environment of ever changing priorities directed by their political masters and responding to multiple stakeholders in hierarchical institutional management. Euske (2003) summarizes differences identified by scholars across public, non-profit and private sectors including "profit focus versus political focus, measurability of objectives, attitudes, accountability, the social good versus the bottom line, rational versus political decision making, contrasting personnel systems, the degree of control of the executive, time as available, duration of projects, and the concept of agency". Euske (2003) follows with a comprehensive comparison of the differences across public, private and non-profit sectors at the institutional level categorized relative to the following factors:

Environmental: Markets, Revenues, Constraints, Political Influence

Transactional: Coerciveness, scope of impact, public scrutiny, ownership

Organizational Processes: Goals, Authority limits, performance expectations, incentives

Differences, at the institutional level as well as similarities may serve to inform and improve learning and processes carried out in infrastructure project delivery. In the context of infrastructure project delivery, understanding the differences at the operational level in the delivery and management of a project across the public and private sector is important in understanding the context and complexity of the environment to which the thesis framework is developed.

The delivery of large infrastructure projects by the public sector differs from that of the private sector by a number of attributes. The factors identified by Euske (2003) in addition to those identified by Nutt (2005) form the basis to differentiate the infrastructure delivery context of a public and private sector organization and the relative impact on public sector delivery of large infrastructure projects. These factors are adapted from Euske (2003) and Nutt (2005) to the Canadian context and are illustrated in Table 2. The project context within which the public sector operates is subject to political pressures, public scrutiny and procedural accountability and is characterized by uncertainty and stakeholder management issues that are multifaceted and complex with specific emphasis on governance (Crawford & Helm, 2009). Public sector government organizations operate in a political environment subject to changes in government mandate and direction. Operations are conducted within complex legislative and compliance frameworks (such as Heritage, cultural and labor legislation) requiring participation and/or consideration of multiple stakeholders that may not otherwise be involved in a private sector project. The 'client' of a public infrastructure project includes the Parliament and Government from elections, taxpayers, and users of the asset. Activities and perceived success in the performance of these activities are with very few exceptions subject to significant scrutiny by the media. In addition, the compliance and audit requirements in the governance framework of the public sector tends to result in processes, activities and risks that differ from its private sector counterpart. Identification of the differences across the public and private sector project delivery environments, as illustrated in Table 2, establishes the context for the risk management approach presented in the thesis.

Table 2: Factors to compare public and private sector organizations delivery of large infrastructure Projects. Adapted from Euske (2003) and Nutt (2005) to compare public and private sector organization delivery of large infrastructure projects

Factors	Public Sector Organizations	Private Sector Organizations	Impact on Public versus Private Sector Delivery of Large Infrastructure Projects
ENVIRONMENTAL			
Market	Absence of competition operating with 'clients' being public sector agencies, departments, public at large and politicians.	Operating in a competitive market where clients originate from the public or private sector.	Delivery agents involved in limited variety of clients needs, public sector has clear understanding of other public sector requirements.
Data Availability	Performance and intelligence data are limited and not recent.	Performance and intelligence data tend to be available and recent particularly where project personnel have experience on similar past projects.	Access to recent, useful data is more difficult in the public sector where large infrastructure public projects are typically unique and one-offs and public sector project teams do not move from one project to another.
Political Influence	Political influence based on authority tree of both the public sector provider and client.	Political influence indirect and internal.	More time is required to perform communications across decision-making and oversight networks across the public sector.
Project Personnel	Project team members typically have limited experience on large infrastructure delivery of asset scale and type. Revolving door phenomena among project personnel at all levels is common in public sector.	Personnel typically have deep or repeat experience in the delivery of projects of similar scale and type.	Knowledge retention and transfer in a public sector project is limited due to turnover at the project and senior decision making level resulting in challenges on time and resources. Staffing in public sector also tends to be lengthy to meet hiring government protocols and policy.
Constraints	Mandates and Parliamentary obligations limit flexibility in decision making. Risk taking is often not	Decision making limited only by legal requirements and internal consensus. Risk taking is often rewarded.	Need for consensus increases in public sector delivery including the consideration of multiple performance factors (including qualitative factors). Requirement to balance multiple stakeholder requirements (oversight, citizen, user).

Factors	Public Sector Organizations	Private Sector Organizations	Impact on Public versus Private Sector Delivery of Large Infrastructure Projects
	rewarded.		
TRANSACTIONAL			
Scrutiny	Projects tend to be under constant media attention and include consultation above private sector industry norms.	Limited media attention and public consultation performed as per oversight, regulatory or stewardship requirements.	Project information is subject to Access to Information requirements with project information more apt to be disclosed as they are identified and considered. Public interest in creating iconic and nation building assets also require addressing.
Ownership	Citizens often act as owners and demand their interests regarding a department's activities and the manner in which activities conducted are considered.	Ownership is vested in shareholders whose interests are typically interpreted using financial indicators.	More stakeholders involved in a public sector project with varying interests and expectations.
Accountability	Higher degree of procedural accountability and transparency requirements instituted by legislation and or regulatory requirements.	Accountability requirements follow that mandated by best practice or industry norm.	Higher degree and frequency of project monitoring and reporting to meet accountability requirements which require evidence based decision making
Time Horizon	Long-term horizon on performance objectives.	Short-term horizon on performance objectives.	Public sector decision-making tends to focus not on the next quarter or year but nation building and/or developing a program/project conscious of activities in the future, institutional/cultural considerations. Factors that in private sector organizations may be considered unnecessary expenses.

Factors	Public Sector Organizations	Private Sector Organizations	Impact on Public versus Private Sector Delivery of Large Infrastructure Projects
ORGANIZATIONAL PROCESSES			
Goals	Goals are often shifting, complex and include perspectives of multiple stakeholders including the enactment of public policies.	Goals are succinct with typically clear financial and efficiency criteria for performance.	Delivery of an infrastructure project in an environment with shifting and sometimes competing goals in the public sector increases the time required to ensure consideration and inclusion in the project documents and delivery mechanism of Government of Canada and departmental priorities.
Authority Limits (Funding Limits)	Limits are contingent upon stakeholders competing priorities and tend to be set by regulatory requirements.	Clear authorities included in the decision to proceed.	More time and resources are required to conduct feasibility studies, need identification and costing to justify funding, respond to governing authority questions and concerns.
Delivery Process	Regulations and accountability requirements set forth in public sector projects limit discretion for quick decision making of project personnel at the project level.	Limited regulations and accountability requirements allow project personnel to have considerable autonomy in bidding processes and decision-making.	Project personnel on a public sector project operate in a hierarchical decision making environment. Acquiring approvals to proceed or a change scope are required at the senior departmental executive or even political level therefore requiring more time and resources to brief while competing with other priorities of the day in accessing decision makers attention.

2.5 General Project Delivery Phases

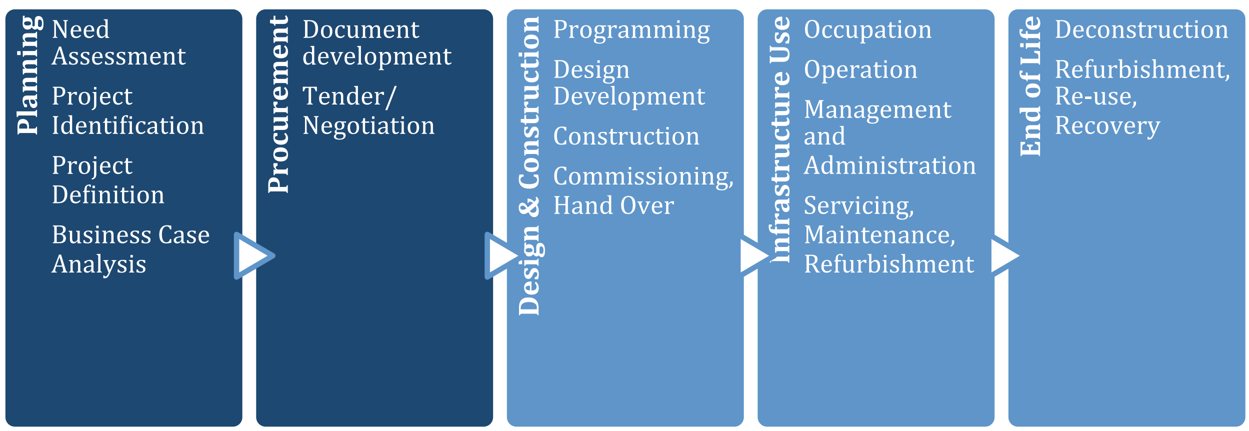
An infrastructure project has a long life (on average 50 years) with multiple phases over the project lifecycle in which the project objectives, risks and stakeholders change. The Project Management Institute (PMI, 2008) defines a project life cycle as "a collection of generally sequential and sometimes overlapping project phases whose name and number are determined by the management and control needs of the organization or organizations involved in the project, the nature of the project itself and its area of application". The PMI generic lifecycle structure includes four phases and associated project management deliverables:

- Starting the project (deliverable: project charter)
- Organizing and preparing (deliverable: project management plan)
- Carrying out the work (deliverable: Accepted deliverables)
- Closing the project (deliverable: Archived project documents)

These PMI phases are generic, applicable across project types and sectors. For the purpose of this thesis the definition of the project life cycle by PMI is adopted. However, the phases applicable for a large infrastructure project have been further elaborated upon for the social and transportation sector and long-term nature of the delivery of public sector projects delivered through a PPP procurement mechanism.

The lifecycle process implemented across organizations is similar on projects (i.e. that defined by the PMI), but the specific steps and tasks performed vary depending on the nature of the organization and infrastructure type, procurement method selected and organizational approvals, oversight and governance requirements. For example, Levitt et al. (2010) identify four phases of the project life cycle notably the project shaping phase, design phase, construction phase and operation phase. The Construction Industry Institute (CII) divides the project cycle into four distinct stages: perform business planning, perform pre-project planning, execute project and operate facility. In the context of a large infrastructure project a project delivery lifecycle is broken down into the five phases illustrated in Figure 3 for purposes of discussion of key activities in a large infrastructure public sector PPP federal project.

Figure 3: Project lifecycle phases and generic activities performed



There is no consistent use of terminology or definition of activities that are performed prior to the project Design and Construction phase. Terminology will vary depending on procurement mechanism adopted, country of origin, industry sector and asset type. Broadly, Yu et al. (2006) defines the early stage for the building sector the briefing process involving the gathering, analyzing and synthesizing of information needed. The Construction Industry Board (CIB, 1997) divides this 'briefing process' into two stages. The first stage, strategic briefing, involves the definition of the scope and purpose of the project and its key parameters including overall budget and program. The second stage, project briefing, involves the translation of the requirements set out in the strategic brief in performance, spatial and construction requirements on which the design is developed. Gibson et al. (2006) define the project delivery process between project initiation and the beginning of detailed design as the ‘Pre-Project Planning Process’ involving four steps: (i) Organize for pre-project planning; (ii) select project alternative; (iii) develop a project definition package; and, (iv) decide whether to proceed with project. Consistent with Canadian public sector terminology and drawing upon these definitions, the two phases of project delivery Planning and Procurement are used in this thesis to define the front end planning stage or what other authors define as the ‘briefing’ stage.

The front end planning of a project is of great importance to the success of subsequent project lifecycle phases in the execution of a large infrastructure project. Gibson et al. (2006) summarize findings of a number of authors and highlight that “poor scope definition in the early planning stage of a project results in final project costs tend to be higher because of changes that interrupt project rhythm, cause rework, increase project time, and lower the productivity as well as the morale of the field work force.” Defining the activities that are performed in each phase is therefore important to ensure that roles and responsibilities of project team members are adequately performed. Other authors such as Samset (2008) break the project life cycle into the Front-end (commences when the initial idea is conceived and completes at the decision to finance), Planning and Implementation (commences upon decision to finance and includes planning, mobilization of resources, and implementation), and Operation (commences upon handover of outputs and operation commences) phases. Samset (2008) highlights that there are different stakeholders with different interests and perspectives on the project in these project phases.

The five project phases and key activities performed (illustrated in Figure 3) are described in the following text. The phases Design and Construction, Infrastructure Use, and End of Life are considered outside the scope of the thesis and therefore detailed descriptions of related activities are not included. For the purpose of the thesis, definitions of the activities and deliverables for the front end planning and procurement phases are developed based on my experience in the delivery of large infrastructure public sector projects and the work and/or guidelines of Gibson et al. (2006), CIB (1997) and the project management framework of the department responsible for procurement of assets in the Canadian government termed the National Project Management System (NPMS) for Real Property Project and Business Projects. The NPMS framework defines key principles and provides the directives, roadmap, deliverables and tools for the successful delivery of Canadian public sector projects and was therefore deemed most relevant.

First, activities and associated descriptions for the planning and procurement phases are described:

Planning Phase: The planning phase is pre-launch to the procurement and the output of this phase is the approval of the public sector entity with expenditure authority to proceed with project procurement. This phase involves a number of sub-activities notably:

- **Project Definition** – Following a needs assessment, a project is identified and capital funding sources are identified, client requirements and project objectives are defined and a preliminary review of the project complexity and risk is performed. The output of this activity is a Statement of Requirements.

- **Project Initiation** – The project team is selected, the project charter including the governance regime is identified and preliminary project scope, estimates, schedule and control plan is developed. The output of this activity is a Preliminary Project Plan.
- **Project Feasibility** – The project scope, cost estimates and schedule are further refined, a market sounding exercise and a procurement delivery options analysis are performed and a preliminary risk assessment is carried out. The output of this activity is a Feasibility Report.
- **Analysis** – The project scope, cost estimates and schedule are developed to sufficient detail to allow for the analysis such that decision makers can commit funds to proceed with the project execution. The analysis includes establishing the case for the investment relative to alternative options, defining the preferred method of procurement delivery, provide complete financial and funding analysis including an analysis of risk, and highlight specific needs pertaining to communications and public consultation. The output of this activity is a Final Business Case (Funding Submission).
- **Preliminary Project Approval** – Project director and team liaise with the approval and funding authorities and seek preliminary approval of the project. Multiple levels of decision-making hierarchy require consultation and signoff of the Final Business Case. The output of this activity is Signed Preliminary Project Approval.

Procurement Phase: The procurement phase occurs upon preliminary project approval to commence the release of procurement documentation to potential proponents. This phase includes:

- **Project Documentation Development:** Upon approval to proceed, the Project team develop project documentation including the Request for Qualification (RFQ) and

Proposal (RFP), a framework for evaluation and the Project Agreement. The Project Agreement includes specifics such as design and construction output specification, service, energy, security and insurance requirements and mechanism for payment. Outputs from this stage include the RFQ, RFP and the Project Agreement in such detail to enable market engagement and procurement initiation.

- **RFQ Process:** The RFQ Process includes the release of the RFQ document to the market, performance of information meetings and responding to Request for Information queries from potential proponents and the evaluation and pre-qualification of potential proponents for the RFP process. The output of this activity is a short list of proponents that may proceed to the RFP Process.
- **RFP Process:** The RFP Process includes the release of the RFP document to the short-listed proponents, collaborative meetings between the Project team and short listed proponents, technical and financial proposal evaluation, and selection of preferred proponent. The intent of collaborative meetings is to permit formal discussions between for the Project team and the shortlisted project proponents on terms and feedback with respect to the Project Agreement and financial 'affordability' limits set and innovative solutions the Proponent may be considering in their proposal. The output of this activity is the identification of the preferred proponent.
- **Negotiations and Approval:** Outstanding issues with the Project Agreement terms and conditions are negotiated with the preferred proponent. Project director and team liaise with the approval and funding authorities and seek approval of the project. Multiple levels of decision-making hierarchy require consultation and signoff of final agreement

and terms. The output of this activity is Signed Effective Project Approval for proceeding with Contract Award.

- **Contract Award:** On Contract Award, the Preferred Proponent is assigned contractual authority to proceed with the design, construction and implementation of the project. The output of this activity is a signed contract between the respective public sponsor and the preferred proponent.

Other project phases in the project lifecycle, but not central to the thesis, are described in the following:

Design and Construction Phase: The design and construction phases may occur concurrently with the design phase overlapping the procurement phase where the preliminary design is completed in collaborative meetings with the Project sponsor.

Infrastructure Use Phase: Infrastructure use phase includes the transition period after construction and the period in which the asset is operated and maintained. The phase may occur over a long period (average: 25-30 years) in a public private partnership transaction.

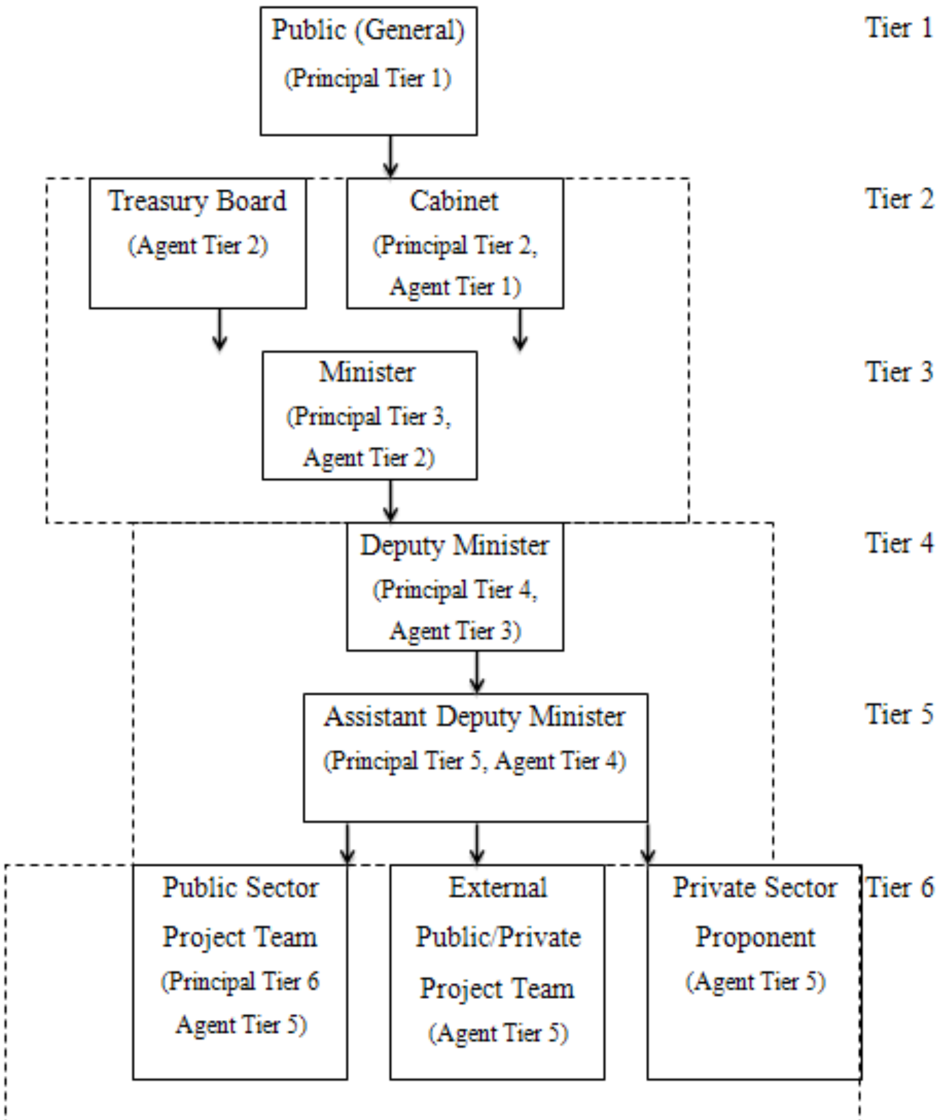
End of Life Phase: It is important to note that decisions at one stage of the project lifecycle can hamper future alternatives available and compromise financial, environmental and socio-political sustainability in subsequent stages (Levitt et al., 2010).

2.6 **Public Sector Stakeholder Roles and Responsibilities in the Front End Planning and Procurement Phases**

The roles and responsibilities of public sector stakeholders in large infrastructure projects delivered by public sector entities through traditional mechanisms such as the DBB approach are unlike the activities of a PPP delivery mechanism. This is because, traditional projects are relatively mute on collaboration across project participants and phases (Guo et al., 2010), and the length and approach to the procurement differ in that a PPP tends to be lengthy, complex requiring multi-stakeholder input (Loosemore, 2007). Understanding the roles and responsibilities of stakeholders and required processes is critical as one considers the importance of project governance in the management and delivery of a project. Samset (2008) notes that this issue has only recently become an issue in the project management community and highlights that understanding of these processes and governance regimes is of mutual benefit to both the public and private sector participants involved in Project delivery. The complexities of public sector large infrastructure project delivery, in particular the activities, requirements and reporting protocol in the planning and procurement phases, are often not well understood by both public and private sector practitioners alike and construction research in this field is limited. There are two key reasons why practitioners lack a holistic understanding of the process, stakeholders and accountability requirements. First, the long timelines and one-off nature (unique characteristic) of these large infrastructure public sector projects result in few practitioners having the opportunity to participate and team turnover. For many practitioners working on a large infrastructure public project occurs once in a career and the sharing or documentation of lessons learned is not typically formalized (Hertogh & Westerveld, 2010). Second, the planning and procurement phases require the involvement of practitioners across disciplines (planning, architecture, finance, communications etc.), where individuals outside the project management field play key roles and each typically having a clear understanding of their own tasks but few have an understanding of all required task timelines, deliverables and interrelationships within the complex web of project delivery activities and reporting requirements. A focus of the thesis is that modeling of the project context assists in improving the quality of risk identification and elicitation of expert opinion tasks. Processes to support the identification of project stakeholders, their objectives and associated tasks required in delivering a project under the governance and accountability requirements of public sector practices are therefore introduced in chapters 5 and 6. This information gathered supports a model of the project context in the research prototype introduced in chapter 7, which facilitates improved risk identification and elicitation of expert opinion sessions. Application of a risk management process early in project planning and delivery is critical in meeting governance and accountability requirements for the complex public sector project decision making environment.

The following descriptions of the typical public sector project delivery decision-making governance and reporting structure, key project activities in the planning and procurement phases and the associated tasks for one key project activity are provided to highlight the complex environment including the multiple stakeholders, their inter-relationships and activities which necessitate clear and structured support processes to improve the risk management tasks. The hierarchy across stakeholders in the overall governance structure of decision making in the public sector is illustrated in Figure 4 in a series of Tiers with stakeholders acting as either Principals (key decision maker) in the specific Tier or Agents (supporters to decision makers in a particular Tier). This complex web of bureaucrats involved in the delivery of a project requires understanding to ensure the positive communicative interplay, collaboration and clarity of roles and responsibilities of stakeholders across Tiers. Delay or failure to include one of the many decision makers can have serious repercussions to project delivery (e.g. delay, lack of commitment and support, political etc.).

Figure 4: Public sector hierarchy of decision making governance



Chapter 5 introduces a framework to identify and document these stakeholders, their interests and engagement approach while chapter 6 introduces a decision support process to clarify objectives and improve decision making across multiple stakeholders. A description of the activities, roles and responsibilities of public sector decision makers in the front end planning and procurement phases are outlined in Table 3 for a federal public sector PPP delivered project. Table 3 illustrates the roles and responsibilities of the multiple stakeholders involved and specific stages of activities to highlight the complexity of upfront planning and procurement decision making. In Table 3, two milestones are identified that public sector senior executives note as indicating progress in large infrastructure delivery being ‘Initiate Treasury Board Approval Process for Preliminary Project Approval’ and ‘Initiate Procurement Process’. Further detail is provided in Table 4 for one of the key activities identified in Table 3 being the specific activities and stakeholders involved in receiving ‘sign-off’ by the Minister for the project stage outlined in ‘Project Analysis Final’. Table 4 highlights that this one key activity involves over 12 sub-activities. Recognizing the differences and complexities in the process steps and stakeholders involved in the delivery of a public sector large infrastructure project relative to a private sector infrastructure project is critical to the identification of associated risks and understanding the project context.

Table 3: Description of activities, roles and responsibilities of stakeholders in the Front End Planning phase of Project delivery

Responsible Project Stakeholder	Description of Project Phase and Activities	Responsible Project Stakeholder Approval Requirements
Sponsoring Department Project Team	*Project Definition* – Review of proposed project to ensure that it is in alignment with Sponsoring Department portfolio strategy and objectives.	Approved by Client & Senior Leader, Portfolio Management
Sponsoring Department Project Team	*Project Initiation, Feasibility, and Analysis*– Preparation of Preliminary Project Plan, Feasibility Report and Investment Analysis Report (Business Case) including recommendation of procurement option.	Approved by Client, Senior Leader, Strategic Solutions & Delegated Authority
Sponsoring Department Investment Board	*Project Analysis (Final)* - Sponsoring Department Investment Board, Chaired by Assistant Deputy Minister (ADM), Real Property approves Investment Analysis Report and recommends it proceed to Treasury Board	Approved by Sponsoring Department Investment Board (In Tandem with Client Investment Board)
Sponsoring & Client Department (Jointly)	*Project Analysis (Final)* - Prepare Treasury Board (TB) Submission and review with Treasury Board Secretariat (TBS) staff. Task can be completed in tandem with preparation of Investment Analysis Report.	Approved by Sponsoring Minister - Ministr(ies) sign off at Ministerial Level on TB Submission
	Initiate Treasury Board Approval Process For Preliminary Project Approval	
Treasury Board Secretariat Staff	*Preliminary Project Approval* - Consult applicable program areas and policy centers as required. Prepare a Précis and recommendations. Brief TBS Executive and President of TB on TB Submission	Approval to proceed to Treasury Board by Treasury Board Secretariat Executive
Treasury Board	*Preliminary Project Approval* - Treasury Board considers the proposals during TB meeting and provides approval (or not). Investments are prioritized in the Department's Investment Plan and funding must be available within Departmental reference levels. Approval, with any conditions, is documented by way of a TB Decision Letter.	Treasury Board approves requested project expenditures and approval terms
Treasury Board Secretariat Staff	*Preliminary Project Approval* - Prepare a Decision Letter to the Sponsoring Department for approval of Preliminary Project Approval	Decision Letter created and approved by Treasury Board to issue to sponsoring department(s)
	Initiate Procurement Phase	
Sponsoring Department	*Project Document Development* – Project team develops project documents including	Project procurement documentation approved by

Responsible Project Stakeholder	**Description of Project Phase and Activities**	**Responsible Project Stakeholder Approval Requirements**
Project Team	output specifications, Request for Qualification (RFQ) and Request for Proposal (RFP)	Sponsoring Department Project Leader as ready to proceed
Sponsoring Department Project Team	*RFQ and RFP Process* - Issue RFQ, Shortlist Proponents from RFQ, Issue RFP to shortlisted Proponents	Approved by ADM to issue RFQ, shortlist RFQ, issue RFP and concurrence from Client Department
Sponsoring Department Project Team	*Negotiations and Approval* - Receive final bids and recommend preferred proponent. Negotiate final terms. Update the Investment Analysis Report and develop TB Submission with Client Department and TBS staff.	Approved by ADM and concurrence by client. Joint Minister sign off on TB Submission
Sponsoring Department Project Team	*Contract Award* - Treasury Board Approval Process for Contract Award and related contract approvals (Real Property Transaction, Project Agreement, Construction Contract as applicable) as per process outlined above for Preliminary Project Approval	Treasury Board Provides Approval to Sign Agreement Approved by Sponsoring Minister to Sign Agreement for Contract Award
	Initiate Design and Construction Phase - Post Financial Close and Project Implementation	

Table 4: Sign off activities to receiving Minister approval for project approval

	Activity	Stakeholders Involved
1	Senior Departmental Leaders signoff Submission documentation by both Client and Sponsor Departments concurrently.	Client Dep’t Project Leader Sponsor Dep’t Project Leader
2	Briefing note prepared to accompany Submission documentation.	Communication Manager, Client Communication Manager, Sponsor
3	Assistant Deputy Minister (ADM) signature acquired from both Departments concurrently	Assistant Deputy Minister (ADM), Client Department ADM, Sponsor Department ADM Senior Advisors, Client Department ADM, Senior Advisors, Sponsor Department
4	Preparation of Letter for Senior Executive Decision Makers signature	Communication Manager, Client Communication Manager, Sponsor
5	Deputy Minister signature acquired on Letter from both Departments concurrently	Deputy Minister (DM), Client Department DM, Sponsor Department
6	Sponsor Department Minster office is briefed on project and contents of submission	Minister Advisors, Sponsor
7	Sponsor Minister Signature	Minister, Sponsor
8	Signed Letter and Submission is sent to Treasury Board Secretariat from Sponsor Minister Office	TBS Senior Staff
9	Client Minister Office Briefing by Project Team and Senior Executives	Minister Advisors, Client
10	Client Minister Signature	Minister, Client
11	Signed Letter and Submission is sent to Treasury Board Secretariat from Client Minister Office	TBS Senior Staff
12	Submission ready for review by Treasury Board	TBS Senior Staff

2.7 **Chapter Summary**

This chapter presented descriptions of large infrastructure public sector projects attributes, activities and the complexity of the public sector project delivery environment to bind the scope of the thesis. First, as there is no universal definition of a large infrastructure project, attributes were identified and defined specific to the Canadian context including a description of the Canadian PPP market place. The dynamic and complex environment of the public sector was then discussed including differences relative to its private sector counterpart. Key activities involved in the delivery of large infrastructure public sector projects were then described with a focus on activities performed in the front end planning and procurement phases of a project.

Chapter 3: **Risk Management in the Procurement Phase: Lessons of a Large Infrastructure Public Private Partnership Project**

This chapter describes the risk management process carried out during the procurement phase (Request for Qualification through to Financial Close) on the Canada Line Rapid Transit project constructed in Metro Vancouver, British Columbia, Canada. The Canada Line is one of the largest rapid transit projects constructed in Canada in recent years and was delivered through a public private partnership procurement mechanism. The project team developed a detailed Risk Register as a component of its risk management plan and used this Register throughout the multi-year planning and procurement phases of the project lifecycle, as well as during the construction phase. The focus of the chapter is on examining the process carried out to develop the project Risk Register, explore its contents and changes made over the procurement phase of the project, and identify the benefits and challenges experienced by project team members in its development and use. Lessons can be learned through its development and application with other project management tasks that are adaptable to other infrastructure project types. The chapter concludes that the development of a Risk Register and its use on an ongoing basis is critical in meeting project objectives and that it is best created early in the front end planning and procurement phases particularly for large infrastructure projects.

3.1 **Introduction**

Risk management is an essential project management task in the delivery of an infrastructure project. It is important for ensuring that technical, contractual, financial, organizational, operational and other performance requirements are met. A Danish study (Andersen, 2001) asserted that savings in the range of 800 million Euros could be achieved annually in the Danish construction industry through the introduction of formal project risk management. A survey (Voetsch, 2003) of more than 150 respondents from various industries, including information and communications, energy, and construction, highlighted that there was a positive relationship between the frequencies of formal risk management practices and project management success. Project risks are managed irrespective of project procurement mode, but risk management is particularly important in the early stages (Maytorena et al., 2007) and to the success of projects delivered through a public private partnership (PPP) procurement mechanism. The value for money of the PPP procurement approach relative to a traditional form is often attested to private sector innovation, efficiencies and the transfer of risk. The value identified at risk (both in quantitative and qualitative terms) across delivery mechanism holds considerable weight in the decision of which procurement delivery mechanism holds 'best value' and in the public interest. Therefore, there is increasing attention on ensuring the risk management process is performed with due diligence and accountability in the early phases particularly for PPP projects.

Numerous academic authors including (Akintoye et al., 2001; Patterson & Neailey, 2002; Chapman & Ward, 2003), government bodies (Partnerships Victoria, 2011a,b; HM Treasury, 2011; PMG, 2011) and associations and institutions (PMI, 2008; AS/NZS ISO 31000:2009) have proposed ways to undertake risk management applicable to the construction industry and identified tools to assist with the process (e.g. content *categories* of a project Risk Register). For example, Partnerships Victoria, an Australian government department with expertise in the delivery of PPP projects, provided an example of a Risk Register to assist in developing a public sector comparator (PSC) to link bid-value-for-money with the most efficient form of public delivery (Partnerships Victoria, 2011a,b). Other authors (see Patterson & Neailey, 2002 and Hall et al., 2001) developed risk management software and recommended suitable contents (such as categories) of a Risk Register. For the most part, there appears consensus across industry and academia that Risk Registers are useful tools in risk management, but relatively little guidance is provided on how to facilitate and develop input into these Risk Registers. Also, it is surprising that in spite of strong advocacy to develop Risk Registries in construction projects no comprehensive study was found to exist on experiences gained on the implementation of risk management and Risk Register development in PPP infrastructure projects in the planning and procurement phases when critical project decisions on budget, design and construction methodologies, partner selection and other factors that impact lifecycle costs and performance are made.

Presented in this chapter is a case study of a major infrastructure PPP, the Canada Line Rapid Transit project (hereafter referred to as the Project) constructed in Metro Vancouver (British Columbia, Canada) connecting the City of Vancouver, City of Richmond and the Vancouver International Airport and Sea Island. Observations and lessons learned are examined from the risk management process used by the public entity during the procurement phase in order to develop best practices that can inform engineering and other practitioners, researchers and students and support tools introduced in chapters 5 and 6 and an enhanced research prototype in chapter 7. The following activities have been conducted: (a) identification of the approach taken to develop, monitor and manage a comprehensive list of risk events and mitigation measures; (b) exploration of how the expectations of different project stakeholders (e.g. project team, public, board of directors, municipal/provincial/federal government representatives) impacted the development and management protocols for the Risk Register; and (c) capturing of lessons learned and observations in the Risk Register development process. A broad definition of 'stakeholder' is adopted in this chapter as provided by PMI (2008) as "persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project". It is believed that the documentation of the process carried out and content of the Risk Register will stimulate discussion and improve understanding of risk management processes during the procurement phase of a large infrastructure project in addition to other project delivery phases.

A number of project characteristics were important in the selection of this project as a case study. The Project was considered high profile with a fixed completion date necessary as a key component to transit improvements required before the opening of the 2010 Winter Olympics. In addition, there was strong senior level support to follow industry best practice for corporate governance including risk disclosure and management. Corporate management emphasized to the project team the importance of allocation of both financial and human resources in order to ensure risks were identified and managed appropriately. It was recognized that the Project was unique in that it was technically complex and being procured as one of the first and largest (dollar value) public private partnerships in the country. This complexity in combination with a fixed deadline and high profile emphasized that risk management best practices be followed.

3.2 **Method of Investigation**

The Canada Line project was selected as a model PPP project because of its scale and the involvement of several levels of Canadian government stakeholders (Federal, Provincial, Municipal and Agency), which added more risks and greater dimensionality to them to the Project. Based on my experience leading risk management processes for Canadian public sector large infrastructure projects, this project implemented industry current best practices in risk management to meet governance requirements. It was also one of the first PPP projects in the Region and was one of the largest projects in capital dollars ever built in Canada.

A three-step approach was applied in developing this case study (Yin, 1999). First, literature was reviewed related to the Project including newspaper articles, project documentation, conference and journal papers, industry publications, and websites. Second, a series of face-to-face, semi-structured interviews with senior project team members who were responsible and accountable for project decision-making was conducted. Lastly, follow up interviews and literature reviews to address gaps and unanswered questions were performed.

The use of interviews allowed for the capture of many of the risk dimensions and events of the Project and identifying the challenges and benefits of risk management in the procurement phase when critical decisions are made. The case was limited to interviewing project participants who either were accountable to the risk management approach required by governance or were involved in the development or review of the project Risk Register. The interview questions were pilot tested with personnel within the University of British Columbia Department of Civil Engineering's Construction and Project Management group. The primary contact for the study was the Chief Financial Officer (CFO) of the Project who supplied relevant project documentation and the most recent and past versions of the project Risk Register, risk management plans and other supporting risk documentation. The CFO recommended the most suitable project team members to interview and in turn, these individuals suggested other personnel whom they thought might provide further insight to the project risk management processes. This commonly used cascading or snowballing approach of interviewee selection allowed for the interviewing of people whose participation was not obvious before work was initiated (Wells et al., 1995).

Interviewees included the CFO, the Finance Director (who also assumed the Risk Manager role), Project Manager Construction, Rapid Transit Cost Consultant, Financial Advisor, and two individuals from the contributing public sector agencies and over 18 hours of interviews. The professional experience of the interviewees was diverse, including expertise in finance, engineering, law, environment and construction project management. Each was a senior decision maker in the Project and all represented the 'project sponsor' perspective of the Project.

Interview questions and formulated statements were developed after a review of the risk literature as it pertained to the delivery of public private partnership projects and infrastructure delivery. As seen in Table 1, questions focus on the risk identification, quantification and management processes, the challenges and benefits of a formal risk management process, and lessons learned. Each interview lasted between thirty minutes and four hours depending on the time that the interviewee had dedicated to the development of the Risk Register, interest in the research questions and time available. It must be noted that consistency was applied across interviews in that all questions listed in Table 5 were asked to the interviewees. The interviews were conducted during the construction period when many were busy with responding to day-to-day requirements. The Project CFO and the Finance Director made a commitment to this research and allocated time to assist with the transfer of information and added many personal perspectives to their participation. Follow-up interviews were conducted when further clarification was required. Time was also allocated for interviewees to review the research findings prior to analysis and publication of the results.

Table 5: List of questions asked to case study interviewees

1. General questions relating to the development of the risk register a. What was the process for developing the risk register? b. Is the risk management process governed by organizational policy? c. Are project participants involved in all stages of the risk management process? d. How much time has been spent on developing the risk register? (week, month..) e. How does the procurement option selected (public private partnership) impact the content and level of detail expected, required or desired in the risk register?
2. A common problem in the development of a risk register is the identification of a comprehensive list of risks, risk events and mitigation measures. a. How were risks identified (group or individual elicitation exercise)? b. What background preparation was done and by whom? (names not important) c. What was told beforehand to participants involved in developing the risk register i.e. what homework did they have to do? d. What sources of information were used to assist in the identification process (commissioned reports, past project risk registers etc.)? e. Who was involved in the risk identification process and what was their expertise? (names not important)
3. Quantifying the probabilities and consequence of risk events is a difficult exercise to develop meaningful values. Participants often disagree on the values assigned and terminology. a. How were values elicited from participants? b. How were the experts around the table calibrated in terms of specifying probabilities and outcomes? c. How was consensus achieved, or did the process rely on the values specified by the one with the most expertise for the topic at hand? d. Which risks were most difficult to assess?
4. This project is complex and unique in which the project context is constantly changing. a. What was the most effective approach found to update the risk register as new information became available? b. How were project participants informed of the changes?
5. A risk register cannot only be used by an organization for managing project risk but also for improving communication with other project stakeholders. a. How has the development of the risk register assisted the project team in other aspects of the project (decision making, communications with other stakeholders etc)?
6. The development of risk registers is not new in construction management; however, best practice now requires a higher level of detail, as that which is illustrated in the CLCO risk register a. What do you think the weaknesses of the process were, or put another way, what would you do that is different if you did it again? b. Did you use any risk software tools – if yes, what and how did they assist?

3.3 **Case Study Project**

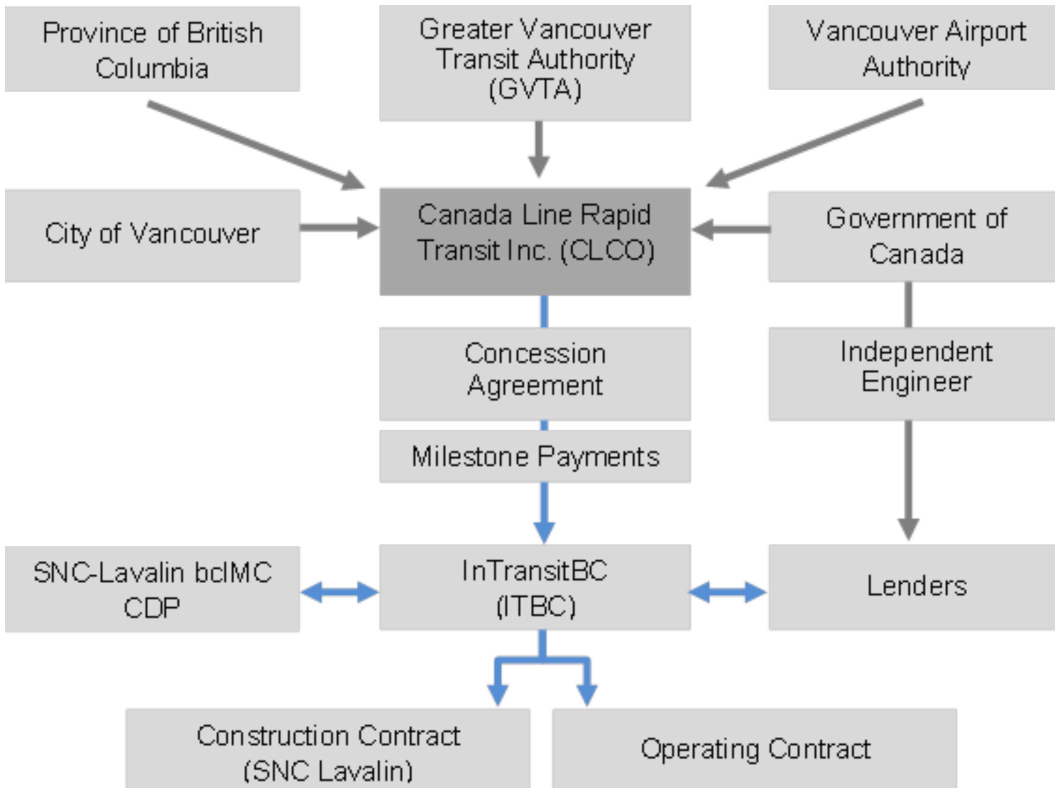
The Canada Line rapid transit project, constructed in Metro Vancouver connecting the City of Vancouver, City of Richmond and the Vancouver International Airport and Sea Island (the "Project") was delivered through a 35-year (inclusive of the construction phase) Design-Build-partially Finance-Operate public private partnership. The Concessionaire, under the Concession Agreement, was responsible to partially finance, design, construct then operate the Canada Line over this 35-year term. Procurement and construction occurred over a seven-year time period, commencing in November 2002 and completing in August 2009. The Concessionaire assumed a number of risks subject to certain compensation events, the occurrence of which required the public party to make compensatory payments. The public entity made milestone payments over the construction period and monthly payments, termed availability payments, over the operations period based on the achievement of pre-determined performance metrics.

The Project was both capital and operationally intensive. To date, it is the largest infrastructure project in the history of British Columbia, with the total construction cost at Financial Close of $1,889 million ($2003 real) and a construction period in excess of four years. The project was complex involving design and construction of components over three water crossings, bored and cut-and-cover tunnels (including through a densely populated urban centre) and elevated and at-grade level components (Infrastructure Journal, 2010). The Project constitutes a transit network improvement outlined in transportation plans developed over the preceding decade to provide a corridor connecting Vancouver and Richmond, identified as one of the region's busiest areas and home to 1/3 of the region's jobs and 20% of its population (Information Bulletin, 2009). The Project involved the design and construction of 19.5km of rapid transit rail line with 16 stations designed to carry 15,000 passengers per hour per day and was required to be in service by a fixed date (November 2009) some 2-3 months before the opening of the 2010 Winter Olympics. The Project completed early, was recognized as a successful innovative project, received a Gold Award for Infrastructure from the Canadian Council for Public Private Partnerships, and was selected by an independent judging panel of *Infrastructure 100* as one of the top 100 infrastructure projects of 2010 based on scale, feasibility, complexity, innovation and impact on society. These features were important in the choice of the Project for this case study.

Canada Line Rapid Transit Inc. (CLCO) is a special-purpose wholly owned subsidiary of the Greater Vancouver Transportation Authority/Translink (GVTA) and created specifically to oversee the procurement, design, construction and implementation of the Project. This public sector counterparty formed to oversee the Project, signed a concession contract with InTransit BC, the private sector proponent (synonymous in this case as 'concessionaire') responsible for constructing, operating and maintaining the entire project. InTransit BC (ITBC) is a joint venture company equally owned by SNC Lavalin (SNC) and two pension funds, the Caisse de Dépôt et Placement du Québec (CDPQ), and the British Columbia Investment Management Corporation (BcIMC). ITBC contributed C$656 ($2003 real) million towards the project and through the concession contract availability payments are made from the public sector to ITBC based on its performance with respect to vehicle availability and schedule performance, quality of service (passenger accessibility, comfort and convenience, and maintenance and upkeep of vehicles and stations) and meeting ridership thresholds.

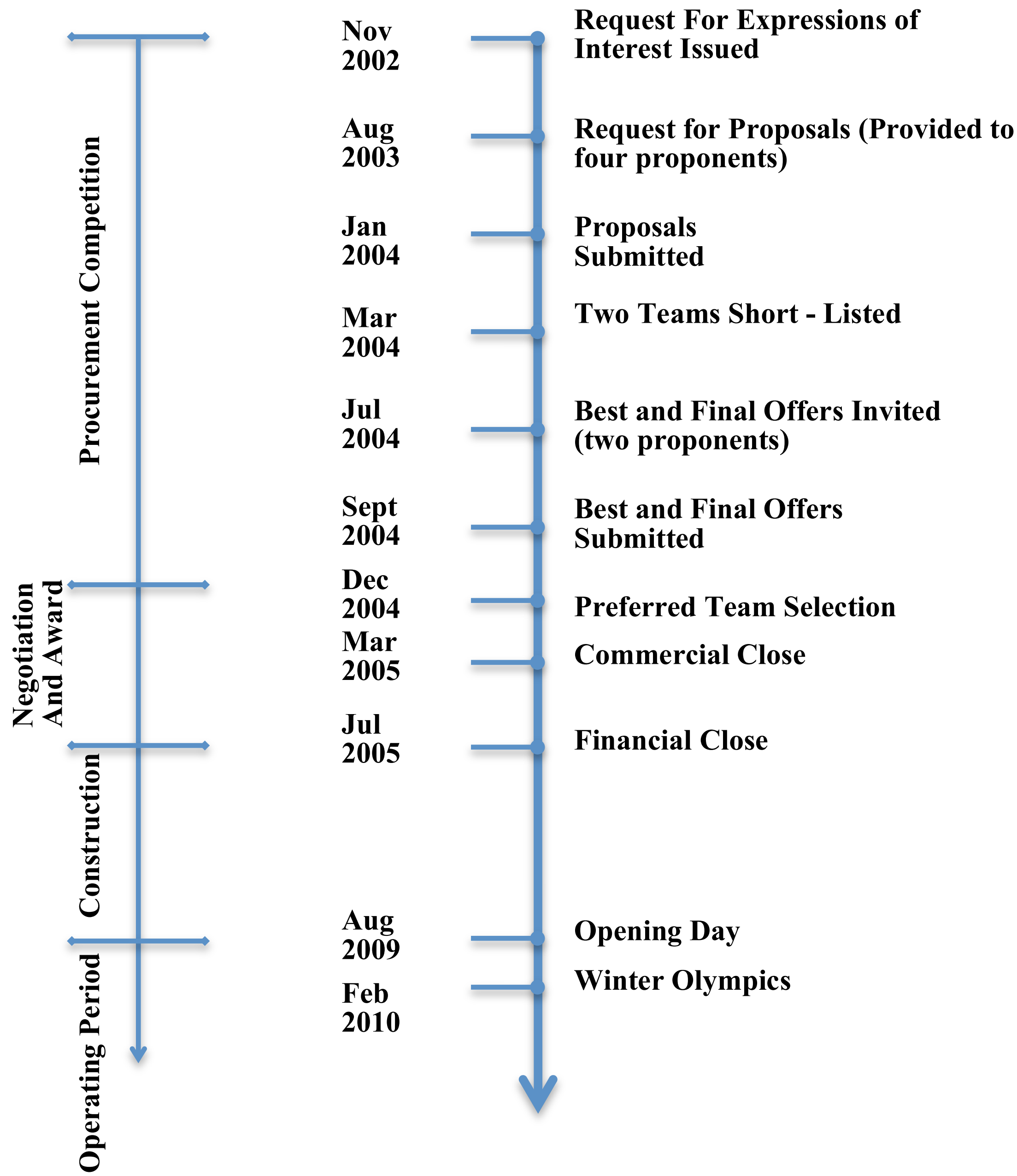
CLCO was a separate independent governed company with governance endorsed by four public funders and it represented several contributing and participating public agencies from three levels of government in Canada specifically: Government of Canada (GoC); Province of British Columbia (the Province); Greater Vancouver Transportation Authority (GVTA); Vancouver International Airport Authority (VIAA); and the City of Vancouver (CoV). CLCO and the Authority entered into various agreements with the GoC, the Province, VIAA, and the CoV, each providing funding towards costs related to the procurement and construction phases of the Project. Figure 5 illustrates the stakeholder relationships in the execution of the Project. The stakeholders contributions ($2003 real) were: $419 million from the GoC, C$235 million from the Province; C$311 million from GVTA; C$189 million from VIAA for the airport line, and C$50 million for common costs; and C$27 million from CoV (Canada Line Rapid Transit, 2006). All public funding was contributed in the form of grants, although each portion was dedicated to a particular part of the project. Each agency financed its contributions differently and individually reported their cost of financing contributions to CLCO. In turn, CLCO provided regular updates to the public funding agencies on the project risk reserve (CLCO Reserve) and the sufficiency of the CLCO Reserve to address retained risks in the construction phase. The contributions from the public agencies accounted for a significant portion of the project costs highlighting the need to ensure appropriate reporting and systems in place for risk management by CLCO.

Figure 5: Canada Line stakeholder relationship diagram (Adapted from Canada Line Final Project Report, Competitive Selection Phase, April 12, 2006).



CLCO managed a multi stage competitive selection procurement process commencing in November 2002 with the issuance of a Request for Expression of Interest (RFEI) to hundreds of companies. Ten consortia of international and local firms ("Proponents") responded and a short list of four proponents was prequalified and received a Request for Proposals (RFP) (Translink, 2003). One proponent withdrew and the three remaining proponent teams submitted responses to the RFP in Jan 2004. Two of these proponent teams were invited to participate in the Best and Final Offer (BAFO) stage and by December 2004 CLCO entered into final negotiations on terms and conditions of the contract. Upon completion of the negotiation, the contract was awarded in July 2005 to the successful proponent ("Concessionaire"). The procurement process was completed in two years and eight months. Figure 6 illustrates this procurement process and key project milestones.

Figure 6: Canada Line project time line



Although the majority of risk of construction cost increases was allocated to InTransitBC, CLCO retained responsibility for some construction-related risks during the construction phase of the Project. In addition, CLCO retained reserve funds to cover the potential occurrence of compensation events, which were linked to construction cost increases. Construction costs in the Greater Vancouver Regional District (GVRD) increased by over 45% during the period 2000 to 2005, driven by the increase in construction volumes, material costs and limited labour resources (BTY Group, 2005). Aggregate construction cost escalation rates were 8-10% per year and up to 20% with respect to some key trades (electrical and mechanical). Compared with the inflation rate, represented by the consumer price index of some 2-3% per year, these increases created enormous budget pressures and a difficult economic environment to operate in. As the procurement phase covered a period just over two and half years, a timeframe that is a project in itself, the management of costs and associated risks was a challenge.

The volatility of the construction market, size of the project, unique procurement strategy, and the multiplicity of public funding agencies working in an environment of increasing disclosure requirements were just some of the complexities of the project. The challenge faced by the CLCO project team involved identifying, tracking and managing risks identified in the Risk Register and updating the Register to reflect the associated new risks with respect to changes in project context, assumptions, stakeholders and economic environment so that retained risks were managed within the available funds over the procurement phase.

The following section highlights the risk management process carried out on this unique large infrastructure Project including how CLCO developed the project Risk Register, the reporting strategy to update project stakeholders on the status of the Risk Register contents and CLCO reserve as the Project progressed over the procurement phase.

3.4 **Risk Management Project**

3.4.1 Background

The company identified the need to adopt industry best practices for risk management and set aside a *multi-million dollar* reserve to cover risks that were retained as per the terms and conditions of the Concession Agreement and risks not envisaged at the time of project approval.

The risk management process followed during the procurement phase included three steps that entailed:

- the development of a risk management plan which outlined the risk environment and the framework that would be followed in the development of the Risk Register;
- the development and updating of the Risk Register over each stage of the procurement process including the identification, characterization, quantification and mitigation of risk events through input from a diverse project team and reviewed by multiple parties internal and external to the project team; and,
- the reporting and communication of the contents of the Risk Register and associated changes to key decision makers and stakeholders.

3.4.2 Risk Management Plan

The CLCO team developed a Risk Management Plan that set out a framework to identify, characterize and quantify the risks retained by CLCO and its sole shareholder the GVTA. The objective outlined in this Plan was to "maximize the understanding of risks and the quantification of risk". In the context of this Project, risk was defined as "anything that impacted the achievement of the Project's strategic objective of the successful implementation of the Project". The framework outlined in the Project Risk Management Plan was influenced by a number of factors including the prevailing regulatory environment, CLCO reserve reporting and accountability requirements set out by the public partners and the evolving nature of project information and long term procurement processes inherent in the PPP project delivery mechanism.

3.4.2.1 Regulatory Environment

At the time of the Project planning, the regulatory environment surrounding corporate governance requirements for public company Boards of Directors were being enhanced worldwide. In the United States a federal law, the Sarbanes-Oxley Act of 2002, set out enhanced standards for all U.S. public company boards and management. In Canada a report published in 2001 by the Canadian Institute of Chartered Accountants, Canadian Venture Exchange and the Toronto Stock Exchange provided interim recommendations to strengthen the role of boards and committees in oversight, reporting, risk management and internal controls on publicly traded corporations (Audit Committee, 2001). These recommendations included a recommendation that a company's Board of Directors has the responsibility to oversee that management has identified principal risks to the corporation and ensure appropriate systems are in place to manage these risks. The Board of Directors of CLCO was not required to meet or exceed the legislative and regulatory corporate governance requirements set forth for publicly traded companies in Canada because the sole shareholder was a public sector entity. However, the CFO highlighted that the Board did set out to meet the highest levels of standards for corporate governance including ensuring that management developed a framework for appropriate assessment, management and internal control of risks and integrity of financial reports, including the emergence of new risks and the implications for the strategic direction of the company. This was consistent with industry best practice for corporate governance which identified that improved risk disclosure facilitates greater understanding of the company risk profile (Linsey & Shrives, 2005). Emphasis from senior executives on the risk management processes and systems adopted by its management was critical for the time, diligence and adherence to best practices adopted by the Project team.

3.4.2.2 Multiple agreements, multiple parties

CLCO was a party to both the funding agreements with each of the public sector contributing agencies and to a Concession agreement with the private sector partner, InTransit BC. These agreements defined terms and conditions for which each party was responsible and clarified their participation in these agreements over the procurement, construction and operation phases that exposed CLCO to risks. The Project Risk Register, which identified all CLCO risks and quantified select risks to reflect these agreements, was considered integral to the Project Risk Management Plan.

The construction of the Project required each of the contributing agencies to agree contractually through contribution agreements to provide funds, including funds for the CLCO reserve, at identified periods over the course of fiscal years 2004/2005 through to 2009/2010. The CLCO reserve was managed by the CLCO Chief Financial Officer who reported to each of the project partners as per the different but agreed terms of their contribution agreements. CLCO's goal as outlined in its Risk Management Plan was

> “*to balance the interests of its various stakeholders with the construction of the project within the constraints of the various Project agreements, including the Concession and Contribution agreements”.*

If the risk reserve ‘went into the red’, and further funds were required from one or more of the public agencies, this was considered a risk given the high profile of the Project and operating in an environment with increasing disclosure and transparency requirements. The political, reputation loss and communication fallout could entail substantial time delays and costs to the Project. There was therefore considerable emphasis from senior executive to be confident in both the value of the CLCO reserve and the monitoring process put in place at the outset.

3.4.2.3 Multi-year Procurement Period – Evolution of Risk

The characterization and quantification of CLCO risks in the Project Risk Register was an evolving process over the course of the two year and eight month procurement process (illustrated in Figure 6). It is common for a PPP project of this scale and complexity to evolve, including its risk profile, as new information becomes available, design progresses after the release of the RFP and partners join the enterprise. The Project Risk Management Plan identified CLCO’s risk exposure as a function of several factors during the procurement phase, in particular the evolving allocation of risk in the various drafts of the Concession Agreement, meeting the requirements of contributing and participating public agencies, and the regulatory, access and permitting processes. The CLCO had to balance the interests of the various stakeholders within the constraints of the various Project agreements including the Concession and Contribution agreements while managing the CLCO risks retained. Several agreements that changed over the course of the procurement phase required the constant monitoring and consideration of these changes with the risks identified in the Project Risk Register.

The evolution of risk information is illustrated in the risk allocation tables (Tables 6 and 7) provided to prospective concessionaires at the Request for Expressions of Interest (RFEI), Request for Proposal (RFP) and the Concessionaire (Table 8) at Financial Close (FC). These correspond to risk categories and within each category are potential risk events. It is inherent in PPP projects that the risk be allocated to the party best able to manage it, and that the early identification of risk allocation is communicated in the risk allocation tables in the procurement documentation. The public sector party identifies key risk categories and makes the most informed assessment of the party who is best able to manage it, termed the 'Risk Owner'.

Table 6: Proposed allocation of risk at the Request for Expression of Interest stage (Adapted from Project Document: Request for Expression of Interest, November 2002)

Risk Category	Risk Owner
Environmental Approvals	Public /Concessionaire
Land/Right of Way Acquisition	Public
Construction	Public /Concessionaire
Systems and Civil Works Integration	Concessionaire
Passenger Volume and Revenue	Public /Concessionaire
Systems Performance	Concessionaire
Operation and Maintenance	Concessionaire

Prior to the procurement phase, the Project team developed the public sector comparator (PSC) of Project delivery through traditional Project delivery mechanisms (Design-Bid-Build) for business case analysis purposes. All risks identified with the exception of the risk associated with the 'cost of construction' and 'construction inflation' (labour, steel, etc.) was assumed allocated solely to the public sector parties CLCO or the GVTA in the PSC. The PPP delivery mechanism was selected in this business case to offer best value and facilitated a greater transfer of risks than through the PSC.

Table 7: Proposed allocation of risk in the Request for Proposals Stage (Adapted from Project Document: Request for Proposals, August 2003)

Risk Category	Risk Owner
Ridership and Revenue Risk	Public /Concessionaire (Minority)
Regulatory Approval Risk	Public /Concessionaire
Land/Right of Way Acquisition	Public /Concessionaire
Construction Risk (Cost and Schedule)	Concessionaire
Geotechnical Risk	Public /Concessionaire
Systems and Civil Works Integration Risk	Concessionaire
Utilities Diversion	Public/Concessionaire
Systems Performance Risk	Concessionaire
Operation and Maintenance Risk	Concessionaire
Contaminated Soil Risk	Public /Concessionaire
Inflation Risk During Construction Period	Concessionaire
Inflation Risk During Operating Period	Public /Concessionaire
Change in Law Risk	Public /Concessionaire

Further, in the early stages of the Canada Line procurement phase very little information was clear to the Project Team on the design and construction methodologies that would be adopted. The Contribution and Concession agreements were in working draft formats and therefore the associated risk allocation appropriate between public and private partners was successively refined as the market provided feedback, and Project information and negotiations evolved. Risk items identified in the RFEI Table 6 are defined broadly and limited in scope. As more information became available to the Project Team, technical reports were completed, and market assessment and industry feedback was given as the procurement phase progressed so that the allocation of risk became clearer at the RFP stage. For example, at the RFEI stage, ‘Land/Right of Way Acquisition’ was identified as a risk item to be retained by the public sector. After industry feedback at the RFP stage, this element was identified as a shared risk between the public and private partner and returned to the public party at the FC stage with further specification of cost and schedule. A second example is the risk events under the category of Geotechnical Risk, not identified at the RFEI stage but included under the 'Construction' category as a shared risk item. At the RFP stage, 'Geotechnical Risk' was an explicit risk, shared between public and private partners. After negotiations with the preferred proponent, clarity was achieved and a specific component of geotechnical risk, 'Changed ground condition (tunnels and foundations)' was transferred to the private sector and 'Undisclosed environmental and archaeological liabilities' were retained by the public sector.

Through negotiation and evolution of the project, the project team was able to allocate risks to the private party best able to manage them. Of particular note was the geotechnical risk identified above. The evolution of the allocation of risk to the respective public and private partners over the course of the procurement period emphasized the need for continuous risk management process and associated tools (such as a Risk Register) for both governance and negotiation purposes. Tracking the changes in project context and associated risks as the project evolves within each phase of project delivery is clearly desired to support and rationalize decision making.

Table 8: Allocations of risks as per contract to the appropriate stakeholder (Adapted from Project Document: Final Project Report, 2006)

Risk Category	Risk Owner	Phase
Land acquisition cost and schedule	Public (CLCO)	Construction
Municipal and regulatory permitting, cost	Public (CLCO) /In TransitBC	Construction
Municipal and regulatory permitting, delay	InTransitBC	Construction
Undisclosed environmental or archaeological liabilities	Public (CLCO)	Construction
Cost of design build packages	InTransitBC	Construction
Cost of construction	InTransitBC	Construction
Construction inflation (labour, steel, etc.)	InTransitBC	Construction
Construction delay	InTransitBC	Construction
Utility relocation cost / delay	Public (CLCO) /InTransitBC	Construction
Changed ground condition (tunnels and foundations)	InTransitBC	Construction
Design integration	InTransitBC	Construction
Integration between civil works and systems	InTransitBC	Construction
Public protest, legal action, embargo or blockade	Public	Construction / Operating
Reasonableness of behavior of Agencies and Cities	Public	Construction / Operating
Force Majeure	Public (CLCO) /InTransitBC	Construction / Operating
Insurance costs	InTransitBC/Public (GVTA)	Construction / Operating
Condition of civil assets (over the 35-year term)	InTransitBC	Construction / Operating
Operating performance (over the 35-year term)	InTransitBC	Operating
Operating costs (over the 35-year term)	InTransitBC	Operating
Maintenance costs (over the 35-year term)	InTransitBC	Operating
Useful life of trains and other systems	InTransitBC	Operating
Ridership revenues	~90% Public (GVTA) ~10% InTransitBC	Operating

3.4.3 Risk Register Development

The Project team developed the first draft Risk Register early in the procurement process prior to the Best and Final Offer Stage. After inviting the two prospective Concessionaires bidding on the Project and beginning negotiations, the CLCO project team developed and maintained two risk registries – each colour coded to represent each team and to reflect the negotiations. Each of these Register's included different risk events, and the aggregation of total quantified risks retained by CLCO differed based on the negotiated terms and conditions with each respective party and assessed at the Best and Final Offer Stage of the selection process. Developing a Register for each short-listed Concessionaire is a worthwhile and necessary exercise to ensure Project team members consider the differences in the solutions presented and terms negotiated (and therefore the aggregate of risks retained by the public sector parties). Upon final selection of the preferred Concessionaire, the project team updated and maintained one Risk Register for the rest of the procurement and through construction.

There was consensus by interviewees that a Risk Register was, as the Risk Manager highlighted, "absolutely critical in the negotiation process" and served as a "good prompt on what to pay attention to". For risks negotiated with the prospective Concessionaires, the project team compared the cost of remedial action if retained by CLCO with the cost if transferred to the Concessionaire (including the conversion of delays into dollars). Interviewees highlighted the Register served as a "memory aid on where the risk lies" and whether "this is your risk or this is ours".

3.4.3.1 Preparation of Initial Risk Register

The preparation of the initial Risk Register was led by the Risk Manager whose role, among others, was to collaborate with the CFO of CLCO to develop, monitor and report on CLCO risks. The Risk Manager worked with internal and external project team members to ensure that enough time was dedicated to the management process and the follow through on related tasks. The Risk Manager had a comprehensive understanding of the environmental, technical, financial and political contexts of the project, had a professional background in finance, and experience operating at a senior executive level in strategic planning, partnering, and both public and private finance. The assignment of the risk management tasks to senior individuals illustrated the priorities for governance and accountability set by the executives of CLCO.

The Risk Manager, with the assistance of the Project team, developed the framework for the first version of the Project Risk Register after review of the "Guide to Risk" released by the Risk Management Branch (RMB) of the Province of British Columbia. The RMB was responsible for the effective management of the risks of loss to which the Provincial government was exposed and the "Guide to Risk" was seen as the primary best practice baseline reference document for the region in which the Project was procured and constructed. The Project team developed the Risk Register in a spreadsheet format using Microsoft Excel software following the framework set out by the Guide to characterize and quantify risks.

3.4.3.2 Populating the Risk Register – Pre Best and Final Offer

Prior to the receipt of the Best and Final Offers by the two prospective project Concessionaires, there was considerable time and resource dedication required of the Project team to creating the base Risk Register and the associated tasks of monitoring/reporting. The risk management process was identified as contributing to project success specifically the documentation and process followed for corporate governance. Literature concurs with these benefits but there is limited discussion on the time, resources and associated costs to complete a Register for a major infrastructure project. Based on the my experience working on similar risk management tasks in industry and consultations with industry practitioners it was found that senior executives placed considerable importance on the risk management process in this Project that was reflected by the level and seniority of resources that they assigned to the task, frequency of meetings to update senior decision makers (monthly) required and the requirement that results were reported on a regular basis to the Board of Directors.

The Risk Manager, with input from the Project team, populated the first Register with the risks retained by CLCO based on a review of the Contribution Agreements and project documentation plus the internal and external risks to which CLCO was subject to in the execution of its objectives, and the updated draft Concession Agreement issued with the Invitation to Submit a BAFO. The Project team included consultants with international experience in rapid transit and major infrastructure project design/delivery who had considerable experience in such projects, which they used to identify and quantify the risks within the Register. The framework and risk quantification approach of a Risk Register developed by another Canadian PPP agency, Partnership British Columbia, which specialized in assisting government departments with PPP project delivery, was also reviewed to ensure that the document was comprehensive and consistent with industry best practices.

The initial draft of the Risk Register was prepared in approximately three weeks, and like later drafts, it was reviewed internally at two meetings of a review team comprised of the Finance Director, the Senior Vice President(VP) Technical, Senior VP and CFO, VP Environmental and Regulatory Affairs, Senior Rapid Transit Cost Consultant, and the Financial Advisor. Each reviewed draft was sent to the internal executive team for comments and further review.

Following the internal review process, three ½ day workshops with a group of external independent reviewers were convened. They met with select members of the internal Project team to review, finalize and add to the characterization and quantification of the risks within the Register. These external reviewers included individuals with experience in similar rapid transit projects, representatives from public contributing agencies involved in the project, advisors from Provincial Ministries of Finance and Transport, experts in the delivery of transport PPP projects in the Region, financial advisors, and the Project legal advisors. Following the workshops, the Register was then considered to be in its best and final format and was presented to the Board of Directors. Following the Board review, the Register and Risk Management Plan were then sent for final independent third party peer review by consultants expert in performance and risk management practices.

The Risk Register that was used throughout the negotiations with prospective Concessionaires required the expertise of individuals across disciplines internal and external to the Project Team. The Risk Manager emphasized that the inclusion of public sector partners in the risk workshops was critical to ensure their buy-in to the Project value ‘at risk’ that would ultimately constitute the CLCO reserve. This section provides the reader with indicative time and multidisciplinary resource requirements to populate, monitor and assess over the procurement phase of a PPP project.

3.4.3.3 Risk Register Content

3.4.3.3.1 Information Categories

The Risk Register was divided into four sections: a. Characterization of Risks; b. Quantification of Cost Impacts; c. Quantification of Schedule Impacts and d. Quantification of Total Cost and Schedule Impact. Categories of information captured in each of the four sections of the Risk Register are summarized in Table 9. The risk events identified included those for the procurement, construction, and operation phases of the project and risk events including those transferred wholly to the private partner. To provide a sense of scope of the Register, a total of 105 risk events were identified with most assessments qualitative (both likelihood and outcome). The categories of information captured are consistent with academic and industry recommendations including those by Patterson & Neailey (2002) and the worked example by Partnerships Victoria (2011a). Information that was not captured but recommended by Patterson and Neailey included: (1) the location where the risk may materialize; and the (b) phase or time when the risk must be evaluated. The Risk Register may be characterized as 'detailed' based on my experience reviewing and developing Risk Register's for large public sector projects as Director of PPP Centre of Expertise for a Canadian federal public institution with a portfolio in excess of $7 billion dollars. To note are the unique categories captured including the description of the current assessment of the risk event, whether or not the risk event is insurable and quantifiable, and a description of the event indicating that the risk event may materialize. The Project Team used the category 'current assessment of the risk event' to assist in the ranking or prioritizing of risk events often conducted by the project team. The categories ‘Insurable’ and ‘Quantifiable’ were included to assist in the quantification and identification of insurance requirements for purchase or through ‘self’ insurance by a participating public agency.

Table 9: Categories and associated definition of information captured in Risk Register

Risk Register Category	Definition
Risk Identification Number	The identification number for each risk category and risk event
Risk	The risk category
Risk Event	Brief description of the risk event under each risk category
Cause	A description of the cause of the risk event
Consequence to CLCO/Client	The consequence of the risk with respect to project objectives to either CLCO or the client
Current Assessment	The likelihood and consequence of risk prior to mitigation as: negligible, unlikely, possible, likely, almost certain, certain. Passed indicates the risk is no longer applicable.
Pro-active Risk Indicators	Failure to achieve interim milestones that indicate that Risk may be incurred subsequently
Mitigation prior to Occurrence	Pro-active mitigation measures to prevent the risk from occurring
Risk Trigger	Action or event that leads to occurrence of the risk
Insurable	Whether or not the risk is insurable. If "no", risk is not insurable; otherwise indicate the insurance required to cover Risk.
Quantifiable	Whether the risk can be numerically quantified in a meaningful way to add to total portfolio of risk
Funding of Risk	The owner of the risk event (CLCO or client)
Probability of Cost Impact	Probability that the risk event will result in a cost impact
Likelihood of Cost Impacts	Distribution of probabilities of cost impact (Low, Medium, and High where sum is 100%)
Cost Impacts	Distribution of cost impacts (Low, Medium and High) expressed in nominal dollars ($)
Gross Cost	Combination of likelihood and impact values for cost
Expected value of Costs	Combination of gross and probability cost impact values
Probability of Schedule Impact	Probability that the risk event will result in a schedule delay
Likelihood of Schedule Impacts	Distribution of probabilities of schedule impacts (Low, Medium, and High where 3 probabilities must sum to 100%)
Schedule Impacts (months)	Distribution of schedule impacts (Low, Medium, and High) expressed in months
Gross Delay	Combination of likelihood and impact values for schedule
Expected Delay	Combination of gross and probability schedule impact values
Expected Value of Delay ($)	With no schedule slack, the cost of accelerating project schedule to accommodate delay - Combination of expected delay and set cost of delay at X$/month.
Total Expected Cost of Risk	Sum of Cost Impact and Cost of Delay

3.4.3.3.2 Characterizing Risk Events

Two risk events, city permits and archaeological finds, are illustrated in Table 10 for the purpose of illustrating how the Project team characterized risk events as per a selection of the Register categories included in Table 9. Both risk events were identified as non-insurable but quantifiable with funding of the risk ‘City permits and approvals’ allocated to the private partner and funding of the risk ‘Archaeological Find’ allocated to the public entity through the CLCO risk reserve.

3.4.3.3.3 City permits and approvals

This risk event was described as ‘Concessionaire fails to receive regulatory permits from Cities on time’. The Concessionaire had agreed to assume the risk of managing city permits and approvals based on the signed agreements at Commercial Close. Cities may cause delay in the approval of designs; however, the Concessionaires’ confidence in assuming this risk event may be related to the confidence in experience and abilities of the stakeholders internal to the core Project team responsible for negotiating and setting appropriate terms in the agreement with the Cities and with the Cities themselves including those stakeholders holding political office. The Project was set on an accelerated schedule in order to meet the start of the Winter 2010 Olympics and any delay by any stakeholder would come under substantial pressure. The Risk Manager consulted its Contributors for input on the quantification of this risk event in addition to appropriate response and allocation. The evaluation of this risk event included the characterization of a number of stakeholders as risk drivers. No formal stakeholder analysis work was conducted by the Risk Manager and illustrates how these risk events are identified in practice without the use of formal or structured approaches.

3.4.3.3.4 Archaeological Find

This risk event was described as ‘Ancient human remains or artifacts found during construction. The Project entailed the construction of components including bored and cut-and-cover tunnels through areas in the vicinity of aboriginal habitats. The current assessment was identified as ‘Negligible’ based on a) the completion of a comprehensive assessment and b) the route for construction was considered well known and construction occurs on this route on a regular basis. If the risk event occurred and the project was delayed, the archaeological event would trigger a compensation event in which the Concessionaire must be compensated with both time and money. Multiple jurisdictions had familiarity with the historical construction activities and existing infrastructure along the transit route. Experts from these jurisdictions were consulted to provide input on the assessment of the risk event. The assessment of this risk event as ‘negligible’ illustrated the inherent confidence the Project team had in the familiarity with the construction route. Interesting to note that both physical (comprehensive assessment document) and environmental (construction route) features and associated attributes of the project context were intuitively assessed to quantify this risk event.

Table 10: Portion of Risk Register illustrating two risk events

Identification Number	Risk	Description of Risk Event	Cause	Consequences to CLCO & GVTA	Current Assessment	Pro-active Indicators	Mitigation Prior to Occurrence	Risk Trigger	Insurable	Quantifiable	Funding of Risk
1a	City permits and approvals	Concessionaire fails to receive regulatory permits from cities on time	Concessionaire and municipal staff unable to reach agreement on design	Construction delayed; scope changes; increase in costs	Unlikely: Cities signed Access Agreements at Commercial Close	Design approvals difficult to achieve without additional unfunded scope increases	All approvals built into Access Agreements	Concessionaire informs project team of potential delay	No	Yes	InTransitBC
2a	Archaeological Find	Ancient human remains or artefacts found during construction	Unknown historical habitation along the alignment	Construction delayed while archaeological assessment done	Negligible; assessment has been completed in well-known corridor	N/A	Additional site investigations	Discovery of unexpected remains or artefacts	No	Yes	CLCO Reserve

3.4.3.4 Risk Register Updating

The Register was in a spreadsheet format reviewed and updated on a monthly basis by the Project Team through the procurement phase. Revisions were added with input from internal consultants with real property, environmental, quantity surveying, financial, legal and engineering experience. Emerging risks were identified during monthly iteration reviews, either in one-on-one meetings or group brainstorming sessions. Risks retained by CLCO were formally reported and updated at six key project milestones over the course of the procurement phase, which began in November 2002 and was completed on July 29, 2005. These milestones included:

1. Pre-Best and Final Offer (BAFO) Stage (Oct 2004)
2. Analysis of submissions by two BAFO Proponents (Nov 2004)
3. After value engineering; decision to proceed to Preferred Proponent Stage (Dec 2004)
4. Pre-Commercial Close (Mar 2005)
5. Commercial Close (Mar 2005)
6. Financial Close (FC) (Jul 2005)

Resources and time dedicated to the review and update of the Register primarily focused around the Negotiation and Contract Award stages of the procurement process. At these stages, CLCO optimized selection of the preferred private partner and ensured that project costs at Contract Award were valid and best value. CLCO wanted to ensure that they had picked a partner that would meet its construction and service requirements over the 35-year operations period while also offering the best value at Contract Award. The value identified for the CLCO reserve that was highlighted in each version of the Risk Register fluctuated upwards and downwards over the course of the procurement phase, primarily driven by the evolving terms and conditions in each draft version of the Concession Agreement and Contribution Agreements agreed upon by the public sector partners and the management of CLCO. Managing the Risk Reserve with accountability and transparency to minimize requests for further funds from the public funding agencies was considered critical in maintaining its stakeholder relations with the CLCO funding partners. The dollar value of project risks retained by CLCO decreased significantly between pre-BAFO and Financial Close for three main reasons; (a) agreements by the preferred proponent to accept selected risk events were identified; (b) the mitigation of selected risks with the signing of the Concession agreement and finalizing agreements with participating agencies; and (c) the reduction of selected risks, such as the risk associated with property acquisition, as a result of project team progress in carrying out identified mitigation measures. The change in overall value of the CLCO Reserve illustrated the change in the CLCO risk profile as the project progressed, changes to the project context including associated Project Agreements, the need to reassess the sufficiency of the CLCO Reserve, and the validity of the Risk Register (characterization of risk events, values assigned, risk treatment and associated Project impacts). Provisions of adequate human resources and time were essential to update the Risk Register during the Negotiations and Contract Award Stages. Tradeoffs are required as these stages in the Project are also resource intensive for other project management tasks.

3.4.4 Risk Register Reporting and Project Communication

3.4.4.1 Reporting Post Financial Close

Once the Register and CLCO Reserve had been finalized during the procurement phase, the Risk Register was reviewed and updated at least quarterly during the construction phase of the Project following FC. Any changes to the Risk Register were provided to multiple Project stakeholders. Noted changes were provided depending on governance and communications requirements of stakeholders within the organization (from team members up to senior executive levels) and to the contributing agencies.

The CFO and senior financial, legal and engineering personnel were responsible for updating the Risk Register and notifying Project stakeholders of changes. The CFO also provided the Audit Committee with a quarterly update on the adequacy of the CLCO reserve and its ability to complete the Construction phase within the funds available at Financial Close. This quarterly report identified material changes to the characterization and quantification of the risk events in the Risk Register at Financial Close, which were attached as a Schedule to the most recent Risk Register that highlighted transfers of contingency and forecasts to the end of the construction period of sources and uses of all project funding. The Audit Committee provided updates to the Board of Directors who had the responsibility to ensure that risks to the corporation were appropriately managed.

The Risk Register was also used to update other public sector contributing agencies on Project risk status and the CLCO Reserve. CLCO provided reports to each of the public funders at different frequencies and details in reporting depending on the terms and conditions set out in the relevant Contribution Agreement. The reports issued were able to provide the assurance required because of the effectiveness of the management processes and that there were no significant unexpected changes to the CLCO Reserve. For example, one public funding agency was provided a report on an annual basis while another funder was provided a quarterly report.

3.5 **Identified Benefits and Challenges of the Use and Development of the Risk Register**

The CFO and project team identified several important benefits of the Risk Register document over the course of the procurement and construction phase of the Project. These benefits included:

1. The document was used to communicate changes in the project context during the procurement phase of the Project and to update the Board of Directors and public contributing agencies about the Project risks and Risk Reserve. During the construction phase, the document was critical to ensuring the sufficiency of the CLCO reserve. Senior executives noted that the Risk Register document was "taken seriously" by Project team members across levels of the organization and was reviewed quarterly at the executive level and monthly at the working level. That is to say, the document was not just a task on a checklist but was considered integral to the management of the project and useful in communicating and responding to stakeholder interests;
2. The level of detail in the Risk Register and importance placed on it by senior executives contributed to a higher level of discipline within the project team to reflect

the changes in Project context with the characterization of risk events (descriptive and quantitative);

3. The document was useful in identifying trends, including potential problems and remedies such that performance was delivered without resort to legal remedies in the contract. This was important for the maintenance of team relationships between the public and private partners as well as with the public funding Contributors;
4. During the procurement phase, the document provided structure for the agenda and management of project team update meetings and ensured that project team members were all intimate with project details (such as the Engineering Manager);
5. The document provided clarity on the identity of the risk owner and identification of remedial actions for appropriate allocation of tasks and management of those tasks.

The challenges included:

1. In developing the Risk Register, the Project team members did not have access to management databanks of information provided by the historical record of similar projects to identify risks and formulate a baseline for the quantification and characterization of risks. That is to say, knowledge management applications were not drawn upon;
2. It was difficult to achieve consensus across stakeholders on the expected impact for every individual risk. Stakeholders, across disciplines, had different perspectives and understanding of the Project context and associated changes as Project information evolved. There was no 'unified' view of the Project. As a result stakeholders had to sign-off the aggregate portfolio quantum of the Risk Register understanding that the expected impact may be incorrect for any individual risk;

3. Pressure by project stakeholders that the value assigned to the CLCO Reserve would not exceed its allocated budget. Contributors would ‘sweat’ the Reserve budget increasing over its allocation by $1m although that change is minor relative to the project budget of $2B, a Reserve in the 10’s of millions of dollars and the evolving nature of the Project over the multi year procurement period. Increasing budget allocations was perceived by public Contributors as undesirable due to potential negative communication fallout such as a loss in confidence or reputation by the general public, negative media or loss in public confidence. Parties were looking for an exact estimate for the Project Reserve although it was understood the Project was evolving as information, design and the multi year procurement process.
4. Some Project team members were not comfortable at times with the risk quantification process because it was not considered exact and struggled with coming to decisions and consensus. The Register was populated with best guesses based on expert experience, intuition, documentation review, consultation and validation with external experts. A more formal approach would have given participants greater confidence; however, the Register implemented at the time was considered best practice;
5. Force Majeure risks events (such as act of terrorism, nuclear catastrophe) identified as low probability of occurrence and high impact were not quantifiable;
6. Interviewees found that it was difficult to track changes in the different versions of the Risk Register developed in the procurement phase to identify the evolution of changes over time. As a result, this created challenges including time/resource

expenditure to identify and rationalize the changes with the various stakeholders who received regular risk status reports; and

7. Updating the Risk Register risks identified and emerging risks with respect to changes in the project context, assumptions, changes in the regulatory or organizational environment over time was a challenge. The Register was in a spreadsheet format and therefore required manual changes to reflect particular changes to funding and Concession agreements as they were finalized. This was considered a difficult and resource intensive exercise.

3.6 **Observations and Lessons Learned**

Ongoing discussions with the project team members led to several valuable insights in carrying out a risk management process in a large infrastructure project. Following are some of the lessons learned based on the findings of this case study.

Dedicate a risk manager

Assigning a project team member, at a senior level, to perform the role of a risk manager responsible to focus on the risk management function informs project members that the position is important. A risk manager is responsible for the management of a comprehensive risk database, and ensuring the Risk Register is up to date relative to changes in the project context and mitigation strategies as emerging risks arise. The Risk Manager is the knowledge steward of risk events that are common across disciplines, information sources and considerations made in the risk quantification process. The value add of the Risk Manager is their ability to identify the interrelated aspect of risk events, which individually may not be considered among Project team members, providing the input into the Risk Register. Skills in helping Project team resources to think creatively about risks, facilitate workshops and consolidate information across disciplines are very important.

Risk Register serves to assist in Characterizing Risk Profile

In this Project, a Risk Register was developed for each of the two short-listed proponents to facilitate the negotiations process. The Register serves as a depository of the sorts of information that can serve to compare risks associated with each proponent's technical solution and team. No two proposals are identical; therefore, a Register serves a purpose for documenting differences and similarities in the risk allocation and for the characterizing of the proponents.

Organizational culture and policy places importance on the risk management function

The culture and policy of an organization initiated from the executive management level impacts the scope and importance that project team members place on the application of risk management practices. An increasing trend towards strong corporate governance includes explicit treatment and management of risk including the application and monitoring of appropriate systems. In addition, it became apparent that Project personnel understanding of risk management theory and techniques differed significantly. Training and calibration of Project team members prior to each risk workshop is critical prior to the elicitation of expert opinion and inputs to the Risk Register.

Use diverse information sources as input data

Many sources of information, research, and expertise across disciplines are required to identify, quantify and manage risks in a large infrastructure project. Project team members consulted to provide input ranged from those with experience in both public and private sector project delivery, including members directly involved in day-to-day Project activities and those from 'Partner' organizations involved on an as-required basis. Of particular note, the Risk Manager consulted with individuals from the Contributors dedicated teams for input on the quantification and response strategy of risk events influenced by political activities and external stakeholders.

Draw upon experts from multiple disciplines

A significant challenge was the identification of the various risk types, which included financial, economic, environmental, organizational, contractual, technical and political, and the review of whether the quantification of these risks was reasonable. Experts with extensive knowledge of the risks that may be encountered on a project are required to perform the risk management functions and/or audit to ensure the quality of the risk management plan

Understand stakeholder output expectations

Different stakeholders (financiers, public at large, Boards of Directors, project team, public contributors) involved in the delivery or oversight of a project and its funds have different requirements and uses for outputs from the risk management process. Stakeholders such as the Board of Directors use the outputs for corporate governance and accountability; public financial contributors use the output to ensure that they are following accountability requirements as set out under their fiduciary duty; project team members use the outputs for day to day operations; while the public at large may look to the output documents to provide confidence that industry best practices were followed and value for money was achieved in the expenditure of public funds. The diverse output requirements illustrates the difficulty in developing a single terse output that is useable and comprehensive to each stakeholder's needs and their respective viewpoint on what constitutes a 'quality' output.

Different project stakeholders require a different level of detail and aggregation of risk events. Stakeholders intimately involved in the delivery of the project (such as the project manager) may require comprehensive identification of project risks while senior executives may be interested in the aggregation of project risk events into 5-10 key risks.

Integrate risk management function with other project management tasks

Risks are associated with the heavy involvement of multi-level government agencies, each with different expectations on reporting and underlying governance policies, in project planning, design and execution. Reporting to these stakeholders and project communication management is internally and externally critical to the project due to this involvement of multiple stakeholders. In addition, PPP projects of this scale entail negotiations with the private sector; a Risk Register provides a tool to assist in the process and mental cues on allocation of risks and associated remedial actions are identified.

The Risk Register was considered a useful tool for responding to stakeholder reporting needs, communications and negotiations.

Understand the dynamic nature of project data

The content of the Register changes over time during the procurement and Project implementation phase leading to a difficult information management task. Information within a project evolves as the design comes to completion, construction methodologies are selected, project teams members contribute their expertise to refining project details, and agreements are solidified.

3.7 Desirable Features of a Risk Management Support Tool and Approach

The case study brings to light a number of risk management support tool and approach 'objectives' or features that are desirable from the perspective of practitioners and in particular the individual 'Risk Manager'. A summary of findings from the case study indicate the objectives of a risk management support tool and approach include:

- Assists in or may be used to facilitate project communication tasks and the identification of stakeholders and their requirements;
- Capable of tracking changes in project context and associated risk information;
- Knowledge and information management capacity for reference over a project's multi-year lifecycle and retaining corporate memory for future projects;
- Model project context information to facilitate consensus and understanding of project details across participants in a risk workshop or interview setting;
- Facilitate the training and calibration of participants involved in the risk management process where practitioner knowledge of risk management theory and techniques is lacking;
- Terminology is understandable by practitioners across disciplines; and

- Risk reporting and documentation structure is flexible to accommodate diverse stakeholder requirements.

The case study also illustrates how members of Project executive and management use outputs of the risk management tasks in project communications with a diverse stakeholder set (Contributors executive, Contributors Project team, Board of Directors, etc.). These stakeholders each have different roles and responsibilities in the project and the identification of these stakeholders, their interests and following through in accommodating their requirements becomes critical for successful organization and project management. Accommodating each of their requirements can be resource intensive; however, failure to do so can impact project stakeholder trust and relations across groups and associated partnerships. Tools and support approaches to assist in this function must facilitate the identification of the stakeholders who best provide inputs to the risk management tasks or require associated outputs, clarity of their interests and requirements and appropriate risk management tools and approaches to support documentation and information management needs.

3.8 **Conclusion**

The case study described in this chapter provides readers with a detailed lens on the process carried out to develop, update and report on the Risk Management Plan and Risk Register for a major, complex infrastructure PPP project including lessons learned that may be useful for future projects. The chapter highlights the need to place a significant level of importance from an executive management level on the outputs and systems in place for the project risk management process. Outputs from this process assist a Project team to make key decisions early in the project such as the appropriate partner selection and terms for negotiation (including the quantification of the value for money of one proponents proposal relative to another); optimal allocation of risk between public or private sector; procurement documentation development; and negotiation strategy with the private sector proponent. Practitioners face a number of challenges related to: the dynamic nature of project data; elicitation of quality qualitative and quantitative inputs as to risk event likelihoods and multidimensional outcomes (e.g. time, cost, safety, etc.); interpreting and understanding a project's risk profile; tracking and managing risks during the project's life cycle; integrating the risk management function with other project management functions; and managing knowledge for future re-use. Addressing these challenges will improve these risk management steps and therefore facilitate better quality decision-making and investment analysis, which is a motivation of this research.

Chapter 4: **Key Risks Managed in the Planning Phase of the First Canadian Federal Real Property Public Private Partnership Project**

4.1 **Introduction**

The front end planning phase of a large infrastructure project often spans a period exceeding that of the construction of the asset and involves decisions and risks that can delay the go ahead of the project or cause its ultimate cancelation. The number and breadth of risks requiring attention and management during this phase are significant for all large infrastructure projects and are further compounded by new risks when decisions such as implementing a new form of project delivery are made. Specifically, implementing a new form of project delivery such as a public private partnership (PPP) in a large public sector organization with established processes, responsibilities to meeting multiple stakeholder interests and internal employees comfortable and efficient at implementing traditional processes is both a challenge and driver of risks. The PPP approach to project delivery is often touted as having significant benefits and is a popular mode of procurement for consideration by governments at all levels in Canada. However, the approach is relatively new to most jurisdictions, involves a document intensive transaction requiring significant upfront planning resources (human and financial), and Canadian federal policy and standardized templates to guide processes are in their infancy. Transition of an organization to consider, plan for and implement the approach entails risks over and above the myriad of risks requiring management in the planning and procurement of any large infrastructure project using a conventional delivery mechanism. These front end planning risks occur at both the organizational and project level and can have significant impacts on either the success of the Project being planned or the objectives of the organization(s) which identified the initial ‘need’ for the Project. Drivers of risks associated with implementation of a new project delivery approach are primarily those of stakeholders responsible for its review, implementation or approval and relate to the concept of change management within an organization. Despite the potential benefits of a PPP approach, disregard of the organizational and project related risks can result in project failure if not identified and responded to early.

This chapter aims at describing the key risk issues identified and managed by a Canadian federal public sector organization implementing the first federal real property PPP in Canada for the delivery of a large infrastructure high security facility. The Project team explicitly identified select risk issues upfront in the risk identification process and documented these issues in the Project risk register. Other risk issues described herein were not explicitly identified in the Project risk register; however, mitigation steps were taken to reduce potential adverse impacts. The chapter serves as a case study describing the key risk issues that arose during the Project planning and procurement phases (collectively termed the front end planning phase), how they were managed successfully and emphasizes the importance of managing risk issues that are driven by stakeholder or process factors in project delivery. As a first of its kind in the Canadian federal government, the Project team needed to both identify and respond to risks early and implement new processes and adapt existing processes for successful Project approval and procurement in the market. Responding to stakeholder concerns and interests was identified as critical to the Project risk management process and Project procurement. Unfortunately, documented examples of successful approaches of organizations responding to risk issues in the early phases of project delivery phases are scarce particularly in an organization operating in a change management context. A study of risk management in large software projects by Bannerman (2008) noted that projects tended to have fewer problems and failures when organizational change was managed concurrently from the beginning of the project. Unique in this chapter is a discussion of those risk issues identified in the front end planning of a project and which are outside of those addressed in the Project agreement, which if not dealt with due consideration could ultimately result in the failure of the Project. Lessons may be learnt by organizations interested in both adopting a change in project delivery direction and successful risk management in large infrastructure projects.

4.2 **Background**

Large infrastructure projects are often characterized by a broad scope and capital dollar size, dynamic stakeholder and governance network, high project risk profile, long front end planning timelines, and high visibility to the public and political partisans. In the context of this chapter, the term stakeholder is defined as "persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project" (PMI, 2008). Front end planning and procurement of large infrastructure projects with these characteristics, thus require the management of processes, stakeholders, and both project and organizational risks with the utmost attention for successful delivery. This is particularly the case for public sector organizations that are implementing the procurement approach for the first time while addressing internal change management hurdles. Research on large infrastructure public private partnership (PPP) project failures highlighted the critical importance of managing risk issues (Akintoye et al., 2003). Although there is a substantial amount of research on PPP risk management, the application of detailed corporate and project risk management in the public sector is infrequent (Fischer et al., 2010). Yet capturing and addressing stakeholder inputs (El-Gohary et al., 2006; Yuan et al. 2010) is important for the success of such projects. The consideration and review of the PPP delivery mechanism over more traditional approaches and the associated comparison of opportunities for risk transfer to the private sector through a PPP has increasingly forced the public sector to spend more time and resources on risk management tasks. The identification of risks early in the process is critical to the delivery of a project in a cost and time effective manner (Uher & Toakley, 1999) and for PPP projects in particular suitable processes should be put in place for the procurement and governance to ensure that the project team is supported and the Project is both marketable and affordable (Fischer et al., 2006). There is a wide array of potential benefits from using a PPP form of procurement for large infrastructure, but implementation of the approach and management of risks at both the organizational and project level is not a simple task.

Governments worldwide have been rethinking how public assets are procured and operated driven by their infrastructure deficit and the need to achieve value for money. This has led to the consideration of alternative procurement approaches such as the PPP approach. Joyner (2007) summarized ideological and pragmatic motivations driving public sector entities to consider PPP to meet the increasing demand for new infrastructure including: demand exceeding capability of public sector to deliver; access to private sector capital, skills and risk-bearing capabilities; improved quality, accountability and speed in delivery of capital needs; and opportunity for public sector entity to focus on core capability. In the Canadian context, Murphy (2008) identified the benefits of PPP delivery to be accelerating construction, on time and on budget delivery, shifting risk to the private sector, cost savings, and customer service improvements, thus enabling the public sector to focus on outcomes and core business. These motivations are aligned with those of the Government of Canada where PPPs are seen to deliver infrastructure with greater cost and schedule certainty relative to traditional forms of project delivery. The private sector is considered to be in a strong position to manage many of the risks associated with the construction, operation and financing of infrastructure projects (Canada, 2007). Although PPPs may result in cost certainty, improved efficiencies, innovation, and timely delivery of projects, these benefits come with additional costs relative to conventional procurement including the cost of transferring selected risks to the private sector, higher financing costs and higher transaction costs (Iacobacci, 2010). In addition, there are the implicit risks and associated costs that arise in changing an organization and the market place practices and processes to this new project delivery approach, which is new to most public and private sector market players. Given the keen interest by governments to evaluate and implement this new approach, the decision to do so may result in new risks in addition to the myriad of 'traditional' project risks managed in the front end planning stage of any large infrastructure delivery. Abdel Aziz (2007) identifies a number of general barriers for PPPs, which may also be interpreted as risks in the implementation of the PPP delivery mechanism, including: social, political, and legal risk; unfavorable economic and commercial conditions; inefficient public procurement framework; lack of mature financial engineering techniques; problems related to the public sector; and problems related to the private sector.

There is much published research on risk management in large infrastructure projects (Akintoye et al., 2001; Biehler et al., 2010), but there are few case studies that outline risks issues identified and managed in the early front end planning and procurement phases of project implementation. These risk issues may have an impact on the schedule, budget or quality targets, and drivers of these risks are often stakeholders or processes. Shen et al. (2006) reviewed a series of studies on the performance of public sector projects (11 in total) and summarized the risks that affect performance (noted to primarily occur in the early phases of the project lifecycle) in the following categories:

Project-related risks: These risks include cost and time overruns, poor contract management, contractual disputes, delays of tendering and selection procedures, poor communication between project parties.

Government-related risks: These risks consist of inadequate approved project budgets, delays in obtaining permissions, changes in Government regulations and laws, lack of project controls, administrative interference.

Client-related risks: These risks include inadequate project budgets, poor project brief, variations in project specifications, delays in the settlement of contractor's claims, lack of project control.

Design-related risks: These risks represent inadequate soil investigation, delays in design, ambiguities and inconsistencies in design and design changes.

Contractor-related risks: These risks include inadequate estimates, financial difficulties, lack of experience, poor management, difficult in controlling nominated subcontractors.

Consultant-related risks: These risks represent lack of experience, performance delays, poor communication with other project parties.

Market-related risks: These risks include increase in wages, shortages of technical personnel, materials inflation, shortage of materials, shortage of equipment required.

Of significant note is that, many of the risks affecting performance are risk events driven by stakeholders and processes such as ‘delays in procedures’, ‘interference’, ‘lack of experience’, ‘poor management’, ‘poor communication’, ‘ambiguities’. These are findings that concur with that of this Project case study and illustrate the importance of managing risks related to processes and stakeholders in the front end planning phase of a project as further illustrated in this Project case study.

Related to the concept of processes and stakeholders, Levitt et al. (2010) identifies governance challenges for delivering large infrastructure projects based on their unique attributes and the organizations involved including:

1. Political legitimacy of private ownership/operation;
2. Difficult to recover full cost from end user fees;
3. High potential for corruption in contract award and administration;
4. Very high transaction costs; Frequent renegotiation;
5. Over-optimistic forecasts of costs and revenues;
6. Lack of market incentives for efficient operation and adequate maintenance;
7. Displaced agency; Suboptimal technical and business decisions;
8. Coordination complexity; Cost and schedule overruns; Slow diffusion of innovations;

Except for item 3, the other items are largely applicable to North American jurisdictions in varying degrees, and all are applicable to most developing countries. Levitt et al. (2010) indicates further that contracts and unified private sector governance through a PPP cannot mitigate these outcomes or challenges alone and suggests other mechanisms such as “fair-processes” are required, processes already implemented in a number of jurisdictions, including Canada. Lehtiranta (2011) elaborates on the lack of a theoretical foundation for managing relational risks within construction project organizations, which are indirectly treated through stakeholder and communication management concepts. Lehtiranta (2011) further identifies the need for an understanding of human interactions as a source for success or failure. The risk issues identified in this chapter and management responses adopted align with these views and highlight “fair processes”, “collaborative processes”, and “network/relationship processes” as mechanisms adopted by the Project team to respond to the risk issues. The focus is on stakeholders as the drivers of many of these risk issues and the need to clarify concerns, develop relationships and trust. Social exchange theory and network theory touch on the importance of these aspects but application in construction management research is in its infancy and project governance has only recently become an issue in the project management community (Samset, 2008). Chung et al. 2009 summarize a number of computer aided tools available to aid practitioners in the front end planning phase and an information communication technology framework to support stakeholder engagement in a virtual environment; however, it is important to note that developers of these tools acknowledge the importance of stakeholder engagement and collaboration, in particular in large infrastructure projects with major cost and schedule implications, yet these tools have not been found to be implemented by Canadian practitioners. Overall, there is little guidance on processes and stakeholders as drivers of risks or on how implementing a new delivery approach, such as a PPP, in a public sector organization impacts the risk process or the risks that may arise. The purpose of this chapter is to help close this gap. Its scope is limited to the front end planning phase, and more specifically is defined as post Project 'need' identification prior to the release of Project procurement documentation (Request for Qualification, RFQ) in the context of this chapter.

Figure 7: Case study project phases of interest

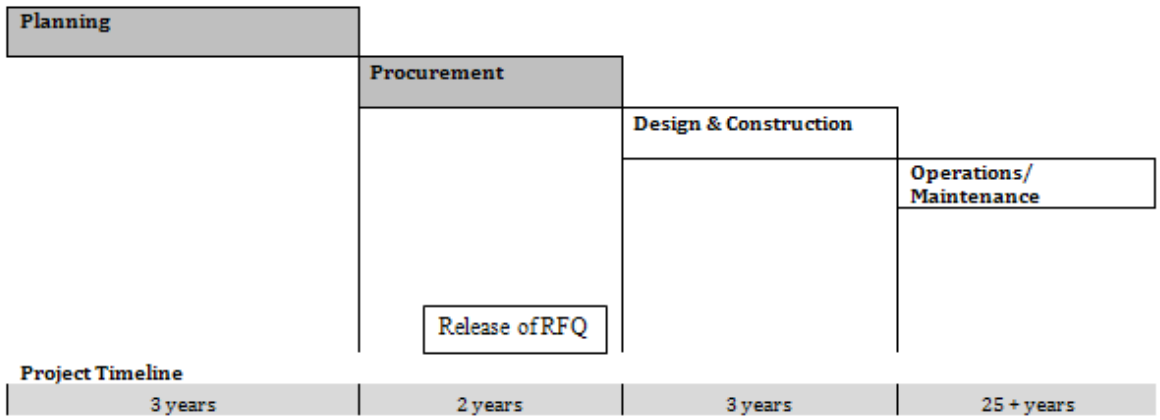


Figure 7 illustrates the Project phases of interest addressed in this chapter. Over this period there are risks realized in the front end planning phases and development of project procurement documentation (first stage in the procurement stage) and prior to the release of the Request for Qualification (RFQ) that can result in diminished Project value, increased costs (both human and financial) for the planning of the procurement and of the potential scope of the bid and extended timelines. In addition, during this early project phase, missed opportunities may arise where risks are not managed appropriately such as structuring the procurement in such a way that maximizes private sector competition and draws upon their expertise in the most efficient manner. Impacts of risk events that occur at this stage can be both linear and nonlinear. For example, a non linear risk event may be that of missing a deadline for submitting project documents for approval by a matter of a week with the impact being a delay of months because of predetermined agendas and scheduled approval committee meeting dates (such as meetings of the federal Treasury Board).

The remainder of this chapter is structured as follows. First, a description of the PPP market in the Canadian context, which includes its definition, drivers behind its consideration and public sector uptake, is given. This is followed by a description of the Project from which much of the content of this chapter has been derived and its unique characteristics as a large infrastructure project, delivery approach adopted and the public entities driving its implementation. Risk issues pertaining to the front end planning phase and deemed significant by the public sector Project Owner organization, and the respective response strategy are outlined.

4.3 Canadian PPP Context

All levels of government in Canada are involved in the delivery of new infrastructure and improvements to existing infrastructure and the PPP model is increasingly seen as a viable means to meet both needs. All levels of government have also implemented the approach over the past decade across construction sectors; however, most commonly in the transportation and social infrastructure sectors. The Canadian PPP market has become one of the most active globally (DBRS, 2011) and over 150 PPP projects have been completed in Canada since the early 1990s (CCPPP, 2011). Projects that reached financial close under the auspices of PPP agencies that were set up in the early 2000s (termed the 'second wave') found projected or forecast savings between 0.8 and 61.2 per cent per project where savings were expressed as a proportion of what it would have cost the public sector to procure the projects through conventional contracting methods (Iacobacci, 2010). The PPP project delivery approach is increasingly perceived as a viable and attractive alternative procurement mechanism by public sector entities, which justifies analysis relative to traditional delivery mechanisms.

A number of Canadian Provinces have been relatively proactive in the consideration and implementation of the PPP model. By 2011, the Provinces of Ontario, British Columbia, Quebec, New Brunswick and Alberta created agencies or departments within their respective Province with the mandate to bring both public and private sector players together and facilitate the consideration and use of the PPP model for project delivery. Of these Provincial agencies, the Provinces of British Columbia and Ontario have the longest standing agencies and project volume. The presence and activities of these agencies have become key instruments for facilitating the PPP market in their regions resulting in both consistency and standardization in the drafting of procurement documents and communication of the merits of the PPP approach to all stakeholders (both public and private). However, the federal government is relatively new to the implementation of PPP projects.

On November 23rd, 2006, the Canadian federal Minister of Finance announced that the Government of Canada would facilitate the broader use of PPPs in Canadian infrastructure projects (Flaherty, 2006). PPPs were seen as a mechanism to leverage the Governments' infrastructure investment requirements and deliver projects faster and at a lower cost than traditional forms of project delivery in Budget 2007 (Canada, 2007). Since the Budget of 2007, the federal Government has evaluated the merits and broader use of PPPs where funds were allocated for the development of a federal PPP office, PPP Canada Inc., with the mandate to identify and execute PPPs at the federal level as well as to oversee the assessment of PPP options for Provincial and Municipal proposals that were seeking federal funding assistance. The Government of Canada intends to expand the use of PPPs as per Budget 2011 (Canada 2011) and require all federal capital projects exceeding $100 million to evaluate the potential for using the PPP delivery mechanism. Federal departments are encouraged to explore the feasibility of adopting the delivery mechanism for other procurements of services and projects. The Budget 2011 (Canada 2011) highlighted:

> *All infrastructure projects creating an asset with a lifespan of at least 20 years, and having capital costs of $100 million or more, will be subjected to a P3 screen to determine whether a P3 may be a suitable procurement option. Should the assessment conclude that there is P3 potential, the procuring department will be required to develop a P3 proposal among possible procurement options.*

As of 2011, two PPP projects in this 'second generation' have been procured and reached Financial Close by the Canadian federal government totaling over 2 Billion Cdn. ($2010) in investment. Activity across levels of Canadian government has also been generated by PPP Canada Inc., which operates a merit based grant program to incent governments to consider the PPP procurement mechanism. In June 2011, the most recent call for submissions for grant submissions to PPP Canada Inc., there was an increase in project applications from 73 in the previous year to 121 submissions. Of these submissions, 80 were from municipalities, 16 from First Nations, and 9 from Provinces and Territories illustrating the range of public entities considering the approach (PPP Canada, 2012).

4.4 A Definition of a Canadian PPP

There is no universal definition of a public private partnership (UN, 2004) and Jeffries & McGeorge (2009) explains why this is the case. The definition of a PPP in Canada differs across the Canadian jurisdictions. Within the Canadian federal context, a PPP has been defined by PPP Canada Inc. (2011) as:

A cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards. The "partnership" is a contractual relationship that spells out the roles, responsibilities and accountabilities of both the public and private sector parties to the contract. The contract sets out the allocation of project risks between the parties. The typical length of the PPP contract term is known as the concession period, which ranges between 15 to 30+ years in the Canadian market.

Broadly speaking in Canada, PPPs are characterized by the integration of two or more phases of a project in performance based contracts, financed in part or whole by the private sector and project delivery stewardship by private sector professionals. The contractual agreement between the public and private entities typically outlines a performance payment mechanism, performance standards, and delegation of power to collect user charges over the contract duration. A traditional approach to infrastructure delivery involves contracts with several parties such that there is no integration of private sector contracts over the project life cycle. For example, a private sector entity involved in the design of the infrastructure is not involved in the operations or maintenance stage. It is believed that through PPPs the private sector has a greater incentive to meet budget and schedule objectives and provide a reliable well-operated and maintained infrastructure asset over the long term since it has a financial stake in the project and is profit driven. Value for money is based on the transfer of risk from the public to private sector and opportunities for private sector innovation, management efficiency and integrated whole life design efficiencies.

4.5 Project Description

A high security Canadian federal facility ("the Project") was proposed to include approximately 55,000 square meters of useable office space and special purpose spaces to accommodate over 1800 employees. The Project was developed for use by the federal tenant organization (Tenant), which would enter into a lease agreement with the federal contracting organization (Owner). Representatives of both the Owner and Tenant organizations had key joint roles and responsibilities in Project planning and procurement documentation development. The joint involvement of two federal organizations added significant complexity to the decision making and project management activities requiring consensus in defining the Project costs, scope, timelines and meeting procurement approval requirements. This complexity was compounded by the fact that the PPP procurement approach was relatively new to the Tenant and Owner organizations as well as the federal agencies and departments providing review, consultation and approvals to the Project.

The Project involved the relocation into one consolidated headquarters of more than 20 Crown owned or leased spaces geographically dispersed across a region. The need for the Project was identified more than 20 years prior to Project contract award and was considered critical for the Tenant organization to maintain operational efficiency. The status quo accommodation scenario was significantly overcrowded, poorly located for efficient response to operational requirements and at the same time the majority of Crown-owned facilities were reaching the end of their useful life when refits would be wastefully expensive. The Tenant organization was growing to achieve the Government of Canada (GoC) safety and security mandate for Canada and its' citizens, putting further pressure to accommodate the real property needs for the anticipated increase in personnel. The Project was the first real property PPP procurement of its kind at the federal level and served as a pathfinder for other federal projects suitable for implementation in the PPP model. Extensive support for Project success came from several levels, including the Project team, the senior executive of both the Tenant and Owner and the Government at large. Any delays in the delivery of the Project would have significant implications on meeting the Tenant organization operational mandate. As the 'first of its kind' PPP, the many GoC media releases provided evidence of support for the PPP approach where 'value for money' was achievable.

The Project was both capital and operationally intensive, with present value costs in the order of $960 million (2010 dollars), a procurement period spanning more than a year (which is fast given the scale of the facility and knowledge status of the Owner and Tenant organizations) and a construction period longer than 2 years. It was unusual for a facility of this size and with its unique program requirements to be constructed in the region and the Project was identified as a PPP early in the business case analysis based on a thorough value for money analysis. The procurement included the release of a Request for Expression of Interest (RFEI), Request for Qualifications (RFQ) and Request for Proposal (RFP) for the design, building, maintenance and financing of the Project. The RFP established the process and schedule requirements for proponents prequalified under an RFQ process to submit proposals to the Owner for evaluation and determination of a recommended private sector proponent (Project Co.). Project Co. would be required to enter into a Project Agreement that would be in place between the Owner and Project Co. for 25 years following construction completion. The intent of the procurement process was for the joint Owner and Tenant public sector team (Joint Project team) to select Project Co. to design the Project; obtain all required planning approvals; and, complete drawings, specifications, schedule, and cost budgets in sufficient detail to allow Project Co. and the Owner to obtain all of their respective final approvals for Project implementation.

4.6 Drivers for the Implementation of the PPP Delivery Approach

In determining whether the PPP would produce value for money, a comprehensive analysis of the PPP approach was compared against two alternative procurement methods: Design-Bid Build (DBB) and Design Build (DB). A number of benefits of the PPP approach were identified based on the original assumption (confirmed through a market testing) that the project documentation and procurement process developed would attract the necessary market interest and competitive bidding environment for them to occur. The primary risk issues identified later relate to not creating the environment to achieve these benefits.
The benefits identified included:

1. Full design risk transfer: Unlike the typical 1 or 2 year Design-Build warranty period, a PPP offers the opportunity for full design risk transfer where the specifications are clear, concise and output based, and the public Project team does not “take back” any of the risk through interference.
2. Schedule risk transfer: Subject to supervening events beyond control of the winning private sector Proponent (Project Co.), a PPP transfers schedule risk for Project completion to its private partner. If Project Co. is behind schedule and the start of the service is delayed, the total term is not extended. This acts as a type of penalty for late delivery.

3. Management of Project scope: The Project must be thought through and outputs defined in the planning and procurement phases so that private sector proponents may clarify and price the Project during a competitive dialogue. After contract agreement signing and award, the private partner reviewing the changes in design, construction and operations and maintenance impacts over the full project lifecycle prices out any change in scope required by the Public Sector Sponsor (Owner). All-in pricing can serve as a deterrent to owner initiated scope changes and associated budget and schedule variances that typically occur on traditional projects.
4. Payment mechanism includes performance indicators: The public sector Project Owner has full recourse to the private capital (debt and equity) throughout the term of the contract and where select performance indicators are not achieved, the monthly payment may be reduced. In turn, as the public sector funds for operations, maintenance and lifecycle costs are assigned at Project approval, departmental pressures to defer or reallocate preventative maintenance activities disappear and the asset is operated and maintained by the private partner according to both long and short-term lifecycle management plans. The Design, Build, Finance and Maintain (DBFM) project agreement features a single payment (or annual service payment) that combines repayment of capital and payments for ongoing operations and maintenance and puts Project Co, and its lenders, at risk for the capital as well as the operating costs. Deductions are made to the single payment based on poor performance in operation and/or condition of the facility, and provide an incentive to Project Co., therefore reinforcing risk transfer.

5. Project documents are not prescriptive: Project documents are performance or outcome oriented versus prescriptive in nature. Forcing the public sector to focus on the outcome or desired result rather than the solution enables the private sector proponents to implement innovations and efficiencies that may otherwise not have been identified. The agreement also integrates separate design, construction and operations/maintenance contracts into one single contract encouraging the private sector proponents to consider a holistic, value focused approach to the design, construction and operation of the asset.
6. Private sector lender involvement: The involvement of private sector lending on both the debt and equity portions of Project financing introduces additional oversight to the procurement, construction and operation, and maintenance phases of the Project. These lenders assess the viability of the Project relative to market norms, whether the identified risk transfer between parties is appropriate with their monies at risk and have incentives (due to their monies being at risk) to ensure construction work is performed with a long-term view.

These six key potential benefits of the PPP delivery approach were identified up front and the associated opportunities for risk transfer to the private partner were then identified. The ultimate impact of poor documentation and procurement process development as an integral part of the planning and procurement stages was not generating sufficient market interest or competition, thus denying realization of the potential benefits offered by PPP delivery. The following overview of the risk management process emphasizes the key risk issues identified and managed by the Project team in the front end planning phase.

4.7 Risk Management Process

The risk management process began early in the identification of Project 'need'. In this case, the process adopted, after approval by the federal Treasury for expenditure authority to examine activities to determine if the PPP would produce value for money (business case development) and development of project documentation. The industry norm to validate the selection of the PPP delivery approach entailed a more robust and resource (human and financial) intensive risk management process than the internal requirements of both the Owner (Nelms et al., 2006a) and Tenant organizations. The senior executives in both the Owner and Tenant organizations recognized transition to the 'new' risk management process as critical to the success of the Project and resources were committed. The negative impacts of poor risk management processes outlined in the construction literature, such as increased uncertainty to project outcome, financial loss, overlooking liabilities, and ineffective decision making (Loosemore et al., 2006) were to be avoided. I assessed the risk management maturity of the lead public sector organization, the Owner, responsible for the project management activities and expenditures as Managed (Level 3) based on the 'Description of Maturity Levels' (Zou et al., 2010) and based on the Risk Management Research and Development Program Collaboration (RMRDPC, 2002). Level 3 is defined as an organization that has formalized, implemented and documented generic risk management systems and processes where the benefits are understood at all levels of the organization (Zou et al., 2010). Based on my expertise in leading the PPP procurement and business case developments in Canadian federal major crown projects and programs, it is clear that Level 4 Optimized maturity level is required so that the Project team implementing a PPP can meet the industry norms and due diligence requirements set by Canadian PPP agencies for business case development. Level 4 is defined as achieved by an organization that has a risk-aware culture with a proactive approach to risk management in all project activities (Zou et al., 2010). The risk management process involved the hiring of management consultants to facilitate more than 10 risk workshops held during the 2 years of project planning and documentation development. Consultants supplemented the expertise of the public sector Owner organization and brought the necessary level of experience in conducting risk management tasks for the size and complexity of the Project. Consistent with the activities recommended by Zou et al. (2010) to move an organization from Level 3 to Level 4, the Project team: populated a Project risk register based on input from individuals across disciplines including those with experience of successes and failures on similar Projects, undertook regular reviews of the Project risk register, dedicated time and financial resources to the process and its integration with other project management tasks, and ensured regular risk management training to update Project team and risk register workshop participants skills and knowledge.

4.8 **Risk Issues Identified**

Risk issues including those pertaining to the political, administrative, and organizational context of the front end planning phases of Project delivery (see Figure 7) are discussed and include the response strategy adopted by the Project Owner. A risk issue is defined in this chapter as a category of individual risk events of the same nature – e.g. geotechnical risks, regulatory risks, capacity risks, etc. These are areas of interest for management at all stages of Project delivery but have been identified based on particular need for treatment at the front-end planning and procurement phases to ensure Project progress and its subsequent approval for expenditures. Each of these risk issues involves interplay with internal and external stakeholders who may drive the risks. This interplay is often identified but rarely discussed in detail in the literature, although it is important for the successful delivery of a Project and an organization's mandate. Each of these risk issues, independent or in combination, should be managed with diligence to avoid significant extra cost, schedule changes, reputation and political consequences, possible failure of the Project and/or adverse impacts on the participating public sector organizations and associated GoC strategic objectives. Selection of the 'key' risk issues are based on my experience and participation in the Project and post Project participation in more than 10 federal PPP initiatives. The probability of success in minimizing adverse impacts through processes and project documents that generate market interest and a competitive bidding environment is critical as well as responding to the concerns of Project stakeholders.

Risk issues discussed pertaining to the front-end planning phase of the Project include the following:

1. Limited Project Personnel PPP Experience and Familiarity
2. Limited Federal Department and Agency Experience and Familiarity with PPP
3. Limited Precedent Jurisdiction Contract Language
4. Establishing a Market Acceptable Governance Framework
5. Integrating New PPP Process With Existing Processes
6. Responding to Regulatory, Policy and Legislative Issues

4.8.1 Limited Project Personnel PPP Experience and Familiarity

It is uncommon for a facility of this size and unique program requirements to be constructed both in Canada and internationally. This Project was the largest real property project ever procured by the Owner in British Columbia, Canada. The Tenant organization is often influenced by world events and complex domestic or international situations. This makes it difficult to identify technical and associated performance requirements as well as its changing needs, which have implications for the development of technical, security, post disaster and environmental design requirements. The PPP delivery approach does compound project complexity, which is a significant departure from the more traditional forms of project delivery (such as Design Build and Design Bid Build) where the roles and responsibilities are understood by the public sector Project team members and the pace of development not as intense. Few of the Canadian public sector professionals had either recent experience with large infrastructure delivery or the PPP delivery approach due to the Projects 'one off' nature and the newness of the PPP procurement methodology in Canada. The perception of many of the public sector professionals was that PPP delivery was a loss of control where their role focuses on management and oversight versus the more 'hands-on' role and responsibilities in traditional forms of delivery performing activities such as design and construction reviews. Until these changes are understood, public sector professionals may inadvertently cause delays in meeting key milestone dates, produce poor quality procurement documentation, and implement an inefficient procurement process that reduces the competitive bidding environment, market interest, governance and does not meet industry best practices.

The Project team drew upon the expertise of public and private sector entities to supplement and enhance their ability to first assess the merits over alternative procurement mechanisms then deliver a competitively procured, efficient PPP that was in alignment with industry norm. A Memorandum of Understanding between the Project Owner organization and the dedicated Provincial PPP agency in the region was signed to facilitate knowledge transfer through the sharing of both documentation and Project personnel. Unique was the recognition and identification by the Project Owner of its knowledge and experience gaps and thus the Project Owner engaged both public and private sector personnel with financial, technical and legal expertise in large infrastructure planning and implementation procured as a PPP. External public and private sector agencies provided expertise with real estate development and portfolio management that helped the Project Owner to improve the development and management of its assets and processes based on experience of the leading industry PPP practices at the regional and international level. In addition, Project funds were allocated to train Joint Project team members (team members from both the Tenant and Owner organizations) on the PPP process, communicating differences in the roles and responsibilities and the associated changes in management agenda required to sustain Project team buy-in and maintain engagement and commitment. Select Project activities, such as risk workshops, served several purposes such as meeting the risk management process requirements and the training of Joint Project team members. Risk workshops involved the identification of risks and associated qualitative and quantitative impacts of Project delivery approaches. Comparisons of risks between project delivery approaches informed the knowledge transfer and training for PPP delivery. The participation of professionals with both PPP and traditional project delivery expertise was critical to serve as sounding boards to

Project team members. The additional time spent on the risk management processes informed the preparation of Project documents such as the business case analysis, project schedule and cost planning, and clarification of roles and responsibilities of Project team members.

Critical to the management of this risk issue was creating a collaborative working environment and an inherent acknowledgement by both the consultants and the public Joint Project team members of differences across each others knowledge set and expertise. The bureaucracy, interests and processes followed in the delivery of a large infrastructure federal project, particularly a Project delivered in a region but requiring oversight of national Headquarter public sector stakeholders, is particularly complex. The public and private sector consultants hired to supplement the expertise of the public sector Joint Project team did not have an integral understanding of the operations, processes, communication protocols and governance requirements of the participating federal government organizations. It took time for the consultants to recognize that differences exist relative to Provincial or private sector project delivery, probe the Owner Project team experts in navigating the federal bureaucracy for a fulsome understanding of traditional versus PPP project delivery. Therefore, there was a tendency for the consultants and the Owner Project team to focus on the identification of design and construction risks and only later were front end planning risks acknowledged. Project team members (both the public sector Joint Project team and its consultants) were so engaged in the planning of the Project that front end planning risk issues tended to be overlooked i.e. without addressing these issues the Project was at risk of not receiving approval to proceed to procurement and contract award. These issues related to stakeholder consultation and ensuring the Project ‘need’ was understood in contributing to both organization and Government of Canada strategic priorities.

4.8.2 Limited Federal Department and Agency Experience and Familiarity with PPP

The delivery of large infrastructure projects by federal organizations involves considerable stakeholder consultation, notification, review or approval with other organizations within the federal family in addition to departments within the sponsoring and contracting organizations. The Project Owner was the primary public infrastructure delivery and procurement arm of the GoC. At that time the Owner organization had PPP precedent experience in the delivery of the first Canadian PPP project; however, over the decade since then employees with experience retired, contract and legal agreements has evolved and new market players have emerged. Projects delivered by this organization often require the involvement of several departments within the organization including those with roles related to legal, financial, architecture and engineering, project management, portfolio planning, communications and facility maintenance. External federal agencies and organizations such as those performing regulatory or funding approval reviews are key project stakeholders. To illustrate the breadth of stakeholder involvement, as a minimum, it was federal policy that the organization ‘sponsoring’ a procurement project, where costs exceeded $100 million and classified as a ‘Major Crown Project’, were required to notify at least fourteen other federal organizations (TBSc, 2011).

The roles of these stakeholders from both internal to the Joint Project team organizations and those stakeholders external in other federal agencies and organizations include the review, consultation on, endorsement or approval of select project tasks. Although the Owner organization experience was limited there was willingness to change, and champions at both the Project and senior executive level examined alternative forms of delivery where 'value for money' was identified. This was necessary as there was no federal PPP policy, guidelines nor a Project approval process. Each of the stakeholders within the Tenant and Owner organizations as well as external federal department and agency stakeholders required engagement and training on PPP delivery. The Owner had to adapt established processes and develop new processes with the pertinent central funding, review and approval federal government entities to accommodate the new delivery approach. This was critical for the effective delivery of the Project due to its magnitude, operational importance to the Tenant organization, and need for efficient decision-making in the PPP approach. It was important to have stakeholders' "buy-in" to the delivery methodology, that they understood how their role and responsibility differed from the established processes in conventional project delivery, and that all decision-making and authorizing authorities clearly understood the process, risks, costs and benefits. In essence, these other stakeholders outside the Joint Project team needed to trust both the individuals leading the Project as well as the process itself.

The potential for resistance or lack of "buy-in" by both internal and external stakeholders increased the complexity of the Project because the Project team had to concentrate on the execution of the Project and to respond to these concerns through communications, training and leading the necessary process changes within representative organizations. The potential impact was burnout of internal Project team members and adverse financial and schedule ramifications to the Project such as the extending the Project time line and becoming over-budget on the Project planning costs. Project team members could be diverted to responding to stakeholders concerns at the cost of concentrating on Project execution. Considering that these Project stakeholders came from across disciplines (financial, legal, procurement, engineering and administrative) their response was not a simple task for one person. It required assistance from all members of the Joint Project multi-disciplinary team and involved changes within organizations themselves. Clarification of key concerns and interests of these departmental stakeholders was critical in response to this risk issue.

The Project Owner undertook several activities to respond to this risk issue. First, the organization sponsored the creation of a Centre of Expertise for Public Private Partnership (PPP CoE) to be located in the region of the Project. The purpose of this Centre was to capture lessons learned, provide PPP advisory services, hire PPP private sector experts, conduct research in the public realm, and develop partnership agreements with other public agencies to increase human resource capacity. Secondly, standardized tools, fact sheets and process maps applied in Provincial jurisdictions were adapted and refined to the federal context by Project personnel under the leadership of the PPP CoE. These documents were useful for public sector organizations with similar interests and governance requirements and were efficiently and cost effectively adapted to deal with the concerns and requirements of federal stakeholders both internal to the Joint Project team organizations as well as those stakeholders external to these organizations. Thirdly, lessons learned sessions and training workshops were held after key project milestones were reached, and communication documents such as ‘Question and Answer’ reports were created to facilitate consistent communication and knowledge transfer of factual information between stakeholders. Lastly, members and consultants of the Joint Project team held regular meetings and provided training for Project review and approval boards. Activities included advising on differences between project delivery approaches, improvements to the risk management process, and the approach adopted to assess Project value for money. Precedents were set in how to respond to concerns of the many stakeholders, which in turn will be useful for federal PPP projects that follow this Project.

4.8.3 Limited Precedent Jurisdiction Contract Language

Precedent agreements currently used by the Project Owner to implement Design Build, Design-Bid-Build or Leaseback project delivery mechanisms differed extensively from the standard PPP project agreement applied in the jurisdiction of the Project. As the first PPP of its kind in the federal jurisdiction there was no precedent federal Project agreement to serve as a template only those applied in Provincial jurisdictions most notably the Provinces of Ontario and British Columbia. The PPP contractual agreement between the public Owner and Project Co. outlined a performance payment mechanism, performance standards and delegation of power to collect user (tenant) charges over the contract duration. A traditional approach to infrastructure delivery involves contracts with several parties and there is no integration of private sector contracts over the project design, build, finance and maintenance life cycle phases. These PPP contracts and legal agreements are not amenable to "grafting on" standard contract terms and require significant participation by legal professionals. The development of a market-ready and competitive form of agreement required the recognition of issues related to indemnity, limits of liability, letters of assurance, and insurance terms typically required by private sector lenders who were not usually involved in the project delivery mechanisms previously procured by the Project Owner. As these documents were output-based to achieve the design risk transfer, Project team members had to resist the urge to dictate specific inputs in prescriptive terms. Demands to use more traditional language or processes from stakeholders within the Owner and Tenant teams required management through continuous communication, training and provision of precedence outside the federal jurisdiction to accommodate their changing leadership roles in setting and managing contract language and processes in the Project of this nature.

In response, the most recent Project Agreement negotiated by the Province in the Project's jurisdiction served as the starting point for the Project Agreement development. Recognizing that jurisdictions differ in several positions taken during procurement, it is important that diligence and input requirements are consistent with both the federal and Project context. The response strategy applied by the Project Owner included retaining the services of federal legal counsel to work with a private sector legal agent and to create a public sector Joint Project team with dedicated resources from both the Tenant and Owner organizations. The Joint Project team served in the development of the Project requirements, identification of key performance indicators, and requirements of the Project performance payment mechanism. The private sector legal agent had developed Project agreements for a number of similar PPP projects in the region, and precedent market compatible contract language. The Owner's private sector legal agent led the development of the procurement documentation and process including advisory services on fairness, evaluation criteria and guidelines for each phase of procurement. The agent developed the roles and responsibility matrix to facilitate communications and simplify the reporting on task status including the assignment of the responsibility of each Project team member for the development of the Project Agreement schedules. Weekly meetings between the Project team legal agents, private and public sector external procurement advisors, the Joint Owner and Tenant Project team ensured that progress led to unprecedented and unique involvement of private sector advisors in the management of this issue.

4.8.4 Establishing a Market Acceptable Governance Framework

A PPP procurement process requires significant dedication of personnel time and expenditures of the respondents to the RFQ and proponents shortlisted to develop the proposals. The RFP is both a price and design competition for a 25-year operation and maintenance period, assuming timely completion of the construction phase of the project. The proponents must typically develop a design up to approximately 25% completion in order to price the full life cycle costs and participate in collaborative meetings with the public sector and respond to internal queries on the Project throughout the procurement process. The time and professional resources needed for these activities are not inconsequential and can exceed several million dollars. Anecdotal evidence reported in the New South Wales Office of Financial Management in Jeffries and McGeorge (2009) suggests private sector bid costs incurred in 2004/2005 on an Australian PPP project procuring nine schools was in the order of $2-3 million per bidder from Expression of Interest to Best and Final Offer stage. Although costs may have reduced since as the public and private PPP market players have improved processes and efficiencies, bid costs have been identified by private sector participants to be high and some Canadian public sector entities have responded by offering financial honorariums to unsuccessful proponents who have been shortlisted to participate in the RFP and submitted a compliant proposal. Pressures are therefore applied to both the public and private sector participants to expedite decisions at key milestones in the Project including the RFQ issuance, RFQ short list, RFP issuance, responses to design, construction, financing, legal and insurance issues, RFP preferred proponent selection, and Final Project approval. Market participants expect the procurement schedule and governance structure for decision making to be clear, reasonable and will proceed as described. Failing to establish a market acceptable governance framework could ultimately result in a Project that is poorly competed and therefore poorly priced by the private sector bidding community. Failure by the Canadian government to follow the established framework set forth or announced commitments would lead to risks of legal action and unacceptable precedent setting and reputation loss by the private sector market of international players bidding on the Project.

Being a first of its kind procurement both in terms of the asset type and procurement approach, market reassurance of the commitment of the government of Canada to a fair and transparent decision making process was required. The potential for a change in government leadership, or organizational policies (of both the Tenant and Owner organizations) in a government environment that was in flux required effective communication between regional and national offices as well as between organizations. The process should track the evolution of decision making over time and justify the final decision made. The Project team established a unique and innovative governance framework to ensure fair, transparent and expedited decision-making. Public sector governance was guided by a joint Tenant Owner senior executive individual who led the Senior Project Advisory Committee and executive Evaluation Committee. A Fairness Monitor (FM) provided assurances that decisions were made objectively, free from personal favoritism and political influence (a standard practice followed by the Provincial organization charged with PPP procurement in the Province in which the Project resides). The combination of a structured "fairness process" with an independent third party reviewer avoided private sector concerns of political intervention, and decision-making that was unfair and slow.

The FM was engaged to provide assurance that the procurement process was applied fairly and reported in public reports. Before the RFQ was issued, the FM had access to all documentation and communication during the RFP process and all meetings held between the public Joint Project team and any of the proponents. Tasks included providing advice and guidance during the RFP process, monitoring and evaluating the fairness and transparency of the deliberations during the evaluation process, debriefing of unsuccessful proponents, and monitoring the final agreement negotiations. Clarifying the role of this independent party provided reassurance to the private sector proponents, political partisans and stakeholders within the Owner and Tenant organizations who had concerns about the PPP process.

The Project was governed jointly by both the Tenant and Owner organizations each with different decision making processes, bureaucracies, objectives and funding priorities. The Project was procured during what is colloquially termed the 2008 Economic Crisis when funding pressures hit individuals and organizations worldwide and credit spreads rose to unprecedented levels. A risk that emerged during the procurement process involved reducing the Project scope. When risks such as these may result in the cancelation or postponement of a project, there are distinct benefits to having a governance structure involving senior decision makers with clear lines of communication and clearly articulated roles and responsibilities. Policy dictated the requirement for a Senior Project Advisory Committee (SPAC) to facilitate decision making at a senior level, to review and discus key Project milestones and objectives, and to resolve issues as they arose. The Joint Project team reported to the SPAC on a regular basis and provided updates on the progress of the Project. Senior members of the Joint Project allocated significant time engaging senior members of the SPAC to ensure that Project risks, benefits and costs of slow decision-making were understood. Also important was that the benefits of Project delivery met the strategic objectives of the respective organization and Government of Canada priorities. Guidelines and protocols were required for the conduct of the evaluation process, evaluation team orientation, Owner evaluation management and decision processes. An Evaluation Committee was created including executive members from both the Owner and Tenant organizations and was supported by a team of experienced evaluators and independent third-party subject-matter experts. The Project proponents were consulted about the proposal evaluation approach to provide further reassurance and response to queries within their respective private sector organizations. Expedited decision-making was required because proponents could hold their contract price for construction and facility maintenance for only a few months and the credit spread for an even shorter period without material premiums or expiry.

4.8.5 Integrating New PPP Processes with Existing Processes

The Request for Proposal set out a detailed schedule of 'collaborative meetings' between the Project team and the three proponents shortlisted at the RFQ stage. The inclusion of collaborative meetings in the procurement process was new to the Owner and Client organizations. The concept was unique to projects procured using a PPP approach, and there was no precedent for its adoption in previous Canadian federal projects. Collaborative meetings enabled open, candid discussions between the Proponent and the Project team that led to clarifications on the terms and conditions, comments could be both given and received, and design ideas could be tested giving the Proponent the means to develop the most competitive and innovative proposal. Documentation facilitated a series of collaborative meetings between each proponent team and the Project team in legal and commercial aspects, financing terms, design and construction, facilities maintenance and insurance. Proponents could ask for more or fewer meetings and for further meetings as part of developing a competitive proposal.

Representatives of the Owner and Tenant organizations expressed concerns about this process, including the open and discursive nature of these meetings, a lack of previous experience and established process within the organization, and concern of breaching fairness principles in the discussions. These representatives expressing concern each had roles and responsibilities related to the review and recommendation of the Project and without their 'buy-in' and support, the Project was at risk of dialogue at senior levels and prolonged time lines to address concerns. A number of steps were taken to address these concerns and consider the potential for adverse impacts. The Project legal agent adopted the industry norm approach applied in previous PPP projects carried out in the region of procurement. Potential Proponents in the region were therefore familiar with the process, where precedent success was established and the process was adaptable to Canadian federal requirements. One such adjustment included the requirement that the Fairness Monitor attend each collaborative meeting versus attending meetings at his/her discretion, which was the norm in the regional PPP market. The Project team participating in the collaborative meetings was trained on conduct protocols for meetings and communications and the implications of not following protocols such as referral to a formal complaint process that could delay the procurement process, or lead to legal action.

4.8.6 Responding to Regulatory/Policy/Legislative Issues

Federal regulatory and legislative requirements and policies of both the Tenant and Owner organizations were incorporated into the Project Agreement. Provincial Project Agreement procurement documentation templates did not incorporate these federal regulatory, legislative and policy issues and standard contract language applied in traditional federal projects didn't work in the PPP context. Gaps in the earlier template Project Agreements and development of Agreement clauses to address them were a key risk issue. Items identified during the Agreement development included personnel and facility security screening, Project funding allocation requirements, human resource related legislation, and federal design and construction policies and guidelines. Specifically the need to develop contract language for the following issues arose:

- Restriction on assignment of Crown debts in the Financial Administration Act;
- Employment equity requirements set out in the Fair Wages and Hours of Labour Act;
- Design and construction standards, information management, health and safety policies and;
- Policy and legislative requirements related to physical and personnel security.

The legal agent accommodated these requirements, in consultation with technical experts, while also respecting the long-term performance nature of the PPP Project Agreement and drafted new schedules and contract clauses. Identifying the human resource requirements (and therefore associated costs for advisory time) to manage this risk issue was found to be difficult in addition to the time to adequately incorporate and perform a review of the requirements. The process was iterative and required continual engagement and consultation from the public sector Project team members. Although the public sector Owner project manager had responsibility for oversight of Project activities, the legal experts, who led the documentation development, performed the tasks traditionally assumed by project managers such as follow-up with Project team members on their input, review and sign off to ensure schedule adherence. Although the legal experts had previous experience performing this task with similar organizations (organizations with limited PPP experience and template documentation), there was a risk that Project documents did not incorporate the federal requirements adequately and schedule and budgets would be overrun. The legal agent addressed this risk issue by creating a roles and responsibility table for each Project agreement schedule. This document served as a communication tool with the Project team members on progress and reminder of each individuals responsibility for a Project proceeding at a dynamic pace and with Project team members assigned to multiple activities.

Security requirements were a significant concern and priority in the procurement, Project Agreement development and associated execution of the Project because of needs for high security in the facility and the national importance of its operations. The security policy required considerable forethought and assessment of current requirements, and matters of Tenant design, construction, operations and maintenance protocols were critical to the long-term agreement. The Tenant organization typically defined prescriptive design and construction requirements for security systems such as IT, facility setbacks and barrier systems; therefore, transition to performance documents where standard clauses did not exist was a challenge. As an example I present here considerations for one area - the clearance requirements of personnel and facilities.

A comprehensive security screening process of individuals involved in the Project and their work facilities was mandated due to the high security nature of the Project and national importance of its operational functions. Project team members on both the public and private sector teams required two personnel clearances, each from different federal entities, to be allowed access to sensitive information. The individual could only gain access and store sensitive information after clearance from both the organization and facility to ensure document safeguarding. Clearance was required for key individuals before a respondent to the RFQ could be invited to participate in the RFP phase. Proponent teams had to submit a list of key individuals to be screened so that there was minimal delay in the procurement process and the respondent was ready for the RFP. Only those screened were allowed access to released Project information after the Request for Qualification stage. Respondents were also asked to initiate the screening processes for the physical locations where Project work would be conducted and sensitive documents would be stored and accessed.

The security screening process for both personnel and physical locations requires considerable time and resources of both the public sector Project team and the respondents to the procurement. Each clearance required approximately three weeks to co-ordinate and conduct. The nature of the bidding community was one where a majority of respondents to the procurement included team members residing and working from facilities outside Canada, further complicating the clearance process to meet the NATO equivalent of the

Canadian requirements. Further challenges included developing a screening process to accommodate circumstances where personnel changes in respondent teams occurred and associated resources and time were required to perform clearances.

While meeting the essential security requirements, Canada focused on responding in the most practical manner as possible in order to prevent delay of the Project schedule and to limit the time and costs demands on respondents to the procurement. Personnel from the public Joint Project team were dedicated to ensure compliance and expedite the process. Personnel from the federal entities responsible for coordinating and conducting the security reviews were dedicated and an information sheet was made available to ensure consistent communications of the requirements and process. Respondent teams were asked to identify a 'Company Security Officer' to be responsible and the sole point of contact for Canada in all security-screening matters. The identification and management of security requirements and associated response processes were critical for the management of this risk issue.

4.9 Summary of Risk Issues, Drivers and Response Measures

All of the foregoing in terms of risk issues identified and responses taken are summarized in compact form in Table 11. Specifically, for each risk issue examined, potential risks and their drivers are identified, performance consequences in terms of one or more of Time (T), Cost (C), Reduced Value for Money (V), Reputation (R), Service Delivery (D), Sustainability (S) given realization of the risk and response steps taken stated. Assessment of impact on Project objectives is based on my experience delivering federal public sector projects and advising the risk management tasks in over ten federal large infrastructure projects. Generic public sector objectives are defined as follows:

Time (T) objective is defined as ‘asset delivered in a timely way to meet start of service delivery schedule date to deliver urgently required citizen services’. This objective may be adversely impacted by risk events such as extensions to the front end planning phase activities and poor process planning. Extended timelines in the front end planning phase could have a non-linear effect on the overall Project where a 1 day or a 1 week delay in reaching a Project milestone could result in several months delay downstream because of the nature of the public sector approval processes and meeting agendas.

Cost (C) objective is defined as ‘complete Project on-budget to both the planning and implementation budget allocated at the Preliminary Project Approval stage’. This objective may be adversely impacted by risk events that extend direct client planning costs and project timelines resulting in incremental cost escalations. Similar to the Time objective, this objective may be impacted by risk events with impacts that are non-linear in nature such as a cost to perform one activity with one organization may in fact require review and consultation with multiple organizations.

Value (V) objective is defined as 'maximizing innovation and procurement competition of bidders proposals for overall efficient project delivery within affordability limits that maximizes the value of each dollar spent to build and operate the asset'. While the government can already access private sector expert knowledge through traditional procurement methods, the use of PPP enables specialized input across project delivery phases such as design, operation and maintenance and experience in the Canadian context is that it facilitates greater access to international specialists, as private sector consortium teams tend to draw upon experts including those outside the local Project jurisdiction. This objective may be adversely impacted by risk events such as prescriptive contract clauses by the public sector project team and process inefficiencies that impede the ability of the private sector to suggest and implement innovative design, construction and financing concepts.

Sustainability (S) objective is defined as 'Delivery of an asset built and operated that demonstrates environmental excellence'. Despite the environmental design, construction and operations innovation that the private partner may bring to a Project, it is also incumbent on the public sector to define output requirements and objectives clearly. This objective may be adversely impacted by the lack of the expertise of the public sector or ambiguity in defining in the Project agreement the outputs that are to be achieved, adequate performance metrics and a rigorous accountability mechanism to meet the objectives intent.

Strategic Priorities (SP) objective is defined as 'Maximize delivery of public sector organizations strategic objectives to support easy coordination of various integrated units both physically and electronically to provide citizens with complete and effective services'. This objective may be adversely impacted by risk events such as the public sector ambiguously defining their functional and service requirements for interpretation by the private partners in developing long term solutions.

Reputation (R) objective is defined as 'maximize positive image of Owner and Client public sector organizations in community at large' where 'reputation' is defined by Rayner (2012) as "an accumulation of perceptions and opinions about an organization that reside in the consciousness of its stakeholders". This objective is adversely impacted by risk events where the organization is perceived by stakeholders to not meet their expectations such as through activities as implementation of poor procurement practices, poorly defined decision making frameworks and the like which may result in future Projects delivered by the respective public sector organizations not achieving the required level of competition or quality of private sector respondents in the RFP stage.

Table 11: Summary of key front end planning risk issues, drivers and responses

Risk Issue/Event	Drivers	Risk Response
Limited Project Personnel PPP Experience and Familiarity		
• Delays in meeting key milestone dates (T,C,V,SP) • Poor quality of procurement documentation (V, C, T, R) • Inefficient procurement process (V, C, T, R) • Industry best practices not met (R, V)	• Low previous relevant experience • Weak commitment to Project • Project not prioritized	• Consultation with experienced PPP agencies; • Identification of knowledge gaps and sourcing of required knowledge; • Knowledge transfer through shared documentation and personnel;

Risk Issue/Event	Drivers	Risk Response
• Consultants do not fully understand client objectives, governance and processes (T,C,V,SP,R) • Public sector team reluctant to share their expertise (T,C,V,SP,R)	• Evolving practices and procedures • Inadequate capacity • Unstructured approach to define client processes and requirements	• Project team supplemented with external PPP experts; • Training of Project personnel; • Allocation of funds to support organization change
Limited Federal Department and Agency Experience and Familiarity with PPP		
• Delays in meeting key milestone dates (T,C,V,SP) • Poor quality of procurement documentation (V,C, T, R) • Inefficient procurement process (V,C, T, R) • Industry best practices not met (V,R) • Project stakeholders do not 'buy in' to Project delivery approach (T,C,V, SP) • Project team concentration diverted to communication versus Project tasks (T,C,SP) • Project team burnout (T,C,SP) • Timelines extended to accommodate consultation jurisdiction authority requirements (T,V,SP)	• Limited relevant experience • Limited established policies and procedures • Insufficient capacity and knowledge • Weak departmental familiarity • Weak endorsing agent familiarity • Internal fighting and hidden agendas • Support of Project not endorsed by all parties	• Communication of support for Project and Project delivery approach from senior executive • Roles and responsibilities clearly delineated • Extensive communication and information sharing • Best practice, guidelines and policy development • Training of internal and external Project stakeholders
Limited Precedent Jurisdiction Contract Language		
• Procurement documentation not reflective of industry best practice (T,C, V,R) • Approval time lines underestimated (T,C,V,SP) • Risks not allocated efficiently (V) • Payment mechanism not effective at incentivizing performance (V,SP) • Procurement documentation misinterpreted by bidders (V,R, SP, S)	• Inexperienced project personnel • Evolving practices and procedures	• Knowledge transfer through shared documentation and personnel; • Project team supplemented with external PPP experts; • Recognition of differences and gaps relative to traditional approaches; • Clarity on roles and responsibilities of project personnel; • Communication strategy that incorporated frequent information

Risk Issue/Event	Drivers	Risk Response
		transfer.
Establishing a Market Acceptable Governance Framework		
•Legal action by industry market participants (C,T,R,SP) •GoC reputation by industry (local,national and/or worldwide) perceived as unable to follow through on commitments (C,T,R,SP) •Government leadership changes during procurement phase (C,T, V, SP) •Project team perceived by market to be indecisive and not following industry best practices (C,T,V, R)	•Complex governance structure •Weak project leadership •Political leadership not influential	•Best practices and procedures of experienced jurisdictions adapted •Structured fairness process developed and carried out •Clear lines of communication established with clarity on roles and responsibilities; •Regular communication and update meetings performed •Training on fairness processes performed with project personnel •Evaluation management and decision processes established and documented
Integrating New PPP Process with Existing Processes		
•Template Project Agreement not refined appropriately to federal context (T,V,R) •Federal policy and legislative requirements not met (R,SP,S) •Project delays to include required changes (T,C,SP) •Collaborative process not established to allow for clarification of terms and conditions (T,V,R)	•Project team inexperienced •Practices and procedures not established •Project team capacity insufficient •Governance structure complex	•Industry norm practices and procedures adopted •Clarifying concerns and interests of stakeholders responsible for oversight of practices and procedures •Training of project personnel on protocols for communication and conducting collaborative meetings •Establishment of clear dispute resolution and a formal complaint process
Responding to Regulatory, Policy and Legislative Issues		
•Template Project Agreement not refined appropriately to federal context; (V, R, SP) •Federal policy and legislative requirements not met; (V, R, SP, S) •Project delays to include required changes (C, T, R, SP)	•Project team inexperienced •Practices and procedures not established •Project team capacity insufficient	•Dedicated project personnel to ensure compliance •Standardized templates and forms created to streamline requirements •Communication plan created and presented to relevant stakeholders •Clarity on roles and responsibilities of stakeholders

4.10 **Lessons Learned and Conclusion**

In this section, a number of lessons learned are summarized to successfully manage risks from the public Owner organization perspective during the front end planning and procurement phases and when adopting a procurement mode that represents a substantial change to the approaches implemented by an organization. As described in the background section of this chapter and depicted in Figure 7, the focus is on the planning and procurement phases of a Project, when the integrity or lack thereof of the processes and management of stakeholder interests followed can strongly influence the potential realization of the risks associated with these projects and as measured in terms of one or more objectives of time, cost, value, reputation, etc. Lessons learned include the following:

- The traditional focus of a Project's risk register is on the delivery process following contract award to a private sector consortium – i.e. the design, construction, and operation and maintenance phases of a project. Risks associated with a Project's planning and procurement phases, while recognized at least implicitly, are not accorded the attention warranted, partly because the private sector consultants retained by government to assist with these phases are not fully versed in the complexities inherent in large government bureaucracies such as processes followed, stakeholders involved in the approval, review and consultation requirements and overall governance requirements. Explicit risk management in this early phase can add significant value to a project by minimizing iterative cycles, setting conditions that enhance competition, minimize frictions within the owner and client's organization, facilitate a positive response to the use of alternative modes of procurement delivery, and so forth.
- Consultants assisting federal organizations must recognize the complexity of the decision making environment within which the Project team members of the federal entities work and spend time to elicit details on key processes, milestone dates, and

relevant stakeholders early in the project planning phase. This is necessary to identify associated risk issues that enable a Project to proceed to procurement and contract award.

- Developing an ontology of risk issues, risk events and impacts is difficult because the issues are varied, intertwined and involve many stakeholders. A concern is that some of the attendant risk issues may not be explicitly identified despite their importance; for example, 'Establishing a market acceptable governance framework' and 'Integrating new PPP process with existing processes'. These are process related risk issues, not technical in nature (such as geotechnical conditions, scope changes and so forth) and relate to stakeholder consultation, and communication management which are not issues traditionally identified explicitly in risk identification. Project managers tend to focus and be comfortable identifying technical risks that may be quantified in dollar or schedule impact terms versus risk issues related to processes, communication and stakeholders impacting project objectives such as reputation and strategic priority typically described in qualitative terms.
- The impacts of the risk events associated with the front end planning phase, should they occur, tend to be difficult to quantify in direct dollar or time terms. It is often difficult to identify relationships between issues, multiple impacts on Project objectives and tradeoff qualitative and quantitative impacts. These risk issues if not addressed may have considerable adverse impacts on success or perceived project success. Again, the emphasis is on 'soft' people and process management versus technical.

- There is a need for practitioners and researchers alike to move beyond the consideration of financial, transactional and technical mechanisms in the management of risk issues and consider the impact of stakeholders, communications and interplay of project personnel.
- Addressing Risk issue 1 'Limited Project personnel PPP Experience and Familiarity' and Risk issue 2 'Limited Federal Department and Agency Experience and Familiarity with PPP' for the Project described herein drew implicitly upon network relationships, training, identifying stakeholder issues and concerns and could have been improved if more formal mechanisms were already in place to identify and map these issues.
- Addressing Risk Issue 3 'Limited Precedent Jurisdiction Contract Language' which involved using another jurisdiction's template brought to the fore the issue of Trust or the 'not invented here' syndrome; considerable effort is required to get buy in that expertise developed by other organizations, in particular public sector ones, can provide a useful starting point and can help mitigate potential risks because of the learning already captured in such a template.
- Risk Issue 4 'Establishing a Market Acceptable Governance Framework' highlights that stakeholder interests/concerns emanating from the private sector need to be fully understood as well as those at the decision making level who would approve/implement the governance approach. Establishing processes for both ensuring fairness of the transaction and decision making provided reassurance to the private bidding community and structure to the roles and responsibilities of relevant

stakeholders in the Project decision making alleviating a number of risks as they arose.

- Risk Issue 5 'Integrating New PPP Process with Existing Processes' demonstrated the importance of understanding of both the collaborative PPP approach and traditional mechanisms employed by the public sector Owner in procurement, governing regulations and policies to ensure appropriate stakeholder dialogue. The need to understand internal departmental stakeholders concerns regarding the use of a collaborative process, including the need to alleviate these concerns through fairness processes' was also identified.
- Risk issue 6 ' Responding to Regulatory, Policy and Legislative Issues' highlighted that to develop appropriate Project documentation clauses and processes to respond to regulatory, policy and legislative issues requires a collaborative approach to be taken across both the public and private sector knowledge experts. This risk issue also demonstrated the difficulties in estimating the time and costs with translating requirements into procurement clauses and the respective project management tasks and expertise that may be required of experts outside the project management discipline (such as legal experts) for successful management of this risk issue.
- It is difficult to contextualize stakeholder concerns (such as loss of control, different value systems or organization priorities) and the importance of continuous communications. For the Project described in this chapter, this was performed implicitly by the Project team with no formal 'stakeholder management plan' in place nor 'roles and responsibility' table that included those outside the Project team. To do so, one must gather a better understanding of the stakeholders, their interests,

objectives, concerns and processes using such techniques as those introduced in Chapter 5 – A stakeholder management framework for application on large infrastructure public sector projects and Chapter 6 – A decision support approach for the identification of project objectives and improved decision making.

Risks and the response strategy adopted for the front end planning phase of a project are rarely detailed but disregarding issues early can have significant adverse consequences to a project or the sponsoring organization or a lost opportunity. Overall, the case study illustrates a number of key points most importantly that one must not underestimate the value and importance of understanding the respective governing organization's processes, policies and stakeholder network communication requirements as these are of particular importance in managing risks in the front end planning phase of a project. Key risk issues in the front end planning phase may be qualitative in nature, not technical or financial in scope, and involve the considerations of multiple stakeholders in their management. The management of risks for projects with these characteristics is not a simple task regardless of the procurement method adopted, and can be a particular challenge where a new procurement approach is selected. In the absence of a clear process and framework, project risk management and associated processes and tasks are vulnerable to well-intended oversimplification or exposure to outside political pressure with implication for the success or failure of a project. Failure to respond to front end planning risk issues includes delays in meeting key milestone dates, poor quality procurement documentation, and an inefficient procurement process that reduces the competitive bidding environment, market interest, governance, and meeting industry best practices. The Project may fail or be identified as 'unsuccessful'. Critical to the management of a Project's risks in the front end planning phase is responding to stakeholder concerns and objectives and ensuring adequate engagement across Project participants. Doing so helps maintain a project's momentum in its front end planning phase, effective continuous networking and communication with senior decision makers across sponsor and client organizations and the respective stakeholders within these organizations such as Ministers and executives in order to avoid lowering of Project priority. Illustrated in this chapter is the importance of responding to stakeholder concerns as critical to the management of risks both early and for successive phases of project delivery.

Chapter 5: **A Stakeholder Management Framework for Application on Large Infrastructure Public Sector Projects**

5.1 **Introduction**

The effective management of stakeholders is critical to achieving project objectives in the planning and delivery of large public infrastructure projects. The scale and scope of these public sector projects require multiple levels of oversight and considerable involvement of decision makers. These projects tend to generate significant public interest as they affect many stakeholders before, during and after construction. The list of stakeholders is often long and diverse, and includes among others: the owner and user of the asset (including the employees and corporate executives); project team members; contractors; developers; suppliers; insurance companies; media; community representatives; neighbors; oversight government officials; and political representatives. In these projects, stakeholders are often the significant source of drivers of risk to the most important project risk issues, which are usually related to objectives and relationships between the key stakeholders (Ward & Chapman, 2003; Yuan et al., 2010). This is particularly the case in the planning and procurement phases of project delivery when a project's scope, budget and schedule are defined under public scrutiny, funding approval is subject to competition across government priorities for limited available public funds, and contract negotiations occur between public and private sector entities. Failure to recognize the linkage between risk and stakeholder management has led to the failure of projects (Bourne, 2005; El Gohary et al., 2006; Hertogh et al., 2008) and inefficient use of project resources (Lemley, 1996).

The construction management literature frequently includes references to 'stakeholder risk' as a risk issue or 'delay in work due to party x', not meeting 'stakeholder expectations' or 'stakeholders not satisfied with delivery' (Aritua et al. 2011; Chan et al., 2011). These risk events are often documented in the project risk register which serves as an electronic database of sorts and management tool to respond to identified risks. Reference to stakeholder related risk events in these broad terms is common both in the literature and industry risk registers, and there is little to no reference to findings from supporting stakeholder analysis processes to populate the risk register, although integration of this data is recognized as helpful (Ahmed & Bakhsheshi, 2009). There is often limited clarity on who the stakeholders are, their interests, roles and responsibilities to the project i.e. what these risk issues or events actually entail. Eliciting information from experts on the specific stakeholder related risk events (including the probability of occurrence, impact or consequence) is often done in a rather adhoc fashion. On a large infrastructure project, particularly one delivered for or by the public sector, these risks are real and impacts may be scalable to the size of the project and seriously affect meeting project objectives such as on-time, cost, quality, scope, reputation and organizational program delivery.

This chapter outlines the importance of stakeholder management in the public infrastructure sector, and provides a structured stakeholder management framework to assist in the identification and elicitation of expert opinion of stakeholder attributes and appropriate response strategies for explicit engagement and documentation of this information. Although concepts and approaches introduced are applicable to other sectors and industries, this approach was developed specifically for application on Canadian large infrastructure public sector projects. The framework draws upon the most recent applications of stakeholder theory and best practice in the construction industry, public administration and management models (Newcombe, 2003; Bryson, 2004; Bourne, 2005; Aaltonen et al., 2008; PMI, 2008; Yang et al., 2011). It is informed by feedback from public and private sector practitioners and findings from a large public sector infrastructure project. It formalizes how public sector organizations should operationalize the consideration of stakeholders including their identification, analysis and response. The provision of tools and a structured framework therefore facilitates broader identification of stakeholder risks, drivers of risks and associated properties and thus constitutes a contribution to improved risk identification and elicitation of expert opinion. The decision process support approach introduced in chapter 6 which assists in the identification of stakeholder objectives and the framework introduced herein are interconnected where outputs from one approach serves to inform the other in an iterative fashion over the course of project delivery. The definition of stakeholder used in this chapter is "persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project" (PMI, 2008).

5.2 Background

Stakeholder management is both a corporate and 'people' issue. The stakeholder management practices adopted by an organization will help it to achieve its corporate mission, and to make and manage relationships between stakeholders. It is well recognized by public entities that ineffective stakeholder management increases the probability of adverse impacts on the project budget, schedule and achievement of overriding objectives, and thus the importance of effective stakeholder management to good project management

(ISO, 2003; Olander & Landin, 2005; Olander, 2007; Aaltonen et al., 2008; PMI, 2008). Where once governments had decisive powers to implement a project according to the initial plan, now numerous stakeholders have enough influence singly or collectively so that no one entity has exclusive decision making power (Hertogh & Westerveld, 2010). Stakeholders involved in large infrastructure projects are also more competent to speak out about their interests requiring early communication (Hertogh et al., 2008) and the 'voice' of an individual or group can be more readily and rapidly heard through the use of social media, a dimension that did not exist for past projects. Increased corporate accountability and governance requirements to adopt corporate social responsibility principles in their business management practices further drive the implementation of stakeholder management principles in project delivery practices. The UN (2008) Guidebook on Promoting Good Governance in Public Private Partnerships (a standard guide for project delivery in large infrastructure projects) emphasized that the "interests of stakeholders are not always taken into account when developing PPP projects" and points to the need for governments to improve governance practices and procedures. Project Managers have always attempted to manage stakeholders, but recent movements are towards a more explicit and formal treatment involving a broader spectrum of stakeholders. This is particularly the case for the delivery of public sector projects, which involve many stakeholders to be satisfied, and include overly bureaucratic reporting systems to meet accountability demands (Williams & Lewis, 2008).

Little research has been conducted on how public sector organizations should operationalize the consideration of stakeholders although work has been conducted on: (i.) who should count as a stakeholder; (ii.) when and how to involve stakeholders; and (iii.) when and how stakeholders mobilize around a particular issue (Thomas and Poister, 2009). In addition, there is no broad framework in Canadian civil engineering with which to manage the diverse set of stakeholders in a complex large infrastructure project that requires cooperation among public, private and non-profit sector entities. This seemingly daunting task may be simplified through the use of the structured process, tools and aids. Specifically, some of the benefits include improved management of stakeholders, prediction of upcoming risk issues and their management, enhanced organizational learning, and promotion of good governance practices.

This chapter provides an introduction to stakeholder management as it applies to the Canadian federal public sector project delivery context as well as a framework, tools and techniques that may be applied for stakeholder management in large infrastructure project delivery. The stakeholder management framework is intended to capture information in a systematic, explicit fashion and inform project management tasks such as risk management over each project delivery phase. Chapter 7 illustrates how this stakeholder information can be used to populate and inform the 'Participant' view of the risk management research prototype introduced. Findings inform the reader how stakeholders may be characterized and how they contribute to the risk profile of a project.

5.2.1 Stakeholder Policies and Directives for Canadian Federal Infrastructure Projects

Best practices show that practitioners require clear criteria to define and identify pertinent stakeholders, and a set of over-riding stakeholder principles that can be consistently applied for effective stakeholder management. Government of Canada (GoC) federal project management policies and directives were reviewed, senior executives were consulted but no formal definition of stakeholder or stakeholder management principles were found. Although there were no direct references to stakeholder management, indirect references to management objectives were included in communication policies and directives at both the National and Department level. Strategic considerations concerning the consultation and citizen engagement are included in the Government of Canada's Communication Policy (TBS, 2011a) which noted that it is Government of Canada policy to:

- Identify and address communication needs and issues routinely in the development, implementation and evaluation of policies, programs, services and initiatives; and
- Consult the public, listen to and take account of people's interests and concerns when establishing priorities, developing policies, and planning programs and services.

Similar to the National directions to consider stakeholders' needs and interests, there are references to policies and directives in federal departments that undertake large infrastructure public sector projects (referred herein as the 'Target Department'). This 'Target Department' manages a multi-billion dollar portfolio of infrastructure assets, serves as the GoC central procurement arm and provides support services for federal programs, including architecture and engineering services, construction, maintenance and repair of public works and federal real property. As mentioned, no direct reference to stakeholder management policy, definitions or principles were found in the Target Department Communications policy (PWGSC, 2011) although there was indirect reference to stakeholder management including direction that the Department shall:

- Adhere to the principles of the Communications Policy of the Government of Canada and to fully integrate communications into its management framework as set out in this departmental policy;

- Provide accurate, complete, objective, timely, relevant and understandable information to the public about its policies, programs and services;
- Take into account the concerns and views of the public in establishing priorities, developing policies and implementing programs; and
- Ensure that the Department is visible, accessible and answerable to the taxpayers, clients and suppliers that it serves.

In addition to requirements set out in the Department Communications policy, the Target Department established a National Project Management System (NPMS) for Project Managers to provide both guidance and requirements on project delivery practices. Stakeholder identification, identification of information needs, and meeting those needs for infrastructure projects are included in the communication management guidance within NPMS. Communication management is set out as the responsibility of the Project Manager, who is required to develop the communication component of the Project Plan. The Project Plan is the primary project management document to control how the project is managed during front end planning and delivery phases and includes information related to the form of procurement, budget, schedule and the communication plan. Within the communication plan, the Project Manager is directed to:

- Identify the minimum acceptable communication requirements/content on a project-specific basis;
- Identify the various stakeholders;
- Determine how information will be disseminated (e.g., verbal, e-mail, presentations, conference calls);

- Determine how frequently information will be disseminated (e.g., daily, weekly, monthly, quarterly, semi-annually); and
- Determine where the Communications Sector (the Branch responsible for implementing Department communications protocol) should be involved (e.g., developing special additional strategies to manage crisis and/or exceptional situations).

The NPMS stipulates that the communication plan within the Project Plan is to be used as the primary tool to communicate with stakeholders as the project develops. Although stakeholder management principles and general requirements are provided for Project Managers to follow in NPMS, the Department Communications Policy and the GoC Communications Policy*, no tools or techniques are yet available to provide guidance on how to operationalize these activities*. The Project Manager would be responsible to consider issues such as the Project's sensitivity, complexity, importance and national interest and further to assess who should be involved and when. Although this leaves the Project Manager with much needed discretion and flexibility to deliver the project as per his/her professional expertise, the provision of tools, techniques and over-riding principles would assist Project Managers across the Department to perform these activities in a consistent manner. It is clear that stakeholder management is important and prioritized within both the Target department and the GoC, just as it is identified in project management guidance documents as good practice. However, both in public and private sector there has yet to be developed widely adopted standardized tools, techniques and approaches to perform these activities in the construction industry. Achterkomp and Vos (2008) review of over 42 articles in the project management literature also noted there appears to be a lack of thorough conceptualization of the stakeholder notion. This research serves to help bridge this gap with a stakeholder management framework and selected tools to suit the project delivery context and approach of Canadian federal large public infrastructure projects.

5.2.2 Stakeholder Definition and Principles

It is my belief based on hands on experience on multiple federal large infrastructure projects that the development of an appropriate stakeholder management framework for professionals working at a project level, requires over-riding direction on stakeholder management at the corporate level. Stakeholder definition and a set of corporate stakeholder management principles are essential to both develop and implement the stakeholder management framework for large public infrastructure delivery that is the result of my research. Both definition and principles are intended for adoption at the corporate level to provide high-level guidance specific to the stakeholder context that may be applied on a Canadian federal project level.

Stakeholder management in complex large infrastructure project delivery requires the Project Manager to draw upon the expertise of individuals from many specialized and interdisciplinary fields within his or her department. The corporate definition and principles to follow allow for the consistent consideration of stakeholder issues by individuals from each of these disciplines including ‘who’ constitutes a stakeholder and ‘how’ stakeholders are managed. Corporate definitions and principles provide high-level context of what matters to the organization and therefore inform the selection of appropriate tools and techniques in carrying out stakeholder management and the development of the framework introduced.

To achieve a stakeholder definition, I reviewed the comprehensive lists of both broad and narrow definitions from the public and non-profit sector literature outlined by Bryson (2004), and the list provided by Ward & Chapman (2008), which is specific to the construction industry. It is important to note that there is no one definition of stakeholder (Mitchell et al., 1997). The Target Department has adopted project management processes and definitions that follow those recommended by the Project Management Institute (PMI). The PMI stakeholder definition is broad and consistent with the seminal work by Freeman (1984) on stakeholder management, and the principles of the GoC Communication Policy because it is inclusive of both individuals and organizations *involved* and *affected* by the project. This definition is also consistent with the GoC principles of values and ethics to be 'Acting at all times in such a way as to uphold the public trust' (TBS, 2011d). The PMI, 2008 definition of stakeholder was therefore selected as appropriate to the research conducted and informed the development of the stakeholder management framework.

In addition to a definition of stakeholder, I selected principles that provide direction on stakeholder management practices. The seven stakeholder management principles, shown in Table 12, were developed from the work of a number of conferences hosted by the Centre for Corporate Social Performance and Ethics (now called the Clarkson Centre for Business Ethics and Board Effectiveness) at the University of Toronto between 1993 and 1998 (CCBE, 1999). Participants in these conferences developed a set of principles based on emerging stakeholder theory that are now regarded industry-wide as a model of best practice. These principles are intended to help managers to respond to the accountability and governance requirements to consider, manage and engage with stakeholders on a large infrastructure project.

Table 12: Clarkson principles of stakeholder management (CCBE, 1999)

Principles	Description
Principle 1	► Managers should *acknowledge* and actively *monitor* the concerns of all legitimate stakeholders, and should take their interests appropriately into account in decision-making and operations.
Principle 2	► Managers should *listen* to and openly *communicate* with stakeholders about their respective concerns and contributions, and about the risks that they assume because of their involvement with the corporation.
Principle 3	► Managers should *adopt* processes and modes of behavior that are sensitive to the concerns and capabilities of each stakeholder constituency.
Principle 4	► Managers should *recognize the interdependence* of efforts and rewards among stakeholders, and should attempt to achieve a fair distribution of the benefits and burdens of corporate activity among them, taking into account their respective risks and vulnerabilities.
Principle 5	► Managers should *work cooperatively* with other entities, both public and private, to insure that risks and harms arising from corporate activities are minimized and, where they cannot be avoided, appropriately compensated.
Principle 6	► Managers should *avoid altogether* activities that might jeopardize inalienable human rights (e.g., the right to life) or give rise to risks, which, if clearly understood, would be patently unacceptable to relevant stakeholders.
Principle 7	► Managers should *acknowledge the potential conflicts* between (a) their own role as corporate stakeholders, and (b) their legal and moral responsibilities for the interests of all stakeholders, and should address such conflicts through open communication, appropriate reporting and incentive systems and, where necessary, third party review.

These principles are directed at 'managers' who operationalize their organization's code of conduct and mission through contracts and project activities with its diverse constituencies. Although broad in scope for large infrastructure project delivery, these principles were selected as a starting point for a Canadian federal department to further refine to suit the context within which they work and informed the selection of tools and techniques of the framework introduced.

5.3 Approach to Framework Development

A number of industry practitioners were consulted in the development of this framework including two senior executives in Canadian federal departments, a senior executive in a federal oversight agency and three public and private sector advisors of large infrastructure and development projects. Feedback from these individuals guided the development of this framework and assisted with the identification of industry best practice stakeholder tools (stakeholder identification checklist, stakeholder register and stakeholder principles). I also reviewed a stakeholder management report, which consolidated the results of a stakeholder analysis workshop conducted in the front end planning phase of a large infrastructure project delivered by the Target Department. The Project Manager and a representative of the Communications department conducted the workshop with participants from across different branches within the department. The senior department executive providing leadership within a region of Canada and who was also leading a national departmental initiative on stakeholder management selected this project and report for me to review as representative best practice within the department. This senior executive, in turn, requested recommendations on how departmental processes may be further improved. The stakeholder report provided information on the stakeholder management approach, individuals and organizations considered as stakeholders, and identified stakeholder needs. A list of these stakeholders, their impact on the project and the project's impact on them are presented in Appendix A, Table 29, edited for reasons of confidentiality. The level of detail presented in Table 29 reflects the information collected in a 3 hour facilitated workshop involving seven practitioners across the disciplines of finance, engineering, architecture and communications. Guidance in the form of tools and an approach to conduct project stakeholder management and integration with the risk management tasks were identified as factors that could improve the efficiency in preparing for and conducting stakeholder management exercises. The findings in this report informed various aspects of this thesis, in particular chapter 7, including the current best practice approach conducted by public sector entities in stakeholder management, terminology used to characterize stakeholders and their potential impact (positive and negative) on a project and the linkage (if any) of stakeholder management to other project management tasks.

The stakeholder management framework developed in this research was presented to the department senior executive who reviewed the framework and distributed it to his senior management for comments. Overall, the senior executive and his management described the approach as 'informative, practical and useful' for Project Managers within the department and the concept to integrate the findings from stakeholder management with risk management tasks was identified as a necessary activity to perform. The senior executive requested that the framework and supporting documents be used as a foundation reference document for the development of a Regional departmental stakeholder management approach directed to the corporate level. The value of the stakeholder management framework was made clear by the senior executive in his final review when he commented the framework would be of "great interest to both the project leadership and project management communities…and strikes the appropriate balance between adherence to government policy and increasing the likelihood of delivering on project goals." Further, the senior executive suggested that the approach, framework and tools could become an adjunct his departments NPMS compendium and would be of interest to the Directorate of the department responsible for the planning and delivery of large infrastructure projects.

5.4 **Stakeholder Management Framework**

Stakeholder management is a key project management activity including the management of risks that arise as a result of stakeholder participation. The framework includes steps in managing stakeholders from identification through to engagement. Alternative approaches are discussed by Yang et al. (2011) whose study of operational stakeholder management tools and techniques included a typology of 30 tools. They concluded that each tool has its strengths and weaknesses and effective stakeholder management is achieved using a combination of tools depending on the project circumstances. The stakeholder management strategy that is applied on each project is unique and must be tailored to suit the project context. The framework presented here is for application in large infrastructure public sector projects, and the multi-stage approach is developed to consider requirements in each project delivery phase including the unique reporting, accountability and multi-stakeholder environment, which distinguishes it from the private sector project delivery environment. The approach is intended to clarify stakeholder interests, needs and capabilities, show how stakeholders affect project riskiness and viability, and the extent to which certain groups or individuals should participate in planning, implementation and evaluation. Outputs from the stakeholder management framework are intended to serve as inputs and/or inform the risk management tasks performed on a project, in particular defining the project context as recommended by various Canadian risk management guidelines (RMB, 2007; CAN:CSA ISO, 2010; TBS, 2011a). The framework is developed with recognition that stakeholders, both internal and external to the project team, have an interest in and can influence the achievement of project objectives. Project team members must complete a number of tasks under tight timelines and with constrained resources (financial and human). The reference tools and techniques included in the framework are intended to assist the project team to identify the relevant stakeholders and to balance a range of interests and demands with time and documentation pressures taken into consideration.

This framework is intended to respond to the following questions adapted from Leung & Olomolaiye (2010):

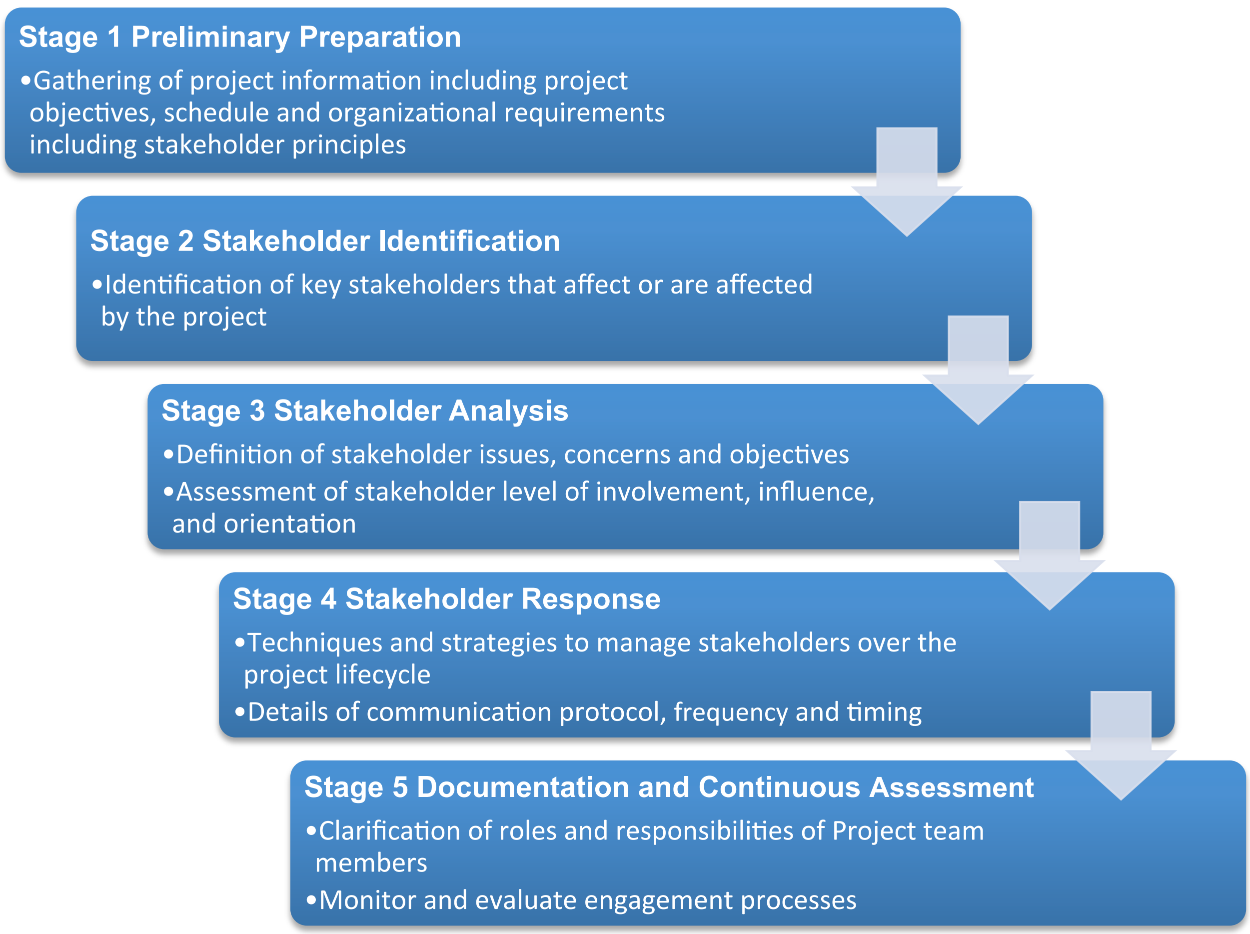
i. Who are the stakeholders?
ii. What are the interests (or 'stake') of these stakeholders i.e. what makes them stakeholders?
iii. What risks (both challenges and opportunities) arise in responding to these interests?
iv. What do stakeholders expect from the project team and what does the project team expect from them?
v. What level of involvement or response is necessary to meet these interests?
vi. What is the plan to respond to these interests and frequency of progress reporting?

Responding to these questions assists a Project Manager both with the management of project risk and corporate objectives and priorities identified in communications policies and directives.

5.5 Framework Overview

The proposed stakeholder management framework consists of five stages (Figure 8). These are: 1) Preliminary preparation; 2) Stakeholder identification; 3) Stakeholder analysis; 4) Stakeholder response and 5) Continuous assessment and reporting.

Figure 8: Stakeholder management framework



The framework provides a structured approach and set of tools that will allow the Project Manager and team to assess the content and context of the project such as the scale, complexity, scope, national importance, and public interest that will determine the time, resources and degree of detail expended to manage stakeholders. The set of tools presented are not exhaustive as there are many tools and techniques discussed in the literature and applied by practitioners. Examples include stakeholder checklists, commitment and influence indices, registers, and power/predictability matrices. For a more fulsome list see Bryson (2004) and Yang et al. (2011). It is important to note that although there is repeated reference to tools and techniques available suggesting a 'heavy armament', there is neither a magic bullet nor an approach that integrates a number of tools and techniques applicable to the iterative and evolving nature of project management tasks across project delivery phases and in particular to the stakeholder involvement and complexities of the public sector planning and procurement phases.

The approach, tools and techniques have been selected specifically for the practical application on large infrastructure public sector projects based on my experience and feedback from public and private sector practitioners. To assist in the selection of stakeholder tools and techniques, Biggs & Kiker (2005) propose a number of factors including: the relative sophistication of the stakeholder participants, information available, familiarity with tools and techniques by participants and facilitator, role of the facilitator and potential for bias. Overall, the approach is intended to be dynamic and applied in an iterative and continuous fashion at each stage of project delivery to respond to the evolution and changes in project information, stakeholders and objectives. Information captured is also intended to inform and be integrated with other project management tasks such as communication and risk management. The output of the stakeholder management framework serves to populate the 'Participant View' of the project context modeled in the research prototype introduced in chapter 7 to improve the risk identification and elicitation of expert opinion tasks in project delivery.

5.5.1 Stage 1: Preliminary Preparation

Preliminary preparation involves gathering necessary background project documentation and plans to perform the tasks outlined in the framework including: the identification of stakeholders, analysis of their interests and levels of influence, responses and documentation protocols development. Activities in this stage feed into subsequent stages:

i. Identification of a *'champion'* to lead the development and implementation of a stakeholder management strategy. This individual typically assumes this role and responsibility and is the Project Manager. In larger complex projects, this may be delegated to a Project Officer who will also assume the community liaison functions.
ii. Clarification of the *organization's mandate* including: objectives outlined during the stakeholder management process, definition of stakeholders and principles followed. Industry best practice stakeholder management principles and definitions should be adopted where guidance is not available or under development.
iii. Identification of *project objectives* that serve to guide the success of the project. These objectives will be used in the analysis stage to identify alignment of identified stakeholder objectives and interests. A decision process support approach to assist in the identification of stakeholder objectives is presented in chapter 6.
iv. Gathering of project *background documents* including: the schedule, communication protocol, project plan, risk management documents, governance structure and procurement delivery mechanism. Each of these documents will provide the

information required to identify pertinent stakeholders, timelines to engage and linkage with other project management tasks.

v. Confirmation and clarification of *roles and responsibilities* of project and departmental representatives (such as personnel from the Communications Department) for the stakeholder management tasks as they relate to the project.

Outputs from this stage of the framework include a list of the core project team members that will participate in the stakeholder management process, background reference documents that may be referred to during the subsequent stages, the organization definition and principles that will be followed to ensure accountability and transparency as it relates to stakeholder management in project delivery.

5.5.2 Stage 2: Stakeholder Identification

Stakeholder identification involves the creation of a list of individuals or groups that are involved or affected by the project's work or its outcomes. The Project Manager may create this list in a group setting with members of the project team or individually, typically in a brainstorming exercise and/or workshop. This list should be developed by those with knowledge about technical solutions, associated timelines and the affects on the surrounding community, the processes of procurement (including the decision making structures of the organization and oversight agencies), and the political, social and environmental context of the project including the 'hot button' issues. For complex large infrastructure projects, rarely does one person hold all this knowledge and therefore individuals across a number of disciplines are typically consulted.

A ‘Stakeholder Identification Worksheet’ is particularly useful. I suggest that questions, adopted from a United Nations protocol for Local and Economic Development and Planning (EPI, 2010) are a valuable tool to facilitate individual or a group brainstorming exercise (Table 13). Thomas & Poister (2009) propose an alternative list of questions to identify stakeholders and highlight the need for such tools, because governmental organizations often do not have such a list nor is there much counsel offered by scholars on appropriate techniques. A second tool developed is a ‘Stakeholder Checklist’ (Table 14), which serves as a prompt that may be used in individual or group sessions to identify stakeholders. The comprehensive stakeholder list including 12 categories of stakeholders and 62 identified potential stakeholders presented by Bianchi & Kossoudji (2001) for World Bank-Financed Projects was used as a starting point to develop the Checklist in addition to the findings of Rowlison and Cheung (2008), Gomes et al. (2010a, 2010b), Foo et al. (2011) and Yang et al. (2011). The list was further refined to reflect the Canadian federal public sector project context by reviewing Canadian federal public sector project reports, discussions with public sector project management practitioners and my practical experience leading advisory work on over ten Canadian large infrastructure projects. A generic list of stakeholders for a Canadian federal large infrastructure project is included in Appendix A, Table 30 and includes over 100 potential stakeholders. Although this list is comprehensive, I belief that a more simplified list of stakeholders, as per Table 14, serves best as a prompting tool in exercises to elicit expert opinion so that the number of stakeholders and categories identified does not overwhelm participants.

Achterkamp & Vos (2008) highlight the various approaches to categorize stakeholders including the role-based method to provide structure to the stakeholder identification approach. A role-based approach may be used as an alternative approach to the stakeholder identification worksheet where categories of stakeholders have not been previously identified by an organization or where one wishes to bring further structure to the identification process. The categorization approach adopted for the Checklist includes stakeholder categories identified in past Target Department reports and guidance documents and therefore pertinent to the Canadian federal project delivery context. Three senior public sector project managers within the Target Department were asked to review the Checklist to confirm that the list of stakeholders and categories identified was both applicable and comprehensive.

Table 13: Stakeholder identification worksheet (Adopted from EPI, 2010)

Project Name	<Enter project name>	**Date Created**	<Enter create date>
		Date Last Modified	<Enter last modified date>
Author	<Enter your name>		
Project Summary	<Provide brief project summary; include project and procurement objectives and key milestones>		

Key Questions	**List of Stakeholders**
• Who might benefit or negatively be affected by the project (e.g. client groups, community, special interest groups)?	➲
• Who should be included because of their relevant formal position (e.g. Government authority, First Nations)?	➲
• Who should be included because they have control over relevant resources (e.g. funding, expertise)?	➲
• Who has power to impact the decision-making process and/or milestone schedule (e.g. regulatory agencies, politicians)?	➲
• Who should be included because they may be potential users of the asset?	➲
• Who has power to hinder or block implementation (e.g. special interest groups, implementing agencies, politicians)?	➲ …

Table 14: Stakeholder checklist

Project Name	<Enter project name>	**Date Created**	<Enter create date>
Author	<Enter your name>	**Date Last Modified**	<Enter last modified date>
Project Summary	<Provide brief project summary; include project and procurement objectives and key milestones>		
Stakeholder Categories	**Participant Identification**		
Project Senior Executive Real Property Investment Board Chief Financial Officer Senior Project Advisory Committee Steering Committee (Project Sponsor) Steering Committee (Client) Department/Agency Leaders Other Department/Agency Leaders (National) Other Department/Agency Leaders (Regional) Department Minister and Deputy (Sponsor) Department Minister and Deputy (Client) Treasury Board Ministers **Project Oversight Reviewers** Federal Authorities Federal Authority Advisors Federal Jurisdiction Authorities Provincial Jurisdiction Authorities Regional Jurisdiction Authorities Local Jurisdiction Authorities Traditional Groups **Project Team (Public Sector)** Project Team (Public Sector) Internal Advisory Committee Public Expertise Support Agencies **Third Party Stakeholders** Regional Organizations Local Organizations Unions Commercial and Business Groups Special Interest Groups Media Political Constituents **Project Team (Private Sector)** Utilities Trades / Subcontractors Project Lenders / Financiers Procurement Consultants Private Sector Owner Advisor Team **Project Developer** Proponent Lending/Financing Advisors Proponent Technical Advisors Lead Proponent **Users** Department user group A Department user group B			

5.5.3 Stage 3: Stakeholder Analysis

The stakeholder analysis stage involves breaking down the comprehensive list of stakeholders developed in Stage 2 to identify their interests, alignment to project objectives and to assess other attributes such as power, influence and criticality to success. Some scholars apply analysis tools in order to identify and prioritize the level of engagement required for select stakeholders (Newcombe, 2003; Olander & Landin, 2005). However, based on practical experience, using a pre-determined list of stakeholders to perform this exercise is most efficient in a project environment where tight time frames for data collection, analysis and decision making are common challenges. Awareness of stakeholder concerns and interests help a project team to respond to stakeholders and communicate effectively to ensure the successful achievement of project objectives. Understanding the characteristics and anticipated actions of different stakeholders involved or affected by the project includes their willingness to expend resources that could either help or hurt the project (Freeman, 1984: 26).

Three tools that assist the 'Analysis' stage are the Stakeholder Register, the Stakeholder Mapping Tool and the Stakeholder Alignment Tool. Due to variances in project context no approach is perfect and combinations of approaches are most successful to manage stakeholders (Yang et al. 2011). Each may be used at all stages of project delivery and information captured in each complements and informs the other tools.

The Stakeholder Register (Table 15) is similar to a Project Risk Register (discussed and illustrated in Chapter 3) and serves as a database of important stakeholder characteristics, response strategies and other information that the project team can record and monitor over the course of the project. Documented in a spreadsheet, the register lists project information, which is reviewed and updated as the project evolves. It lists the stakeholders, identifies their role in the project and their issues/interests, and helps the project team to develop a strategy to record and monitor responses over the course of the project. There appears to be no consistency in what is recommended to be captured in a stakeholder register; however there are examples of variations of its application in industry by public sector entities and project management guidelines (Bibby & Alder, 2003; PMI, 2008; GNL, 2011).

The Stakeholder Mapping Tool (Figure 9) assists in the stakeholder analysis by assessing each stakeholder's position on the project with respect to 'current orientation' and 'criticality' to success. Variations of this grid may include an assessment of each stakeholder's influence and impact rating. The Project Manager can then develop a strategy to manage each stakeholder's level and appropriate timing for implementing a response strategy. Olander (2007) and Ward & Chapman (2008) identify and summarize key stakeholder mapping approaches including: Power, legitimacy, urgency framework; Position towards the project; Power/interest matrix; Power/predictability matrix; The vested interest-impact index; and External stakeholder impact index. Each of these approaches are variations of the same theme in that they apply simplistic categorizations to assist the user to characterize and group stakeholders. Applying these mapping tools at each phase of project delivery assists the Project Manager to develop appropriate response strategies as stakeholder interests and ability to influence project decision making change over each project delivery stage (Newcombe, 2003). Yang et al. (2011) summarize a number of alternative approaches that may be considered including social network analysis methods and a proprietary methodology successfully applied by practitioners termed the Stakeholder Circle (Bourne, 2005). The Stakeholder Mapping Tool has been selected as an appropriate tool to provide information in combination with the Stakeholder Register and Stakeholder Alignment tools identified.

The Stakeholder Alignment Tool (Figure 10) is used to assess and visualize if and how each category or individual stakeholder's (depending on the level of detail) interests/objectives align positively or negatively with the project objectives. This tool will assist with identifying appropriate communication protocols and response strategies. Listing of stakeholders and project objectives alongside each other also facilitates the visualization of groupings of alignment across stakeholders, such that collaborations amongst groups may be identified.

For project success, it is critical to identify stakeholders early in the project, and note their issues and objectives related to the project. The project team can find opportunities to include these interests and facilitate a participatory approach particularly public sector projects that identify responding to 'public interest' as a key priority. Alternatively, the identification of differences across stakeholders' project expectations and objectives, which are a source of project risk, serves as a risk reduction approach (Yeo and Tiong, 2000).

Table 15: Stakeholder Register (Adopted from PMI, 2008; GNL, 2011 and Bibby and Alder, 2003)

Project Name	<Enter project name>	**Date Created**	<Enter create date>
		Date Last Modified	<Enter last modified date>
Author	<Enter your name>		
Reference Documents	<Provide a listing of reference documents considered to populate register>		
Project Summary	<Provide brief project summary; include project and procurement objectives and key milestones>		

Stakeholder	Current Orientation to Project	Role	'Stake' in the Project Issues/Objectives	Desired Orientation	Strategy Recommendation	Assigned to	Timeline for Stakeholder Initiation	Frequency for Stakeholder Follow-up	Risk Events Driven by Stakeholder	Performance Metric
<Identity of group or Individuals>	< What is the most likely position they will take on project - Supportive, Neutral, Resistant >	<Enter role in project >	< What are their main interests, issues or expectations at a high level>	<Enter the desired orientation with consideration of current orientation identified>	<Enter strategy to manage stakeholder such as Inform, Consult, Involve, Collaborate, Empower>	<Enter name of project team member assigned stakeholder management strategy >	<Enter timeline for response strategy to be implemented>	<Enter frequency of follow-up applying response strategy>	<Enter risk events that are driven by the stakeholder >	<Enter how project team performance is measured by this stakeholder >
Regional Director General	Supportive	Lead	On-time delivery and stakeholder and communication management	Supportive	Keep informed	Project Director	Project Initiation	Monthly	-Project priority demoted -Key personnel reallocated to other projects	Performance Appraisal
Business Unit A	Neutral	Steering Group Member	Concerned about availability of resources for initiative	Supportive	Consultation - Invite to regular meetings, present staffing strategies	Project Leader	Project Analysis Stage	Semi-Annual	-Inexperienced personnel allocated to project -Limited capacity to perform review exercise	Client Service Template

Figure 9: Stakeholder Mapping Tool (Adopted from Bryson, 2004)

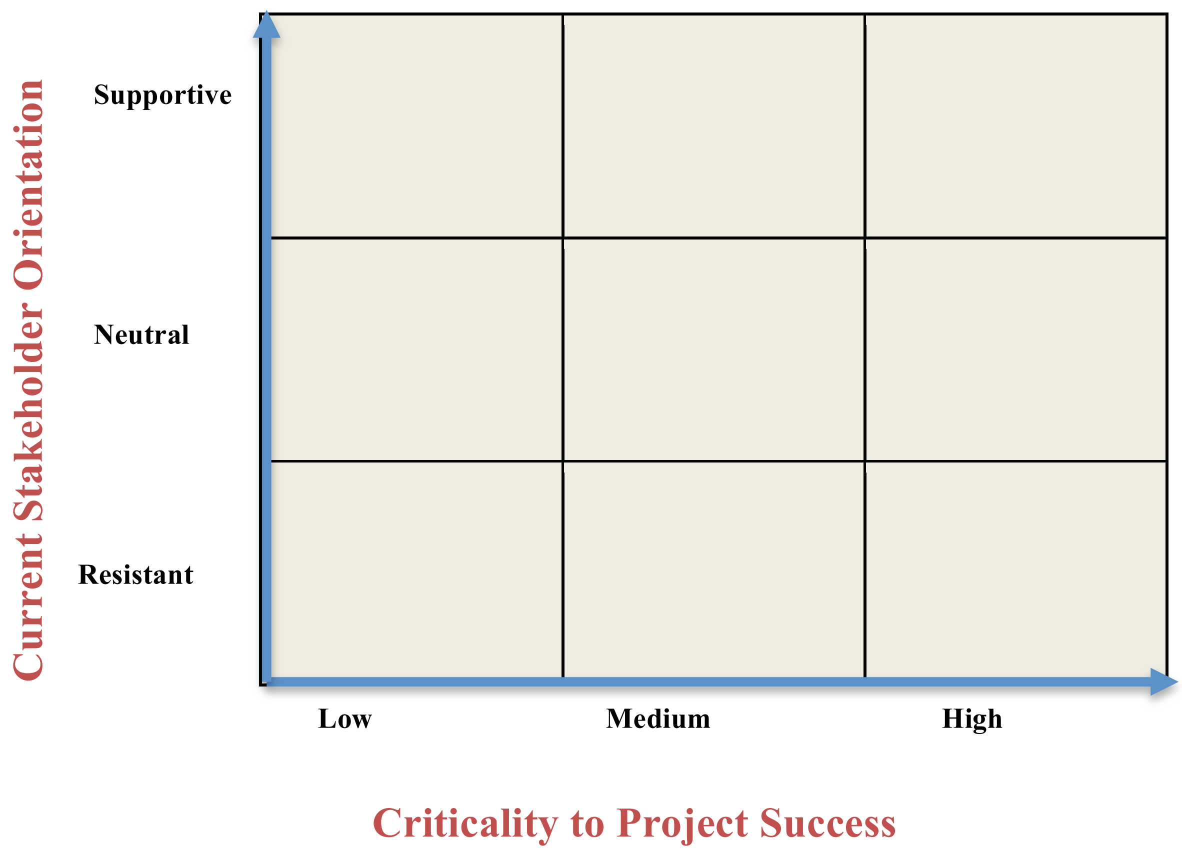
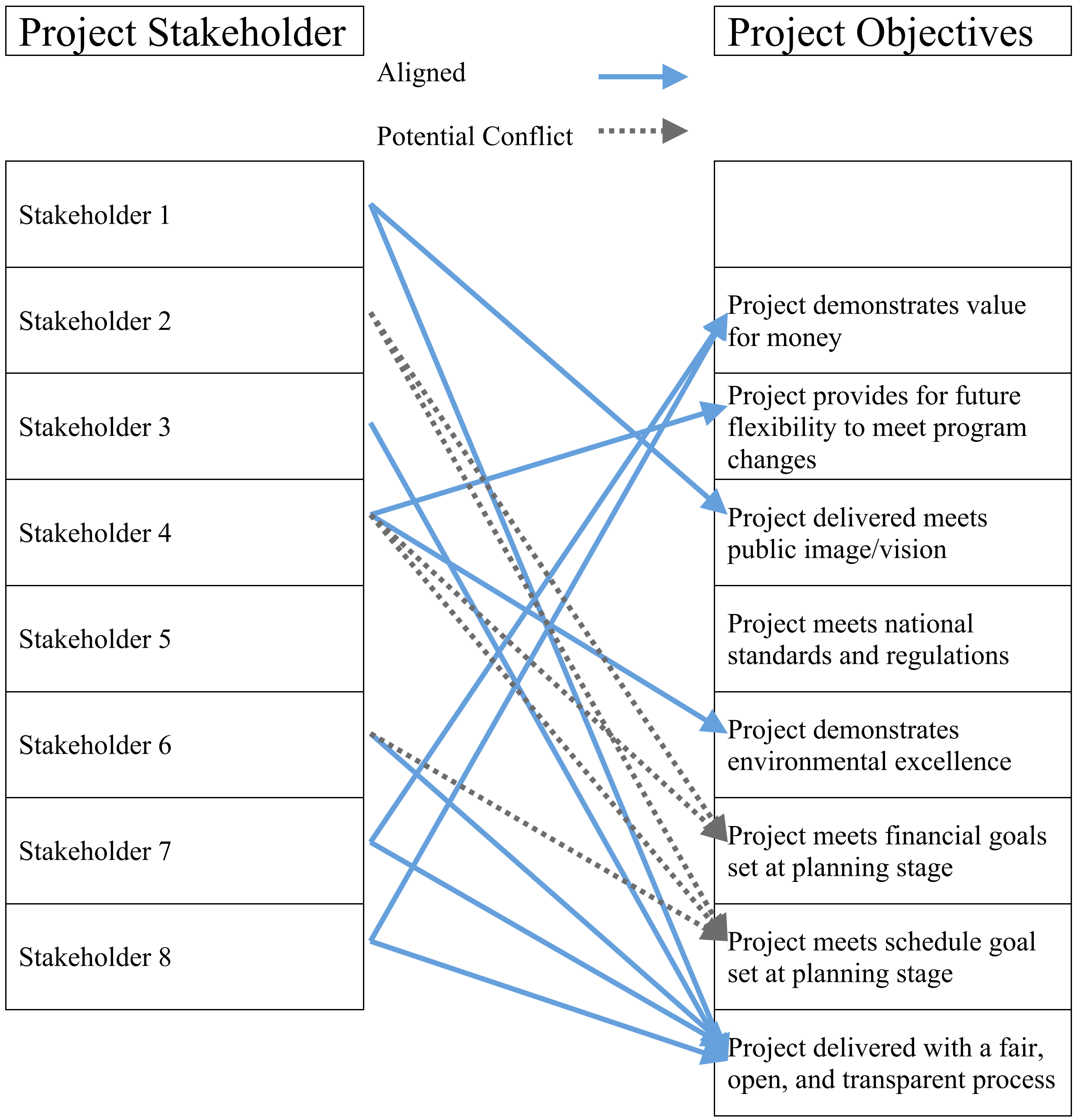


Figure 10: Stakeholder Alignment Tool



5.5.4 Stage 4: Stakeholder Response Strategy

The stakeholder response strategy allows the project team to identify a response strategy that is suitable and applicable to the stakeholder under consideration based on the results of the stakeholder analysis (Stage 3). Each stakeholder's influence on project objectives and associated outcomes will vary. Each response strategy is therefore tailored to the attributes and interests of the stakeholder based on Stakeholder Analysis. The diversity of stakeholder interests and attributes requires a number of response strategies (from least to most participatory) such as *Inform, Consult, Involve, Collaborate or Empower* is illustrated in Table 16 and adopted from Bryson (2004).

Stakeholder engagement activities can be delivered in various ways. The choice of the most appropriate method will depend on the project context and information available at the time. The method to respond is documented in the Stakeholder Register (illustrated in Stage 3), timing, frequency of engagement, and a project team member is assigned to implement the strategy identified. Methods of engagement may vary from formal meetings to notification through a project website. Commonly used methods of engagement are: formal meetings, informal meetings, mailing lists, project website, newsletters, information displays, private sector consultant/contractor or user complaints management, re-active communication, official correspondence, media releases, public forums, and project liaison committees.

Following the implementation of a response strategy, the question of whether the stakeholder has been repositioned needs to be carefully considered. A response strategy can ensure a stakeholder will champion an issue or decision in the project or lessen the influence of a key stakeholder. Where the stakeholder drives a risk event, particularly the case where the stakeholder's current orientation is not the desired orientation, the response strategy, changes in stakeholder position and interests should be documented in the stakeholder register and cross-referencing in the risk management register is recommended.

Table 16: Engagement strategy participation planning approach (Adopted from Bryson, 2004)

Engagement Strategy	Participation planning approach
Inform	Promise: We will keep you informed
Consult	Promise: We will keep you informed, listen to you, and provide feedback on how your input influenced the decision.
Involve	Promise: We will work with you to ensure your concerns are considered and reflected in the alternatives considered, and provide feedback on how your input influenced the decision.
Collaborate	Promise: We will incorporate your advice and recommendations to the maximum extent possible.
Empower	Promise: We will implement what you decide

5.5.5 Stage 5: Documentation and Continuous Assessment

Documentation and continuous assessment of the process is crucial to the management of stakeholders and to meeting related accountability requirements. Like other project management tasks, the stakeholder management process steps require continual review as the project evolves. Stakeholder's interests and the project information change over time requiring due diligence during continuous monitoring and reporting.

Project documentation should include an appropriate level and standard of documentation for the project's scale, complexity, national importance, and public interest to meet a thorough audit. Documentation should include the following:

i. *Policy* and organizational protocol followed;

ii. *Process* followed including timelines for initiation and follow up reviews;

iii. *People* involved in the stakeholder identification, engagement and monitoring activities; and

iv. *Performance* of the process, measures of performance used and level of performance assessed.

Each of these elements is captured in the Stakeholder Register introduced in Stage 3. It is also important to develop measures that test the effectiveness of stakeholder management practices over the project lifecycle so that:

- Project team members understand the purpose of the stakeholder management strategy and their associated role and responsibility in its application;
- All project stakeholders have been identified and consulted relative to the appropriate response strategy identified;
- Strategies for communication amongst stakeholders are consistent and unified (i.e. a clear plan of action is developed);
- There is integration of the stakeholder management plan with other project management processes (risk management, communications management, project costing etc.); and
- The formality and frequency of stakeholder involvement is reasonable for the project's importance and complexity.

Alternatively, critical success factors such as those identified by Yang et al. (2009) may be adapted to formulate measures for continuous assessment and monitoring of the information available at the different stages of the stakeholder management framework.

5.6 **Conclusion**

Conflict and disputes during construction projects are common due to the great diversity of people and organizations that are involved or are affected by the project and its outcomes. Managing stakeholders is a crucial project management function and deserves considerably more attention than past practice shows and new approaches to integrate the exercise with other project management tasks such as communications planning and risk management. It is clear that current industry practice and understanding of the stakeholder notion is lacking, if performed explicitly at all. Stakeholder management constitutes a key corporate activity in large public sector organizations as illustrated by numerous references in policies and procedures; however, structured approaches and direction to conduct such activities are not formalized nor are tools and techniques identified commonly implemented over each phase of project delivery and linked with other related project management tasks. Further research is recommended to investigate why Canadian practitioners appear to seldom implement current tools and techniques in the literature and necessary adaptations to suit other project delivery types.

The proposed stakeholder management framework provides a structured and explicit approach to identify stakeholders, understand and clarify their interests, needs and capabilities, informs how stakeholders affect project riskiness and viability, and determines the extent to which certain groups or individuals should participate in the planning and delivery phases of infrastructure project delivery. The framework provides reference tools and techniques that will assist the project team to identify all relevant stakeholders and then to balance the range of interests and demands (sometimes competing) in timely, structured and explicit ways. Improving Project Managers' ability to operationalize their stakeholder management responsibilities serves both their governance and accountability requirements in addition to their understanding of stakeholder characteristics and associated contribution to the risk profile of the project.

Large infrastructure project stakeholders have various needs, interests and expectations. These interests are often in conflict and many will not be met. The formal identification of stakeholders, their interests, and prioritization for response following a structured stakeholder management framework is intended to improve the probability of successfully achieving project objectives and reduce project risk profile. The identification of stakeholders helps the project team to know who is involved in and affected by the project. The analysis of stakeholders helps the project team to understand stakeholder interests, concerns and expectations including the power and influence they may exert on achieving project objectives. Developing a formal response strategy that includes a strategy that is related to the power and influence of each stakeholder ensures that a member of the project team has responsibility to respond accordingly will thus to ensure that accountability and governance requirements on stakeholder management are met.

Chapter 6: **A Decision Process Support Approach for the Identification of Project Objectives and Improved Decision Making**

6.1 **Introduction**

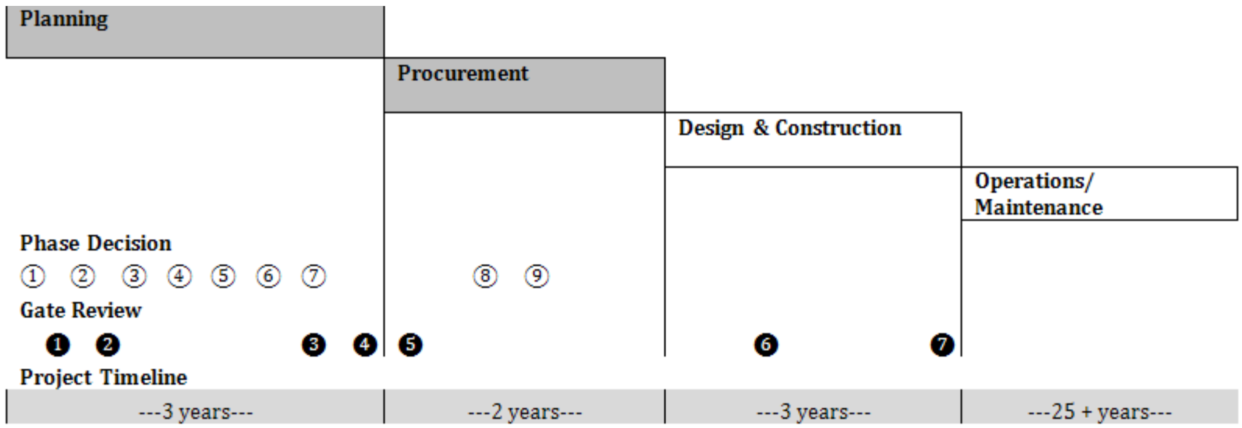
Government agencies and other organizations responsive to a diverse constituency face enormous challenges in the planning and delivery of large infrastructure public private partnership projects. Of paramount importance is establishing transparent decision processes that reach accountable, defensible and wise outcomes. Based on an extensive review of the literature, documented examples of the ***successful*** application of decision support approaches in the construction industry literature are scarce. In this chapter I present a structured decision support process, using value focused thinking and decision analysis techniques and offer a descriptive case study of the approach to a complex site selection decision problem in a public private partnership (PPP) large infrastructure project. The approach serves to improve the decision making process in the planning and delivery of large infrastructure projects while informing the identification of risks, outcomes and stakeholder objectives of interest. The case study illustrates the varied public sector objectives considered in a large infrastructure decision problem and how the application of such an approach reduces the risk of poor decision making on the successful delivery of the project. The approach addresses common challenges such as potential technical and non-technical knowledge conflicts across decision makers, distinguishing between ‘facts’ and ‘values’, incorporating uncertainties, generating criteria weights, making tradeoffs and building consensus across interests. The context of this approach is in a Canadian federal government large infrastructure case study to relocate and consolidate geographically dispersed facilities to a single headquarters. A project includes a series of major decisions. This chapter drills down into the details of those and helps identify specific risks and their sources. Lessons from this approach may be applied to other complex decision problems in large infrastructure planning and delivery such as selection of the 'best' procurement delivery method, long term partner selection, performance metric selection and allocation of risks across project stakeholders. In the context of this thesis, the contribution of this chapter as it relates to improving the identification of risks and elicitation of expert opinion is seen to lie in: (i.) mitigation of stakeholder related risks and improved quality of project decision making through the application of an improved decision process that identifies multiple stakeholder objectives, and (ii.) insight to a number of project management tasks including stakeholder and risk management (as discussed in chapters 5 and 7) through a structured elicitation and clarification of stakeholder objectives.

6.1.1 Background

Large infrastructure projects, particularly those delivered by or for public entities involve and impact multiple stakeholders who have a broad set of financial, technical, social and environmental objectives. The need to incorporate or consider in project decision making the multiple objectives and concerns of this complex network of stakeholders is particularly necessary in the planning and delivery of projects delivered through a PPP mechanism (Yuan et al. 2010). In these partnerships, the public sector entity is committed in a long-term agreement (typically 25 years+) with its private partner and therefore decisions made over the planning and procurement phases have long term, wide strategic and financial impacts to its organization. Where stakeholder opposition is cited as a main reason for the failure of many PPP projects (El-Gohary et al. 2006), identification and consideration of these stakeholder objectives and expectations is critical for project success.

The planning and procurement phase of these large infrastructure projects typically occur over a long time period, in some cases over a decade (Hertough et al., 2008) and involve a series of ‘major’ decisions, each involving a potentially different set of decision makers and their associated objectives. A number of public sector approval and oversight agencies (TBS, 2010; OGC, 2011; and AUF, 2012) have developed project gating frameworks to define key decision ‘checkpoints’ from early planning through to project operation phases of project delivery to support improved and accountable decision making. Figure 11 illustrates the decisions, gates and an optimistic approval timeline for a typical Canadian federal large infrastructure project. Each gate defines a key point where senior decision making executive are required to consider project status and grant approval to proceed to the next decision gate. Key decisions made between gates in addition to project progress are assessed and issues identified in a structured manner. Unsuccessful or delay in passing a decision gate may be driven by a number of factors most notably an assessment of a poor decision or unaccountable decision-making process. Poor decision-making in a project of this nature with long partnership involvement, as well as the large financial and scope commitments are sizable. Consequences may include project cost and schedule over-runs, scope reduction, resource competition across projects, unfavorable media attention, loss of reputation and stakeholder trust. Despite the wide array of issues and stakeholders involved for each decision problem, the core tests remain the same: how is “best” defined in the context of making a decision, who should be defining best and how is it measured? These are not simple tasks and responses that apply a structured approach can reduce the overall risk of ‘getting it wrong’. This is critical in the front end planning phase where project risks arise from the decision making environment associated with the pursuit of project objectives and the decisions made early in project planning have the greatest impact on project delivery phases that follow (Edwards et al., 2009).

Figure 11: Project Delivery Time Line Illustrating Multiple Decisions



Phase Decisions:

1. Project Need Assessment – The project need including the scope, cost and time requirement is determined;
2. Asset Ownership Assessment – The project approach to meet need is assessed (ex. acquire, lease or rehabilitate an existing facility in its portfolio);
3. Preliminary Project Funding Assessment – The project funding requirements to cover both internal and external costs to implement the Project;
4. Site Selection Assessment– The selection of appropriate geographic location for the asset;
5. Project Delivery Approach Assessment – The procurement approach to deliver the project that will offer best value to the organization;
6. Project Governance Structure – The project decision making structure including roles and responsibilities for effective and timely decision making;
7. Procurement evaluation criteria – The criteria used in the Request for Qualifications and Request for Proposal to shortlist proponents and select the preferred proponent;
8. Project Performance Specification – The performance requirements for the Project documented in an Output Specification; and
9. Payment Mechanism Approach – development of key performance criteria and requirements where if breached private partner would incur financial penalties, warnings or notices;

Gate review Points:

Planning Phase Gates

1. Gate 1: Strategic assessment and concept: For confirmation of the project's objectives—both what is to be done and why—and the identification of key stakeholders
2. Gate 2: Project approach: For confirmation of how the project's objectives will be achieved

3. Gate 3: Business case and general readiness: For confirmation of funding and business outcomes
4. Gate 4: Project charter / project management plan (PMP): For confirmation of resources, support, and governance

Project Procurement Phase

5. Gate 5: Detailed project plan and functional specifications: For confirmation of readiness to proceed with construction

Project Design and Construction Phase

6. Gate 6: Construction complete and deployment readiness: For confirmation of readiness to deploy for both business and IT domains

Project Operations and Maintenance Phase

7. Gate 7: Post-implementation review: A post-mortem and final step to gather lessons learned

Practical experience in delivering PPP large infrastructure projects for public sector entities requires decision makers to adopt a structured system of decision support that may be integrated with and inform the risk management tasks within a project. A link is forged between this chapter and chapters 5 and 7 where the objectives identified through this decision process support approach can be input into the stakeholder analysis processes performed (chapter 5) and characterization of the project stakeholder context including risk consequences of importance (chapter 7). An iterative approach to carrying out each project management task as project information evolves over time is recommended. In preparation for the procurement and negotiation with the private sector, the public entity must also be well versed on the project risks for appropriate allocation between the public and private sector parties. Clarity on what risks exist, their characteristics including source, mitigation, potential response strategy and consequences to objectives are essential for effective management and negotiation with the private partner. Long-established methods of project risk management typically focus on evaluating and managing consequences of risks related to project objectives that are measured in financial terms notably related to time (risk of not meeting the scheduled completion target), cost (risk of not meeting cost target), scope (risk of not meeting project requirements) and quality (risk of not meeting required specifications) (PMI, 2008). This narrow view excludes the multiple and broad objectives valued by the public sector decision makers, as illustrated in the case study described herein and ultimately the holistic treatment and management of risk.

Good decision-making requires facts (technical information on alternatives and consequences) to be clearly separate from values (preferences) and the results should be defensible and easily communicated to decision makers and staff, political representatives, legislators, boards of directors, and the general public. Numerous facts, values, objectives, stakeholders and constraints confound even relatively straightforward decision problems. It is clear from decision theory that both individuals and groups are bad at making complex decisions (Slovic et al., 1977) and that they do not have adequate tools and techniques to define the full range of values or value tradeoffs that are common in both risk and management decisions in general (Keeney, 1992). It is therefore critical to identify information needs and to create attractive alternatives that can serve as the basis of qualitative and quantitative analysis, including risk analysis. A clear understanding of stakeholder values and objectives is critical (Keeney & McDaniels, 2001). Clarification of an organization's objectives can provide insight and be adapted and refined in dealing with all decisions facing an organization (Keeney & McDaniels, 1992) including those related to project delivery. The notion of responding to a range of stakeholders and families of objectives such as financial performance, social, customer service, environment, and economic development is not new in corporate Canada and is identified in the notion of the triple bottom line, corporate social responsibility, and multiple account evaluation (MAE, 1993; BC MoT, 2006; GRI, 2011). Identification of the full spectrum of objectives is critical early and applying a structured approach clearly separates facts from values and is thorough, inclusive and transparent

(Arvai et al., 2001). The selection of the ‘best’ decision problem alternative without a clear process and framework is vulnerable to well intended oversimplification, exposure to outside political pressure, or selection of an inferior decision alternative. Decision makers may only partially address the full range of their objectives or may fail to understand the value trade-offs across alternatives. Disadvantages to the large infrastructure project delivery environment include inferior treatment of existing risk issues, the risk of new events arising such as stakeholder discontent or protest, financial impacts, and delays to revision or to respond to poor problem decision alternative selection.

Although group decision making and fuzzy entropy methods have been successfully applied in construction scenarios to integrate preferences across stakeholders (Yuan et al., 2010), there are few documented case studies in the construction industry literature that outline a decision support approach that can be broadly applied and integrated to provide insight to risk management tasks on large public sector infrastructure projects. The purpose of this chapter is to help close this gap by describing and applying a sensible approach, decision process support (DPS), on a typical complex infrastructure decision.

The DPS approach involves the elicitation of objectives from multiple stakeholders to guide the development of decision criteria. The result should be applicable, clarify stakeholder objectives, and the management of risk associated with complex decision problems that are encountered in the planning and delivery of large infrastructure projects. Industry practitioners who adopt the process outlined will have an improved understanding of workable objectives and measures, and then can explore the impact of stakeholder values on the decision under consideration. This approach will help to minimize the polarization and politicizing of the decision process by focusing on the importance of the criteria before examining the range of decision alternatives. Across project delivery stages, outputs of the DPS approach improve: the development of a comprehensive set of project objectives that represent stakeholders interests; risk management tasks including informing the development of the project risk register (e.g. risk drivers, risk impact tables, etc.) and the risk identification process; and the project teams understanding and characterization of the multiple stakeholders involved in the project and their competing values.

The DPS approach applies value focused thinking (Keeney, 1992) and provides a decision analysis technique to a typical complex decision problem encountered in large infrastructure project delivery, in this case the selection of a project site. Value focused thinking emphasizes the need for early attention to stakeholder values to improve decision-making and to develop a set of decision criteria and performance metrics. I identify common approaches used by industry practitioners in responding to the site selection decision and project risks that arise when the process fails (stakeholder discontent or protest, financial impacts, delays, project cancellation etc.).

Use of a case study project provides an example of the application of the DPS approach for site selection of a large infrastructure PPP project. The many decision criteria and performance metrics provided by senior executive decision makers from the public sector entities (the client user and delivery agency) are the underlying objectives of that sector and show how achievements are measured through performance metrics or attributes. The results highlight the many and varied objectives considered by public sector decision makers in a complex decision problem and provide explicit identification and descriptions. The identification of these objectives will improve the evaluation of the impacts or consequences of risks beyond the 'Time', 'Cost', 'Quality' and 'Scope' impact categories traditionally considered and the overall management of risk by developing appropriate management responses. The last section of the chapter will show the broader applicability of the approach to decision problems faced by an organization over the course of project delivery and linkage with the risk management framework introduced in this thesis.

6.1.2 Perspectives in Site Selection Problems

Developing an approach to site selection requires integrating several perspectives. Technical experts, such as security professionals, engineers, architects, environmental scientists and human resource specialists, have their ideas of what qualities define a property as "best". Accountable decision makers bring additional ideas about what is a high quality site, but are also expected to balance competing interests, many objectives, stakeholder values, and a variety of risks that are inherent to site selection decisions. I have observed that 'common practice' is an informal decision process based on an opportunistic and reactionary approach where staff put forward a limited number of sites based on poorly defined decision criteria. Experts and decision makers are then asked to choose a site and rationalize their decision with a limited set of objectives (e.g., such as cost and availability). A step up from this approach is for technical experts to develop the site selection criteria and score site alternatives. Site selection therefore becomes a constrained optimization problem with limited treatment of project/corporate objectives. While development of criteria is more rigorous than the informal approach, these methods suffer from the "black box syndrome" that limits both the transparency of how criteria were developed and the involvement of the decision makers who are ultimately accountable to the final site selected.

All these approaches can alienate stakeholders and may lead to technical “hard data” (e.g. cost) criteria driving out more qualitative criteria, or “soft data”(e.g. quality of life).

6.1.3 Site Selection Process Failure Risks

The process of site selection for a public asset is not simple, particularly the siting of undesirable facilities such as landfills, jails and wastewater treatment plants. Often, the decision problem involves several decision makers, complex public communication requirements as well as the technical, environmental and financial criteria common to project siting problems. A review of a failed site selection process for a new Provincial prison facility in British Columbia, Canada carried out by the Province (Project sponsor), provides an illustration of when decision makers are perceived to inadequately address the values of stakeholders early in the project delivery. The process is perceived as lacking both transparency and defensibility. Information about this Project and the site selection process failures was publicly available through industry and government reports, presentations by project executives, and news clippings.

The Project involved the selection of a preferred site for a new adult pretrial center in the Lower Mainland of British Columbia. The Project was initially planned in 2007 for construction in another region of the Province but faced considerable public opposition at the site selection stage. An alternative region was identified, the Lower Mainland, and a preferred site was selected by the Province early in 2009 as a result of findings by consultants retained to review and identify priority sites. Shortly thereafter, the Project faced considerable opposition by the constituents and representatives of the City of the selected site. The Mayor of the City sent letters of opposition to the Provincial decision makers, city constituents protested, adverse articles about the siting process were presented in television, radio and print media and the City began to rezone the target land parcel to block the siting of the facility (CBC News, 2009). The design of the Project was to resemble an office building and to be built to the Canadian Leadership in Energy and Environmental Design Gold or equivalent standard to meet public concerns related to environmental and community fit issues. Despite efforts to consider these broad objectives and to establish a Community Advisory Board with the mandate to promote dialogue with the local community, share information and resolve issues as they related to the facility (SSBC, 2009) opposition by the public and City representatives of the preferred site continued. The Director of Planning of the City released a detailed a review and assessment of publicly available information released by the Province on the site selection process that concluded that the process was "fundamentally flawed and based on incomplete information" (City of Burnaby, 2009). Issues that constituted the City's opposition to the validity of the site selection process included the following:

- The Province did not require the consulting firm to conduct a comprehensive study to determine the most suitable site for the Project based on detailed and defined criteria for evaluation purposes;
- The consultant site selection report was substantially a real estate availability report with a mandate that was limited to the creation of an inventory of potentially available public and private land parcels based on broadly expressed search parameters;
- Selection of preliminary inventory sites was primarily on the basis of the site area of the properties;
- Limited summary information was provided on the inventory of sites evaluated that was contradictory to the Province's statements of a comprehensive site review, which should have been based on a detailed evaluation that considered established and sound criteria;

- The report did not provide a comparative assessment or scoring across all sites;
- There was no basis on which to support the validity of the ranking of sites; and,
- Basic property inventory information on each site was provided with only a single and marginal evaluation criterion related to regional access and public transit.

Overall, the City Planning staff noted that the site selection process lacked the critical information, clear assessment guidelines, and evaluation measures to determine a best candidate site in the region. Final comments regarding the site selection process identified the importance of public values often not defined in explicit measurable terms. These included the City's recommendation that criteria be established to:

- Evaluate and protect adjacent land uses and local municipal planning considerations;
- Evaluate and ensure the safety of neighborhoods and the public;
- Support open and responsive public consultation.

In mid 2009, after the site selection process was deemed to have failed, the Project was reshaped and a new site selection process was initiated across the region through a Mayors' Committee to identify viable locations (Metro Vancouver, 2009). Mayors in the target region were asked to review or suggest suitable development sites, a preferred site was identified and the Project was expanded to include both a renovation of an existing facility and a new build.

A number of key risk events (project delivery delay, reputation loss, relationship conflicts) arose as a result of the failed site selection process including:

1. The Project construction start date was delayed by 1.5 years from 2010 to mid 2011 resulting in delays in the delivery of much needed correctional services to the public, project cost escalation, and additional governmental administrative costs;

2. Opposition by the public concerned with their safety and the consultation undertaken resulted in reputation loss, damage to image and adverse media attention to the Provincial and Municipal politicians and associated public entities; and
3. Relationships between governments and communication management were negatively affected, time wasted and resources (human and financial) redirected to respond to stakeholder concerns.

Impacts of these risks were both financial and non-financial at both the project and corporate level. What may have been one line on a Project risk register, ‘Site selected faces opposition by stakeholders’, materialized into a number of impacts ranging from the strategic objectives of the Province to uphold public trust, accountability and positive image to financial and time impacts on the service delivery and management of the Project. Multiple stakeholders perceived this decision process as a failure. It illustrates the risks that arise where major project decisions are carried out without a clear process, and criteria selected are based on technical ‘hard’ criteria and exclusive of many broad objectives (most often ‘soft’) of stakeholders affected by the decision.

6.1.4 The Approach

Recognizing these challenges, I developed an approach in collaboration with William Trousdale (a decision and process expert) that supports decisions and the processes that are required for a site selection decision problem (Trousdale & Nelms, 2009). The decision problem is representative of a ‘major’ project decision made in project delivery, that is to say it involves input from multiple stakeholders informed by technical reports, interviews and research conducted over a time frame typically ranging from a few months to a year. The approach builds on a substantial body of work in location theory, particularly in the siting of socially undesirable facilities (see Klose and Drexl, 2004; ReVelle and Eiselt, 2004; Ricci, 2006), the use of objective functions to optimize facility siting (Flahaut et al., 2002) and the use of an analytical hierarchy process to improve site selection decisions (McIntyre & Parfitt, 1998). The approach moves beyond static and deterministic problem formulations to provide help to practitioners facing real world problems such as the influence of stakeholders, a wide range of interests, limited data, inherent uncertainty, and values (Owen & Daskin, 1998). The approach offers a practical and straightforward method that avoids some of the confusion and potential pitfalls associated with the alternative choice applications as described in the literature, including the limited application of the analytical hierarchy process (AHP) (Dyer 1990; Harker & Vargas, 1990; Saaty, 1990; Holder, 1991).

The approach is based on a facilitated participatory process, using negotiation theory as a framework guide. Much of the core methodology of decision and process support (DPS) is based on many criteria and expressed preference methods in the field of decision analysis (von Winterfeldt & Edwards, W. 1986; Keeney, 1992; Clemen, 1996). The approach incorporates constraints, clarifies technical and non-technical criteria, and integrates stakeholder values. As the name suggests, DPS is used to support the decision process, not replace it. This means that accountability remains with the responsible parties (decision makers and managers). The expanded inclusiveness and insight gained by using this approach improves site selection outcomes. The process of characterizing what is important to stakeholders through the clarification of objectives and associated measures in a specific decision context serves to inform the risk management process. It facilitates legitimacy, minimizes conflicts and allows for key tradeoffs (both technical and value based) to be productively addressed. In developing such an approach, there are important project contextual issues that must be considered such as availability of background information and key stakeholders and practical constraints such as time allocated to making the decision and money for consultant support. The approach can be broken down into three tasks as determined by the authors to sufficiently meet the Canadian public sector accountability requirements while working in a typical Canadian federal large infrastructure project environment with time and resource constraints:

1. To identify what is important (values or objectives) by defining a complete range of decision-relevant criteria and practical constraints. This necessarily requires taking a participatory approach, working with all those interested, involved or potentially impacted in the selection of a site. Eliciting factors that are important in the context of the site selection from these participants allows generation of an unambiguous hierarchical list of structured criteria. These criteria frame the problem and helps refine stakeholders' thinking by providing a framework for systematic appraisal of site selection choices.
2. To establish clear criteria attributes. These are the performance measures used to test how well alternative sites satisfy the criteria, within the defined constraints. Establishing clear performance measures greatly facilitates communication by clarifying what the criteria mean and are essential to conducting a consistent, quantified analysis.
3. To explore and incorporate value-based information in the form of relative value weights. Several techniques are available to derive these weights, such as swing weighting or pair-wise comparisons (Hobbs & Horn, 1997). The basic concept is to determine which change between different performance measures is most important (i.e., is a cost savings of $2 million dollars more or less important than an average daily per staff time saving of 10 minutes from a reduced commute?). For a single decision maker, this process is relatively straightforward. Where there

are several decision makers the use of a facilitator who understands decision tools and techniques and has experience facilitating multi-disciplinary groups is critical to the success of the approach. Once the technical information from the performance measures and their value weights are agreed, this quantitative information is used to develop simple algorithms to rank and sort site choices and gain insights into tradeoffs that are required for the identification of priority acquisition decisions. Qualitative information is used to support the ranking and to improve communication. Spreadsheets can be developed to model and support the process, providing instant feedback and results, and can be helpful in group settings to communicate the value systems of the several decision makers.

6.2 Case Study: Headquarter Relocation

Features of the site selection process can be applied to a unique building infrastructure project, in this case that proposed for a proposed construction by 2013 of a new Headquarters facility in Metro Vancouver. Facilitators (myself and Mr. Trousdale) were asked to develop and implement an accountable and transparent site acquisition process that included economic, social, environmental and technical decision criteria. I served on the project management team for over two years and was therefore familiar with all technical and user requirements of the project. The project is both capital and operationally intensive with a proposed budget in the order of $300 million dollars and a construction period in excess of 2 years. The facility was proposed to accommodate 1800 employees in a new (55,000 square meters) rentable consolidated facility. The complexities of the Project that make it unique include, volatility in the construction market place, high tenant involvement in the site selection and design phases, the uniqueness of the functional program, special technical performance requirements, and the multiplicity of stakeholders including all three levels of government.

It is anticipated that the tenant organization will enter into a lease agreement with the contracting organization who will own the facility. The involvement of several organizations complicates the decision making process to meet the program requirements of the two primary organizations, and brings in risks related to the long times required to reach consensus. The potential for a change in government leadership, or changes in organizational policies (of both organizations) in a government environment that is in flux highlights the need for effective communication between regional and national offices and between organizations. A process is needed that can track the evolution of decision making over time and justify the final decision made. Other project stakeholders include government authorities from all three levels of government as well as the tenant organization, which has service delivery responsibilities to the public and to other government agencies.

It is uncommon for a facility of this size and with the unique program requirements to be constructed in the region. The tenant organization is influenced by world events, and its response to complex domestic or international situations adds difficulties to site selection and associated technical requirements. The tenant organization also has changing needs, with implications for the flexibility in the building site that can accommodate future changes, as well as technical, security, post disaster and environmental design performance requirements. There is a substantial risk that the selected site will not be responsive to user needs at the time of building occupancy, a primary risk that the project team wishes to minimize.

Two tasks were completed prior to the development of the DPS approach for this project. The first was completed at the Planning stage of the Project, and included the development of decision criteria to assess and evaluate concept design options. Criteria included: headquarters as community and as part of the community, image, environmentally sustainable design considerations, integrative environment, flexibility (internal adaptability), flexibility (site expansion capacity), site access/traffic circulation, security (external), security (internal), building accessibility, building net to gross efficiency, site efficiency, key adjacencies, operational efficiencies, facility operation costs, capital costs, and programmatic ‘fit’. Criteria definitions and metrics were not available; therefore, although helpful in assessing one option over another, the criteria were subject to different interpretations and value tradeoffs by decision makers.

A preliminary site selection process had already been initiated in which sites were ranked based on size, cost, availability, location, traffic impact and available utility services. Decision makers had difficulties agreeing on the ranking of the sites and Facilitators were asked to develop an approach that would satisfy interests of several decision makers.

6.3 Decision Support Process

The decision support process in this project involved three steps. The first step was to define the problem. Above all, the tenant and contracting organizations wanted a site selection process that was rigorous and practical, and would identify the "best" potential site. The project manager required a process that would provide a transparent and easily communicated set of site requirements and preferred qualities and assist with communication of decision criteria in a complex stakeholder environment of a technically sophisticated facility that was flexible to changes in both the owner and tenant organizational and operational policies.

The second step involved identifying interested, involved and knowledgeable stakeholders, to work through the issues related to the potential construction of the new facility. Starting with contracting organization senior management, where final accountability rested, an initial set of key issues and stakeholders was generated. We then reviewed both the contracting and tenant organizations national and regional strategies, prior work completed during the programming phase and we developed a preliminary list of mandatory and preferred site selection criteria.

We interviewed experts within both organizations, technical and non-technical staff, and other relevant government agencies to refine more specific criteria in the decision context. These expert interviews allowed us to generate initial performance measures and identify key data gaps that would help to distinguish between sites. We also used these interviews to translate objectives outlined in the national and regional strategies, which are broad in context, to reach objectives that were applicable in the site selection process. These interviews were iterative as many technical experts were consulted to review all performance measures and units to provide relative measures based on available data and judgment as well as qualitative support and explanations. This included suggestions for developing indices, indicators, constructed scales or proxy performance measures. The goal of this step was to develop measures that were relatively accurate (rather than absolute) and provided basic insight into the objective.

The third step was to structure the problem. This required translating issues into a criteria-based analytical framework with clear performance measures. Understanding the issues was important so that means and ends criteria could be separated, as could regional and site specific aspects, mandatory site requirements, preferential site criteria and influencing factors. Steps two and three were iterative, as the additional insight derived during this step uncovered more stakeholders and issues. We then developed with Senior Management a phased decision process as summarized in Table 17 and discussed further in the following section. A phased approach provided a time saving exercise that narrowed the list of candidate sites to a manageable few.

Table 17: Simplified overview of sequential screening process for potential new building sites

Phase	Comments
Phase 1 Regional Screening Technical analysis using mandatory technical criteria	The region of interest for HQ site selection is reduced through mandatory requirements at a regional level.
Phase 2 Site Analysis Using Mandatory Criteria	Number of potential sites is reduced through technical analysis using mandatory criteria requirements at a site level.
Phase 3 Site Analysis Using Preferential Criteria	a. Number of sites is reduced through first a technical analysis of preferred criteria. Technical scores) indicate dominance analysis/red flags to minimize the smaller number of potential sites for detailed analysis
	b. Value weights are elicited from Senior Managers and applied to performance measures (technical scores x value weights). Number of sites is reduced through a preferential analysis using weighted performance measures to arrive at a smaller number of potential sites for detailed analysis.
Phase 4 Final Due Diligence and Negotiation	Subject to detailed analysis, final candidate sites from Phase 4 are examined with a focus on key tradeoffs and requisite due diligence. Negotiation with landowners is initiated and a final decision made.

6.3.1 Phase 1 Regional Screening

Phase 1 involved the identification of priority areas as opposed to sites. Two mandatory criteria were identified for use in the regional evaluation. First, it was required that the site not be located in areas with zoning that was not available for development, such as provincial parks or the provincial agricultural land reserve. Second, the site had to meet basic emergency preparedness requirements with respect to the avoidance of large-scale disaster areas covered by two sub-criteria: flood risk and seismic risk. Areas that did not meet defined minimum standards of acceptance (e.g., the site must be located outside the 200-year flood zone) were excluded from further consideration. Because the new facility was proposed to include a post disaster unit, the second sub criteria included the requirement that the facility be located south of the Fraser river to improve regional distribution of facilities with post disaster functions (in this case, a facility with post disaster functions was located north of the river).

6.3.2 Phase 2 Site Analysis Using Mandatory Criteria

After the regional evaluation was complete, potential sites within these regions were evaluated. Phase 2 involved the evaluation of sites using three mandatory site-specific criteria.

1. The site had to have a minimum size to accommodate the tenant organization user and expansion flexibility requirements. Technical experts estimated the number of full time equivalent employees that would occupy the facility, parking requirements and uses to define minimum site areas. For example, based on a 25-year planning horizon for the new facility, it was determined that site size and configuration provide for a minimum 25% future expansion of employees housed at the site (effectively 2250 full time employees), including areas for additional parking. Other minimum size requirements included environmental setbacks from high water marks and a physical security perimeter around and between the proposed building footprints.

2. The site must meet the contracting organization's basic adjacent land use, prior land use and access requirements.

3. The potential site must have a reasonable chance to have a final negotiated price within the approved maximum amount allocated to site acquisition in the project budget.

6.3.3 Phase 3 Site Analysis Using Preferential Criteria

Each site satisfying the Phase 2 mandatory criteria was evaluated using eight preferential criteria. The practical reality of site selection is that no site is optimal for every criterion. Therefore, a clear way to evaluate the implications of imperfection was done through preferential criteria, in which preferred criteria could be traded off against each. For example, a little more flexibility to accommodate existing and future program requirements might be traded off against improved service delivery. The eight preferential criteria are summarized and elaborated upon below:

1. Promote tenant organizations service delivery;
2. Encourage staff retention and recruitment;
3. Promote flexibility to accommodate existing and future program requirements;
4. Support environmental sustainability;
5. Encourage public acceptance and positive corporate image;
6. Promote positive partnerships (current and future);
7. Promote "on time" project schedule; and
8. Minimize costs.

Promote Tenant Organizations Service Delivery

A fundamental reason for the construction of a new facility by the tenant organization was to improve service delivery well into the 21st century. Two service delivery criteria, operational response and business travel, were identified as contributing to this objective. Operational response was defined as travel directly related to the fundamental performance requirements of the organization. This was measured in travel time, using models that accounted for traffic during different times of the day and type of road (e.g., 2 lane rural vs freeway). The second service delivery criterion, business travel, was defined as the travel related to meeting internal or external clients and partners to discuss programs or administrative matters.

Encourage Staff Retention and Recruitment

Another significant issue, with site selection implications, facing the tenant organization's management was staff retention and recruitment. Potential factors that were necessary to consider included: commute time, affordable housing, staff safety, and the attractiveness of the new work location. Minimizing staff commute time was an issue in staffing and was affected by the accessibility of the site by both public transit and private automobile. Challenges that arose in the evaluation of this criterion included the identification of where staff currently lived, the potential for moving nearer to the new building, and choice of transit. The potential for staff to move nearer to the new building was related to access to affordable housing. Another issue considered was the safety and security of the staff. The personal safety and security of employees could be enhanced not only by the location of the site but also the opportunities the site offered for building and landscape design that can contribute to crime prevention through environmental design (CPTED) principles and defensive layering. A final issue raised in interviews with staff representatives was that the new location should be attractive. The new site should contribute to "live-work-play" opportunities by providing easy access from the new building site to service and retail nodes, trail systems and parks. These factors were deemed desirable for a supportive work environment and staff satisfaction.

Promote flexibility to accommodate existing and future program requirements

Site location and shape will impact its ability to accommodate existing and future program requirements in the new facility. Different sites will offer opportunities for more, or less, flexibility in the facility design, including current proposed use and future potential use. Limiting factors that may inhibit flexibility include site size, shape and geographic constraints. Considering buffer requirements for security and environment and usable acreage was a proxy for flexibility. A second aspect is access to the site itself, for example, corner lots that ease automobile access are preferred as are sites that provide access to major arterials, including number of arterials and their distance from the site.

Support environmental sustainability

Supporting, promoting or just being consistent with environmental sustainability is a common theme. However it is often not adequately described or measured, and therefore is not adequately addressed in most site selection challenges. For this new facility site selection, the issue of environmental sustainability was addressed through four criteria. First, it was to be compatible with the Regional District's Livable Region Strategy. Second was to minimize environmental impacts. To do this, the site should support more general organizational initiatives and environmental objectives for both the contracting and tenant organizations. The preferred sites should be sites where environmental impacts are avoidable or easily mitigated, considering species and habitat, (flora/fauna), sensitive areas, hydrology, drainage, land forms, and regulations. Third, the site selection process should give preference to sites where there was an opportunity to promote environmental improvement as well as minimizing environmental impact. These would include brown-field site clean-up opportunities, redevelopment sites, and habitat restoration opportunities. Detailed assessment would be conducted as part of the final evaluation, and environmental issues would be part of removing "subject to" conditions prior to acquisition. Fourth, was to promote sustainable building principles. Technical staff recognized that the some sites would be more suitable for implementing a "green building" or environmental technologies, including opportunities for on-site water, waste-water and storm-water self sufficiency.

Encourage public acceptance and positive corporate image

Public acceptance and image are important to the tenant organization. Site selection should include consideration of the general public, in particular neighbors, and promotion of a positive corporate image. Local business and community impacts should be minimal. Site selection should consider the contributions of the tenant organization to local traffic congestion, increases to local commute time, local truck route interference, ambient noise levels (in particular related to helicopter access routes), and visual impacts. The sheer size of the facility suggests that it could raise visibility issues. The tenant organization was interested in encouraging a positive corporate image by giving preference to potential sites with public visibility, where the prestige and presence associated with the tenant organization could be highlighted. This meant that visibility from major arterials and transportation routes would be desirable.

Promote positive partnerships (current and future)

Working together with government agencies and all levels of government was considered to be desirable by the tenant organization. The site selection could embrace opportunities for federal, provincial and municipal partnerships to achieve greater value from expenditures by the tenant organization, such as favoring sites that offer opportunities for co-location, and complementary services with governmental organizations.

Promote "on-time" project schedule

The minimization of potential project schedule delays was essential. Schedule delays can result in significant project costs and are therefore undesirable. Preferred sites would offer a minimum of potential development delays, such as delays caused by removing “subject to” clauses, permit process delays, and delays related to assurances on compatibility of future use zoning.

Minimize costs

Cost is always a fundamental issue, and one associated with an array of variables. The purchase cost should obviously be within the allotted budget as a prerequisite for consideration. It was agreed that site development costs should also be considered in the evaluation. This included reviewing site geotechnical conditions (e.g. soil type, drainage excavation requirements etc.), the presence and capacity of utilities (water sewer, electricity, gas, fibre optics, cable feed), environmental mitigation, protection or enhancement costs, and threat of risk assessment mitigation costs to address security risks identified by the tenant organization.

6.3.3.1 Developing Measures

Meaningful criteria require measures for sites to be consistently compared. Some of the measures were ‘natural’ measures, which are widely recognized, such as cost measured in dollars, for example, minimizing costs associated with site development is an exercise in estimating costs. In other cases, natural measures could be combined with proxy measures, for example, access to affordable housing used cost in dollars as the measure, but the proxy was the average cost for a 3 bedroom detached 2 level house in a 10km radius to the site. Similarly, the use of travel time to respond to an occurrence was used as an indicator for service delivery and average round-trip drive time (staff home-new facility) using personal vehicle was used as a proxy indicator for commute times.

Still other criteria were unique to the new facility site selection process and required the development of “constructed” measures (see Keeney, 1992). Most are familiar with constructed measures, such as “high, medium, low”, or a “1 (worst) to 10 (best)” scale. Two aspects of developing constructed measures are important to highlight here. It is important to establish consistency and legitimacy in such a system and these scales must be defined. These can be single attribute scales such as what was used for avoiding project delay with a score of ‘2’ for “No Delays Expected (less than 4 months)” a score of ‘1’ for “Delays are mitigable and negligible (4-12 months)” or a score of 0 for “Long Delays Expected, not controllable (such as dependent on a regulatory authority) or high technical requirements”. Other criteria, such as the attractiveness of the work location, required a multi-attribute index that gave a score: 0-2 if the site is within walking distance (under 0.5 km) to public park, green space, or nature trail system and an additional score of 0-4 if the site offers positive urban aesthetics such as historic buildings, pleasantly treed or landscaped, diverse mid- to upscale services and small retail outlets, absence of institutional buildings and derelict or semi-derelict spaces. The development of such constructed measures provides a means to help experts agree on the meaning of criteria and for participants to make tradeoffs between different levels of both easy- and hard-to-define values relevant to the decision at hand (Trousdale & Gregory, 2004). The use of formal expert judgment solicitation was undertaken as a means to get experts to agree on consistent measures, (Keeney & von Wintefeldt, 1991). This was especially useful in areas where uncertainty and data gaps in many technical attributes affected the anticipated consequences of selecting alternative sites, such as those surrounding security.

With the measures in place, technical staff assessed a full range of potential sites. This activity helped to test the adequacy of the performance measures and to establish the range of potential impact each criterion might have on the site selection decision. Understanding the range, “best to worst", for each criterion established the required context is a prerequisite for making meaningful value judgments as part of Phase 4 of the decision process. For example, affordable housing across the sites ranged from a "best" of $297,000 to a "worst" of $355,000 using the proxy measure of an average cost for a 3 bedroom detached 2 level house in a 10km radius to the site.

6.3.3.2 Providing Value Judgments

Value input quantified as a "weight", is required to prioritize the candidate sites. This weight provides insight into the relative importance of the range of the technical scores for each fundamental and sub-criterion. We achieved this during a two-hour meeting with senior management of both the tenant and contracting organizations, the accountable decision makers. Participants were sent a pre-meeting package that included a detailed explanation of the criteria and measures as well as information related to the test sites that were used to establish the range of measures and a set of exercises in a workbook. These exercises were used to solicit the value weights. The worksheets were designed as a swing-weighting exercise (von Winterfelt and Edwards, 1986). The worksheet asked senior management to consider a range of possible outcomes, from worst to best, for each fundamental and sub-criteria. Although the information was provided beforehand, the exercise itself was conducted at the meeting so that clarifications could be made.

Participants were asked to rank order the criteria, and then to weight them on a scale of 1-100, with 100 associated with the criteria they ranked as number 1 (see Table 18 for an example). Each independently developed his or her own set of value weights. During the break, these weights were entered into an interactive spreadsheet computer model developed specifically for the meeting. The model normalized each manager's score and these were placed on the screen next to each other so that participants could compare and discuss similarities and differences, which the model automatically highlighted. The advantage of this approach was that key value differences could be discussed, perceptions separated from reality, and unnecessary conflict avoided. The ultimate goal was to develop a consensus set of weights, rationalized and agreed upon, that could ultimately be applied to the potential sites. Consensus was quickly achieved with all present coming to a mutual understanding of the priorities. With both the technical site scores and the value weights quantified, it was possible to combine these and develop a weighted score to prioritize sites as they were evaluated.

Once value weights are quantified and value independence is established, the combination rule for additive functions is applied. An additive function, given criteria $x_1,\ldots,x_N$, $N \geq 2$, can be written as:

$$U(x_{1\ldots},x_N)=\sum_{i=1}^{N} k_i u_i(x_i)$$

where U is the overall value (in this case the weighted property evaluation score) and the k_i are value weights showing the relative contribution to the overall value from a change in a specific criteria, x_i. The u_i are technical scores, (or the single attribute utility functions), one for each of the x_i criteria (Keeney, 1992).

Table 18: Example of a sub-criteria ranking and weighting exercise for the primary criteria "Staff Retention and Recruitment"

Rank	Weight	Sub-Criteria	Worst	Best	Comments
		Staff commute time	93	63	Average round-trip drive time (home-HQ) using personal vehicle
		Access to affordable housing	$355,000	$297,000	Average cost for a 3 bedroom detached 2 level house in a 10km radius to the site ($)
		Staff safety *Crime prevention through environmental design*	0	3	- Topography meets DIVISION surveillance requirements (Yes=1/No=0) - Site is conducive to DIVISION security (Note If security on the site is unacceptable, site will not be considered in this phase of evaluation; also priority sites will be subject to a final detailed evaluation) 0=high security concerns; 1=mod; 2=low Total out of a possible category score: 0 – 3 pts
		Attractive work location	0	6	0 - 2: Walking distance (under 0.5 km) to public park, green space, or nature trail system 0 – 4: Urban aesthetics - workplace is in area of historic buildings, pleasantly treed or landscaped, offers diverse mid- to upscale services and small retail outlets, absence of institutional buildings and derelict or semi-derelict spaces Total out of a possible category score: 0 – 8 pts

6.3.4 Phase 4 Final Due Diligence and Negotiation

One advantage that the decision model provided was an objective and rigorous method to identify the best sites and distinguish between them (e.g., why is Site A scoring higher than Site B). It is a decision aid and does not replace final decision making, but it helps internal communication by clarifying the main reasons why sites scored differently, and provides the staff who must negotiate sites with more information about the best sites and, perhaps even more important, what priorities the senior management have so that these can be pursued in the negotiation.

6.4 Applying the Outputs of DPS to Risk Management Processes

Preferential objectives identified by decision makers in the case study problem were broader and varied relative to traditional objectives ‘Promote “on time” project schedule’ and ‘Minimize costs’. Risk events that impact these other preferential objectives related to effective service delivery, staff retention and recruitment, environmental sustainability, partnerships, public acceptance and positive corporate image are clearly important. For a holistic risk management process, the impacts of risk events on these objectives should be considered. The structured decision support process outlined in this chapter informs a number of large infrastructure project tasks. First, the process assists with characterizing the multiple stakeholders involved and affected by the project applying an explicit approach to elicit both ‘soft’ and ‘hard’ objectives. The objectives identified are particularly useful in stage 3 ‘Stakeholder Analysis’ of the stakeholder management framework introduced in chapter 5. Secondly, the approach informs documents and processes followed in project risk management including the development of risk impact tables (one must understand impacts of risk events relative to objectives) and the identification of risk events. It is clear that stakeholders involved in large infrastructure projects, in particular PPP projects, are a source of risk to a Project. Poor decision processes, which do not facilitate meaningful consultation or consideration of broad stakeholder interests, can result in a myriad of risks (as illustrated in the Prison siting example). These risks are real in both financial (cost escalation, time delays etc.) and non-financial terms (loss of reputation, legal liabilities etc.)

and are ‘felt’ at both the project and corporate executive level of management. Understanding stakeholder preferences and values assists a project team clarify their expectations and concerns and perform meaningful consultation in the early project delivery stages thereby reducing the project risk profile.

6.5 **Conclusion**

Decisions made in the early stages of a public private partnership large infrastructure project can have profound impacts on strategic and financial objectives of an organization and the Project itself. The chapter illustrates the many and varied objectives considered by a public sector entity in selecting the ‘best’ solution to a decision problem. In the absence of a structured and transparent process that may be easily communicated to a range of stakeholders, the selection of ‘best’ is fraught with risk of failure. Risks that may arise where a decision process fails are provided on a site selection problem and a structured approach is developed to address multiple decision makers’ interests. There are many advantages to undertaking a more thoughtful and rigorous approach to decision analysis and specifically site evaluation and selection. Most important is that it will improve the quality of decision making by facilitating clear thinking and good communication. The improved communication reduces internal conflict between decision makers and staff. An explicit process also helps to insulate against charges of favoritism or other accusations that often arise in scrutinized processes that can, in the extreme case, result in legal challenges and stakeholder opposition. Finally, thoughtful application of the DPS approach should not result in additional costs or time. In fact, because of the higher level of transparency, the ability to evaluate alternatives quickly and improved communication should reduce both time and cost over the entire planning phase of the project. The consideration of many objectives is not new; however, the early structuring and eliciting of clear organizational or project objectives can provide significant insight to a number of project tasks including stakeholder management and risk management. The process can be adapted and refined to respond to the numerous decision problems encountered in the delivery of a large infrastructure project and ultimately on the improvement of the risk management process applied.

Chapter 7: **An Integrated Risk Management Process: A Prototype Application**

7.1 Introduction

In this chapter, a framework and aspects of this framework incorporated in a project management research prototype for the management and re-use of risk knowledge and related information are introduced to improve the processes of risk identification and elicitation of expert opinion in large infrastructure delivery. Carrying out the risk management functions in the delivery of large infrastructure projects remains more art than science with industry practitioners based on observation and practitioner feedback. This is particularly the case with the identification of risk events and the elicitation of quality estimates of their properties from experts. The identification and consideration of drivers of risk events is one approach to improving both of these approaches. Improving the quality of output from each of these two steps can result in a more accurate representation of a project's risk profile and, selection of more appropriate responses to risk and allocation to the party best suited to manage it, thereby providing an opportunity for improved project risk management. Emphasis is placed on the concept of characterizing components of the project context and is applicable to both the identification of risks and elicitation of their properties using expert opinion, and how it has been realized in an Information Technology (IT) environment.

This work builds upon earlier research conducted on how to best represent the relationship between project risks and project context (DeZoysa, 2006) which identified that much work remains to be done on how best to carry this out. While the approach can be applied in many domains such as business management and information technology, it has been developed and its features are specific for improving these two risk management tasks (risk identification and elicitation of properties) performed in the front end planning and procurement phases of large infrastructure public sector projects. The risk framework introduced has a number of characteristics that differentiate it from other risk management processes:

1. Developed specifically for improving the quality of the risk management tasks associated with the identification of risk events and elicitation of expert opinion – tasks which are a subset of a holistic organization/project risk management framework;

2. A structured approach to elicit information on project context specific to public sector infrastructure project delivery to help make explicit drivers of risk;

3. A focus on integrating information gathered across project management tasks that establish the project context, such as stakeholder management planning, budget management etc., for the identification and elicitation of risk properties;

4. A specific step to identify and define the objectives and characteristics of project stakeholders and include these objectives as metrics in the risk management process; and

5. A step to define the purpose of the risk management tasks, accountabilities, calibration of participants for elicitation of their opinion, and risk metrics.

Motivation for this work has come in part from the increasing trend by governments worldwide to adopt the Public Private Partnership (PPP) procurement approach to meet large infrastructure needs under affordability constraints and achieve greater transfer to the private sector of project scope, time, and cost risks that are inherent in infrastructure projects. The focus on project delivery using PPPs has in turn led public sector entities to place greater emphasis on risk management in the planning and procurement phases of a project when the contract is being formulated and decisions to allocate risks between partners are made. Poor treatment or the inappropriate allocation of risk events can become problematic for both parties involved with respect to project objectives (such as accountability, scope and value for money, etc.) and may result in strained relations for what is intended to be a co-operative long-term partnership to deliver and operate an infrastructure asset.

The objective of this chapter is to demonstrate and apply the research ideas and concepts, including the concept of characterizing project context, to improve the approach to the risk identification and elicitation of expert opinion so as to address identified weaknesses. How this can improve current practices is demonstrated by way of a project management research prototype. The multi-view representation of a project in terms of hierarchical structures of components, combined with the ability to characterize components in terms of user and in some cases system generated attributes and make associations amongst components of the various views, facilitates an integrated approach to the tasks of risk identification and elicitation. The software prototype provides a flexible platform in which risk terminology is made explicit. In the framework and prototype, a risk is defined as the potential variability in a project parameter from its anticipated value (e.g. higher than expected inflation rate during the construction phase which is described in terms of a density function for the inflation rate), or as a discrete risk event (e.g. contaminated soil encountered) which can be described in terms of different state values realized, likelihood of occurrence of each state, and vector of outcomes, given the realization of a specific state of occurrence. The primary focus here is on discrete risk events as opposed to assessing variability in estimates of basic variables, and within this focus, attention is directed mainly to the identification of risk event drivers, to help with determining potential outcome(s) as well as selecting the most appropriate risk response(s), and the elicitation of risk event properties.

Features of a less fully developed version of the framework and the concept of characterizing project context utilizing the research prototype to assist with risk management tasks have been presented in other publications (Nelms et al. 2006a, 2006b; Nelms & Russell, 2007; Nelms & Russell, 2008) in addition to support tools (Trousdale & Nelms, 2009). Building on previous work, primary aims of the research presented in this chapter are: 1. Exploring how modelling project context can improve the processes of risk identification, and elicitation of risk properties for large public sector infrastructure projects in the early phases of a project; 2. How can one best model project context and specifically characterize stakeholders; and 3. The roles for IT in the design of a support tool for real time risk identification and elicitation of expert opinion sessions. Underlying this research are two fundamental hypotheses including: 1. The processes of risk identification and elicitation of risk properties can be improved using methodologies and tools that treat a specific characterization of project context; and 2. Characterizing the components and associated attributes used to represent the various views of a project can provide valuable insights to project managers and improve the overall risk management process. These hypotheses have been supported by both my experience in leading risk management processes in Canadian public large infrastructure projects and the opinions of senior industry executives outlined in Chapter 8.

The remainder of the chapter is organized as follows. First, a brief description of the challenges in eliciting probabilities and the established techniques and protocols for eliciting risk information are summarized based on a review of the literature. Next is a short description of a case study scenario (the same project described in chapters 4 and 6) that reflects the characteristics of large infrastructure projects delivered by Canadian federal public sector entities and key planning and procurement risk issues modeled in the research prototype are presented. This case study is used as a background to highlight the role of drivers as part of the approach to risk identification and elicitation of expert opinion and describe in some detail the concept of characterizing and its application to improve risk management tasks. A structured three-process step framework to risk identification and elicitation of expert opinion in conducting risk workshops is introduced. This framework is applicable for the risk tasks performed in any project phase and applied in the front end planning and procurement phases of a large infrastructure public sector project. The concept of characterizing project context as it is applied in this research is introduced followed by a detailed framework that involves characterizing the components and associated attributes used to represent the four views of a project. These four views include the physical (what will be built), process (how it will be built including schedule), participant (organizations and individuals involved) and environmental (the natural and man-made environments in which it is being built). Emphasis is on how different categories of project participants may be characterized to assist with the risk management process. Lastly, how this framework can provide valuable insights to project managers and improve the overall risk management process is then discussed.

7.2 Risk Identification and Elicitation

The processes of risk identification and elicitation may be defined as identifying perceived issues or concerns and determining their characteristics or properties. Chapman (1998) identifies three principle approaches and techniques applicable to perform the risk identification stage with varying degrees of project team involvement listed from least to most project team involvement: a) identification of risks by risk analyst; b) identification of risks by risk analyst through one-on-one interviews; and c) the analyst leading a working group to identify risks. In Canadian large infrastructure projects, risk analysts apply each of these approaches in the planning and procurement phases with the interaction of individuals and groups predominately occurring when business case analysis is carried out and procurement method selection decisions are made. Tools commonly used for risk identification include checklists, brainstorming, interviews, historical documentation reviews, cause/effect and influence diagramming techniques and expert judgment (Bajaj et al., 1997; PMI, 2008; Akintoye & Chinyio 2005;). Expert opinion elicitation is a term used to describe a process of gathering information and quantitative or qualitative estimates that can support the risk identification process. That is, and as expressed in relatively general terms, one seeks to **identify** X (the risk event) which occurs at **process step** Y because of the presence of drivers $\{D_1, .. D_n\}$ in the form of components and their attribute values at process step Y, and **elicit** the properties including likelihood P of event X occurring, the drivers $\{D_{1,}\ldots,D_n\}$ of the risk event, the performance criteria $\{C_1, \ldots, C_n\}$ impacted and criteria outcomes $\{O_1, \ldots O_n\}$, expressed quantitatively or qualitatively or a combination of the two in deterministic or probabilistic terms, as appropriate. The notion of process step in the previous definition can be very broad (global) or narrow (project specific) in scope. For example, a global process step could represent multiple process steps within the entire project while a project specific process step could represent the Project Analysis step within the Project Planning Stage, or the front end planning phase of a building infrastructure project. Risk drivers, also termed 'risk sources', may comprise a number of components. For example, consider the risk event: 'National funding authority representative does not submit the Project Sponsor department capital construction funding approval request for authorization by senior management by the scheduled date,' the impact being ' delay in Project Sponsor department issuing procurement documentation and increase in costs through escalation.' The drivers of this risk event may include: (a) **inexperience** of project team members in providing complete documentation; (b) inadequate **capacity** within National funding department to carry out review and submit for authorization; and, (c) an overly **optimistic estimate** of the time required to carry out and submit recommendation for authorization. It becomes clear that there may be a number of drivers for a risk event and that knowledge of potential risk drivers can contribute to more effective identification and elicitation of risk properties and selection of risk mitigation measures.

It is recognized in the construction industry that of all project delivery phases, the risk identification and elicitation of expert opinion tasks performed early in the project planning phase have the largest impact on the accuracy of any construction risk assessment (Chapman, 1998). That said, performing these risk tasks effectively has its challenges and results in practitioners of large civil infrastructure projects applying ad hoc approaches to both risk identification and quantification (Tah & Carr, 2000; Adams, 2006). A significant challenge is the identification of the multiple risk types, which include financial, economic, environmental, organizational, contractual, technical and political, one of several risk classifications found in the literature. Most often risks are considered in isolation of one another even though in many cases they can be interrelated (Thomas et al. 2006). Also, there is no readily available approach to synthesize data collected or apply knowledge from past projects. In addition, because of tight time frames for data collection, analysis and decision-making, the estimation of values for risk event likelihood and outcomes is often derived from off the top of the head or highly subjective estimates that are not easily reproducible. Nevertheless they are made to illustrate that an accountable process was undertaken to develop the project budget, schedule and management plans.

7.2.1 Elicitation and Behavioral Research Findings

To assist with the **elicit** part of the foregoing, a rich literature exists on expert opinion elicitation techniques applicable to the field of engineering, including approaches for combining expert opinions and dealing with cognitive heuristics and biases of which facilitators and participants of risk identification and expert opinion elicitation sessions must be aware (e.g. Tversky & Kahneman, 1974; Spetzler & vonHolstein, 1975; Morgan & Henrion, 1990; Cooke, 1991; Ayyub, 2001). Behavioral decision research with individuals has clearly demonstrated people seem to lack the intuition and cognitive capacity for dealing with complex problems (Gregory & Slovic, 1997). Broadly speaking, people are not trained on how to make decisions and on the heuristics and cognitive and motivational biases that influence their judgment. Having an understanding of heuristics or 'rules of thumb' that help explain how people make judgments that in some cases may result in cognitive biases is of assistance in developing a framework to improve the quality of the risk identification and elicitation of expert opinion processes.

Heuristics and biases influence the estimates given by the assessor, which calls for both awareness of their occurrence and the need for a structured elicitation process and supporting tools to minimize poor quality estimates. Cognitive biases arise in the processing of information by the assessor and are typically a result of subconsciously using heuristics, or rules of thumb, to simplify the task at hand. Three common heuristics in making probability or consequence judgments in the risk identification and analysis processes include (a) representativeness; (b) availability; and (c) anchoring and adjustment. Representativeness is the process where an individual uses the similarity of two events or previously formed stereotypes to estimate that one event is representative of the other. Availability is the process where the estimates of the event occurring is influenced by the ease with which the event comes to mind such as vivid, recent or emotional events such as a Project participants recent experience on a similar Project. Anchoring and adjustment is the process where an individual selects or is given an initial estimate, the anchor, and adjusts the estimate relative to the anchor to make a final decision. Motivational bias involves the scenario where the assessor is influenced by their personal interests or situational context which as a result influence the values given to the evaluator. These biases and heuristics commonly influence the quality of the risk management process and highlight the need of risk analysts to clarify a project context with risk participants such that distinctions across present and past project contexts such as geography, climate, and personnel are made.

In addition to these commonly referred to heuristics, the attributes of the risk object itself, the affect heuristic, and the position of the person or social group making the judgment are critical to understanding risk judgments. Each of these elements can contribute to the risk judgments but may not be easily separated from each other. In terms of risk attributes, experts in risk assessment have typically focused on quantitative measures to define risk by assigning probabilities and measures such as time, dollar and mortality to the consequences of risk events. However, the risk literature has shown that experts tend to perceive risks differently than the public who think about risk in a much broader and more qualitative way. This becomes particularly pertinent for consideration in the delivery of public sector large infrastructure projects which are typically mandated to consider public interests and values. Slovic (1992) identified qualitative and value attributes of risks that affect how the public perceives different risks. He defines a two dimensional "factor space" in which the degree to which a risk is "dreaded" is ranked on the x axis (Factor 1) and the degree to which the risk is "unknown" is ranked on the y-axis (Factor 2). Factor 1 includes a combination of risk attributes such as whether the individual can control the risk, whether the risk is voluntary or involuntary, whether the risk has catastrophic consequences or not; and other attributes. Factor 2 captures such risk attributes among others as whether the risk is observable or not, whether the risk is new or old, whether the risk is known or unknown to science. Slovic's research shows that where a risk was ranked high on the "dreaded" and "unknown" axis (the top right corner of the "factor space") the higher the public perceived the risk and the more they wanted to see the risk reduced. The public perception of risk was found to contradict the expert perspective because the unit of analysis that drives risk perception differed between parties (for example, qualitative/psychological risk attributes versus mortality or morbidity). This research is informative to policy makers who are interested in evaluating the public perspective and potential social impact (and associated costs) of a particular risk event and illustrates that risk judgments are, in part, formed by the attributes of the risk.

Risk judgments are not formed solely on the basis of analytical judgments of risk attributes but they are also formed by an individual's affective judgment. Affect, for the purposes of this Chapter, is defined as a visceral, emotional reaction, which is often more rapid or basic than cognitive evaluations (Loewenstein et al., 2001). Loewenstein et al. (2001) defines these reactions as "anticipatory emotions" such as fear, dread or anxiety and suggests that emotional reactions depend on such factors as the individual's ability to conjure up an image and their exposure to or experience with the risk outcome. These authors go onto state that anticipatory emotional reactions sometimes diverge from cognitive evaluations and that when an image of a negative outcome is easily imaginable, people become more concerned about the risk than if a positive image is imagined. This idea is supported citing Johnson et al. (1993) with an example of people willing to pay more for travel insurance covering death from “terrorist acts” (a highly imaginable, recent negative outcome) over death from “all possible causes” (common terminology not invoking the same degree of fear). In some cases these emotions may result in the individual neglecting to consider the probability of the risk (Slovic et al., 2004). Slovic et al. (2004) highlight people’s emotional reactions to stimuli are sufficiently rapid that they bypass formal cognition and so are not bounded by analytical decision making processes particularly in response to a visceral reaction. An example discussed is if one has a phobia of snakes, running away from a non-poisonous snake is not a cognitive act but an affective one with the decision to do so occurring almost instantly. It becomes clear that in order to understand a full spectrum of risk judgments that may be encountered on a project one must consider the impact of affect on an individual’s risk judgments.

Risk judgments are also a product of socio-economic factors such as age, education, class, gender and the social group to which an individual belongs. This is pertinent for consideration in risk management tasks for infrastructure projects, which involve the input of experts across a range of disciplines (financial, social, policy, architectural, engineering, etc.), educational backgrounds and represent multiple stakeholder interests. It is difficult to separate each of these inter-related socio-economic variables and conduct a definitive analysis to explain this phenomenon. Satterfield et al. (2004) looked at the influence of four variables (gender, social vulnerability, environmental injustice and race) on risk perception and found that all four variables are key predictors of risk perception (gender and social vulnerability being the strongest). Slovic (1992) highlights that it has been widely demonstrated that people perceive risks beyond their control to be more risky than those they feel they have some control over. A survey of experts and laypersons attitude of risks of chemicals by Kraus et al. (1992) found that group status, education, race and gender were predictors in determining attitudes towards risk (group status being the most important) and found there was a clear difference in risk perception by experts and the public (public more risk averse than experts) and also the perception of risk between the sub groups of experts differed (women more risk averse than male counterparts). Slovic (1992) also indicates strong subgroup differences in risk perceptions – age, sex, education, political activism and states that "It is most certainly the case that information processing, personality, social factors, economic factors, and cultural factors interact to determine individual and societal response to risk". It is clear in the risk literature that socio-economic factors do impact risk perceptions and knowing this can help in the risk identification, elicitation of expert opinion and provision of appropriate risk information in the risk communication stages of a project.

Similar to behavioral research findings for individuals, groups equally find difficulty and tend to be unable to make wise choices about complex tasks in an unaided decision making environment (Arvai et al., 2001). Kadane & Wolfson (1998) and Garthwaite et al. (2006) provide a comprehensive review on the eliciting of probability distributions including an extensive list of references on the subject of expert elicitation. Within the construction industry literature, Adams (2006) introduces a comprehensive model for eliciting subjective probabilities specific for application in the construction industry and draws upon concepts addressed in the decision analysis literature. Overall, there are a number of themes discussed in the risk literature to explain differences and biases involved in risk judgments and these explanations are not necessarily exclusionary.

7.2.2 Elicitation Techniques

There are a number of approaches that may be used in expert elicitation; however, it is clear in the literature that there is no universally accepted protocol and little work has been conducted on empirical evaluation of alternative approaches (Lau & Leong, 2005). Three approaches to elicit probabilities include the Stanford/SRI protocol, Morgan and Henrion protocol and the Wallsten/EPA protocol (Morgan & Henrion, 1990). The Stanford/SRI protocol is performed in five phases where in the first phase, *motivating*, the analyst outlines the objectives of the elicitation exercise and explains the benefits of a probabilistic over a deterministic assessment. The second phase, *structuring*, involves the development of a clear and unambiguous definition of the quantity to be assessed. The objective of the third phase, *conditioning*, is for the expert to think rigorously about the information available and how this information can be used to form a judgment to avoid as much as possible cognitive biases'. In the fourth phase, *encoding*, the expert generates values for the probabilistic judgments. The objective of the final phase, *verifying*, is to test the expert's judgment to determine whether or not the elicited distribution are consistent with his or her beliefs.

The Morgan and Henrion protocol is similar to the Stanford/SRI protocol in that it is also a five-phase process; however, the expert is provided with a briefing document summarizing findings of the problem context and a document outlining the problems and processes associated with human judgment about uncertainty. Similar to the Morgan and Henrion protocol, the first step in the Wallsten/EPA protocol is the provision of a background document to the experts outlining difficulties in eliciting probabilities, a brief description of the purpose of the analysis, and a description of how the process will be conducted. Each of these approaches emphasizes similar steps and focus on structuring the elicitation process. These concepts including *motivating, structuring, conditioning, encoding and verifying* have been adopted in the activity steps of the risk framework introduced in this Chapter.

7.2.3 Integrating Project Context with Tasks

Integrating the tasks associated with risk management with those associated with the overall project management process and incorporating knowledge management techniques in support of these tasks poses a significant challenge, which must be addressed if better quality risk identification and quantification is to be achieved. The importance of establishing context to assist with the risk management process is a concept adopted in the AS/NZS 4360 Risk Management Standards and highlighted in the Enterprise Risk Management Guidelines (RMB, 2007), a framework for performing risk management for public sector projects in the Province of British Columbia, Canada. In support of this observation, Akintoye et al. (2003) summarize the results of an investigation of risk management in Private Finance Initiative (analogous to a public private partnership) projects which highlighted that incomprehensive upfront project information, poor historic statistical risk data, and lack of risk information from previous projects in the form of a risk library can adversely affect the ability to meet value for money requirements of the government sector. The use of an integrated project context model as an approach to improve the undertaking of risk management tasks is clearly supported; however, it is clear that are limited examples illustrating how this may be performed in a practical manner, such as by utilizing new concepts and IT tools.

7.3 Case Study

A high security headquarters facility case study ('the Project'), a case also highlighted and described in chapters 4 and 6, is used as a backdrop to illustrate the risk management framework along with implementation details for identifying risk and eliciting their properties for purposes of risk management and other project management functions. In so doing, I seek to illustrate how concepts developed are applied in real project modelling. The Project serves to consolidate over 18 groups within a Canadian federal department distributed in over 20 facilities, which are neither purpose-built nor suitable in terms of space, adjacencies, systems and technology to meet current service delivery requirements. The Project consists of approximately 55,000 square meters of useable office, warehouse and garage space in addition to special purpose spaces to accommodate over 1800 employees. The Project is particularly unique with special base building and fit-up requirements including blast walls, post disaster systems, and back-up utility services in addition to special fit-up requirements such as security walls, acoustic separations, and security hardware.

The procurement mechanism selected to deliver the Project made it first of its kind for both funding Departments. The Project Sponsor procured the Project using a design-build-finance-maintain (DBFM) delivery mechanism (a public private partnership) and both the Project Sponsor and the jurisdictional authorities had no recent experience or established processes utilizing this procurement mechanism. In addition, the Project was jointly funded by both the Project Sponsor (procuring agent) and the Project tenant (user) and therefore entailed significant project delivery process complexity with each departmental leader required to follow their respective in-house project delivery processes and requirements for appropriate Project delivery scoping, sign-off and approval. The unique partnering strategy with the private sector was new to both federal departments and involved the transfer of select responsibilities to the private partner and payments linked to their performance and the availability of the facility. The private partner responsibilities in the Project included:

- Financing for the project term (construction period plus 25 years) over and above Project Sponsor milestone payments;
- The design, construction and commissioning of a state-of-the-art Facility incorporating the latest best practices and technologies;
- The provision of facilities maintenance and rehabilitation services for the Facility to ensure that it is at all times in a specified condition over the 25 year Project term; and
- The provision of some non-core services such as cleaning, waste management and food services.

Two key planning phase risk issues in this Project related to the management of environment and heritage related concerns and meeting scheduled funding approval timelines. These two risk issues are further described in Section 7.6 including associated risk drivers and impacts and the use of the research prototype as one step of the risk management framework is illustrated.

The first risk issue related to the multiplicity of Project stakeholders that use or were associated with the Project site who were concerned how the Project was delivered with respect to the environmental and heritage features of the site. Adjacent land owners and uses to the Project site included an urban park, an arboretum which extended onto the site and residential homes, commercial and government institutions. Key environmental and heritage risks included the demolition of existing buildings that may also require contamination abatement, appropriate integration with the 'look and feel' of the surrounding Park(s) and urban setting, meeting site preparation and construction requirements in the vicinity of a protected stream that made up a portion of the site property line, and responding to requirements to protect endangered species encountered on the site.

A second key risk issue related to meeting project funding requirements in a changing political environment where political pundits and the media anticipated an election prior to the scheduled date for submission of the project funding and approval documents. Goals are often shifting and complex when governing parties change and enact their party priorities with new Ministers responsible for Department decision making. Responding to a political environment in flux where funding Department Ministers or Ministers sitting on the Project funding approval board, the Treasury Board (TB), may change in an instant is a challenge. Project funding is contingent on the approval of the federal TB and the recommendations for approval by the respective department Ministers. Risks associated with attaining Project approvals included timing of submission documents to meet the select dates within which the federal TB sits, co-ordination of communication between respective funding departments and ensuring the Project remained prioritized by both joint Project funding departments. TB sits during select dates to review funding submissions for approval. If the sitting date is missed, delays of months for a second submission date are not uncommon. There are a number of reasons a scheduled date for submission is missed including the submission is identified by reviewers as incomplete, sign-off is not attained by the respective Minister(s), change in Ministers, the respective submitting Department replaces the Project submission with an alternative priority project or to address prior submission backlogs.

In summary, both the public sector Project sponsor as well as private sector consortia interested in the project face the challenge of identifying and quantifying potential technical, environmental, financial, stakeholder and regulatory risks, some of which are interrelated, from their respective perspectives, and determining relevant risk response strategies. Key decisions for the Project Sponsor deal with confirming selection of preferred procurement mode, allocation of risks to achieve value for money, and selection of risk response strategies, while private sector decision making relates to whether or not to bid, and if yes, how to price out the risks, etc. Improving the risk identification and elicitation of expert opinion assists multiple project stakeholders involved in project delivery and their overall quality of decision making.

7.4 An Improved Risk Management Approach

A structured risk management framework to improve the identification of risk events and elicitation of expert opinion for quality inputs in risk assessment in the front end planning phase of large public infrastructure is discussed. The framework draws upon the models and techniques for probability elicitation described in the risk literature but with specific focus on addressing the time, resource and evolving organizational and information environment challenges experienced by practitioners in the front end planning phase of project delivery in public sector projects. Project information is often evolving in the early planning and procurement phases requiring users to model information at a “summary” or coarse grained level. An overview of three process steps of the risk framework is provided and is further detailed in Table 19:

Process Step 1 'Preliminary Preparation' involves the necessary preparatory work of the risk analyst to confirm the project requirements, its objectives and deliverables to be met. It is at this step that the risk analyst carries out a review of the organizational risk management protocols including a review of reporting requirements, accountabilities, risk terminology and processes that are to be followed and connection with enterprise risk management tasks.

Process Step 2 'Risk Management Task Preparation' involves the necessary documentation preparation of the risk analyst and defining in further detail the project context. Document preparation may include developing feedback templates, communication protocols and risk registers to be used throughout the risk management process in all phases of project delivery. Risk tasks such as elicitation and record keeping of expert opinion is of particular importance in ensuring there is an accountability trail of information used to substantiate the Project risk values and metrics. At this step, the research prototype is first used by the risk analyst to model the project context. The analyst may draw upon a database of historical information or previous project templates to efficiently model a project in a manner consistent with organizational requirements. To assist with populating project views such as the 'Participant' view one may refer to chapter 5 which highlights how stakeholders are identified along with their concerns and interests and chapter 6 which highlights how project objectives may be identified and inform the development of the risk impact and consequence criteria in the 'Risk' view.

Process Step 3 'Risk Identification and Expert Opinion Elicitation' involves the tasks to carry out one-on-one or group interviews with experts. It is at this stage the research prototype is used through interactive sessions with risk participants.

The intent of this three-process step framework is to provide guidance to users of organization or industry recognized project risk management frameworks (AS/NZS 4360; RMB, 2007; PMI, 2008). These frameworks have minimal guidance on user implementation of risk identification and elicitation of expert opinion tasks with specific focus on project planning and procurement phases including the integration of project context with the risk tasks as often advocated in these frameworks. As such, the 3-Step Process framework is intended to provide reference to more detailed support tools and a process to help fill this gap in process support to practitioners and the research community.

Table 19: A risk management framework for the identification of risk and elicitation of expert opinion

Process Step	Process Step Description	Process Step Activities
STEP 1 Preliminary Preparation	Define the Project *Confirmation of Project definition, objectives and activities.*	Project Requirements • Establish team to lead risk management exercise and stakeholders; (refer to Chapter 5 for a support approach to assist with this task) • Confirm project definition, budget, scope and schedule; • Establish Project objectives, vision statement (refer to Chapter 6 for a support approach to assist with this task);
	Define the Organization Risk Protocol *Confirmation of the organizational requirements in performing risk management tasks, reporting and connection with the enterprise risk management processes'.*	Organization Requirements • Identify the enterprise risk management plan and organizational definitions applied (pre-determined definitions of risk, consequences, classification categories etc.); • Identify the stakeholders required to participate in the risk management process and accountabilities as per organizational policy/guidelines; • Determine how information will be disseminated and frequency (e.g., verbal, e-mail, presentations, conference calls); and • Identify the minimum acceptable time and resources allocated to perform risk management tasks and communication requirements.
	Document and Communicate *Ensure risk information is documented and communicated for review by identified stakeholders as required.*	Communicate and Document Results • Communicate results and update documentations as required for audit and project requirements.
STEP 2 Risk Management Task Preparation	Define Project Context *A model of the Project context based on a compilation of existing project documentation that may be utilized by the risk analyst in the risk management tasks performed.*	Project Context Model • Define the 'Process' view including how it will be built and when sourced from Project documents such as Project schedule of activities, tasks and durations, plan and brief; • Define the 'Physical' view including what is to be built and where sourced from Project documents such as Project brief, output specifications, program; • Define the 'Environmental' view including the natural and man-made environment in which it is being built sourced from Project documents such as statutory requirements (health & safety, fire safety, environment), Department of Finance and Treasury economic reports, and site condition reports (e.g. geotechnical studies); • Define the 'Participant' view including the participants that will be involved sourced from Project documents such as Project stakeholder management plan and communication plan;

Process Step	Process Step Description	Process Step Activities
	Prepare Key Risk Management Documentation *A compilation of key documents that are used by the risk analyst to assist with the identification of risk events, elicit expert opinion and record keeping.*	Documentation Development • Develop a risk management plan including the structure and plan for engagement of personnel; • Develop the base risk register document with information and risk categories that co-ordinate with organization requirements. • Pre-populate the risk register if this is organizational practice from relevant sources such as risk registers of past projects, audit reports, project brief, minutes of team meetings, organization checklists; • Develop risk impact and consequence criteria;
	Document and Communicate *Ensure risk information is documented and communicated for review by identified stakeholders as required.*	Communicate and Document Results • Communicate results and update documentations as required for audit and project requirements.
STEP 3 Risk Identification and Expert Opinion Elicitation	Prepare for Individual and Group Interviews *Develop documentation to support the risk identification and elicitation of risk information processes.*	Develop Risk Preparation Material • Identify key risk participants for consultation and/or elicitation of expert opinion; • Develop elicitation approach including schedule of activities relative to project schedule; • Consult organizational protocol on risk language that is to be utilized to ensure consistency in terminology;
	Prepare Risk Register *Pre-populate risk register with risk events based review of internal and external Project documentation.*	Review and Update Risk Register • Identify risk events from relevant sources such as risk registers of past projects, audit reports, project brief, minutes of team meetings, organization checklists;
	Perform the Risk Identification and Expert Opinion Elicitation Process *Interview risk experts in one-on-one interviews or group sessions.*	Select and Invite Experts • Develop and distribute information packages for each expert that will be interviewed including: a) Objective of meeting and preparation required of expert; b) Relevant background information on the Project such as project definition, programmatic requirements, vision statement, objectives and stakeholders involved; c) A list of participants that will attend the meeting; d) An agenda for the meeting and anticipated outcomes; e) If available, a risk register that will be populated with information elicited from the expert and a list of risk events the expert is expected to provide input should be highlighted; f) A description of the elicitation process, feedback process and a background paper on challenges eliciting human judgment and uncertainty; Prepare Experts for Workshops and/or Interview • Conduct interview with meetings including the

Process Step	Process Step Description	Process Step Activities
		following steps: a) Describe the background context of the project, how the risk information will be used and relative importance to project delivery processes, and objectives of the interview session; b) Formal discussion on heuristics and biases; and c) A description of the elicitation of risk information process; d) Calibrate participants on probability and risk impact tables; Conduct Workshops/Interviews with Experts e) Using the process view of the project, step through each activity and identify pertinent risk issues; f) Identify each risk event with a unique identifier code including the drivers of the risk event and rate the likelihood and impact of occurrence relative to Project and organization objectives identified; g) Assess whether an existing risk management control mechanism exists for the risk event and the adequacy of this control mechanism; h) Carry out periodic checks on risk information elicited from interviewees.
	Document and Communicate *Ensure risk information is documented and communicated for review by identified stakeholders as required.*	Communicate and Document Results • Communicate results and update documentations as required for audit and project requirements.

7.5 Research Prototype Features and Implementation Details

Use is made of the case study to highlight features of the research prototype IT approach and research concepts discussed. The prototype draws upon an integrated multi-view representation of a project, knowledge management concepts, and the concept of characterizing to assist in improved risk identification and elicitation of expert opinion. Processes overviewed are: (1) defining project views to model the project context; (2) characterizing project view components in terms of attributes related to risk (i.e. risk drivers) and other project management functions; and, (3) developing a risk view (risk register and associated properties). The role of knowledge management is also briefly discussed.

7.5.1 Defining Project Views

The modelling of project context to assist with the risk identification and elicitation of expert opinion is a key tenet of the research. This is premised on the belief that in conducting risk workshops, participants must have a clear understanding of the project context as well as be provided with the necessary background documentation such that they are able to identify the pertinent project risks and associated properties in their area of expertise. These sessions typically involve project participants from a range of disciplines who identify and manage risks from their own experience and knowledge domain. Few, if any, have a complete understanding of the full project context or spectrum of project risks. An interactive multi-view representation of the project context can be used to guide or structure these sessions, help develop a common understanding amongst session participants, and serve as a mnemonic device to trigger the identification of potential risk events, interrelationships, and mitigation strategies.

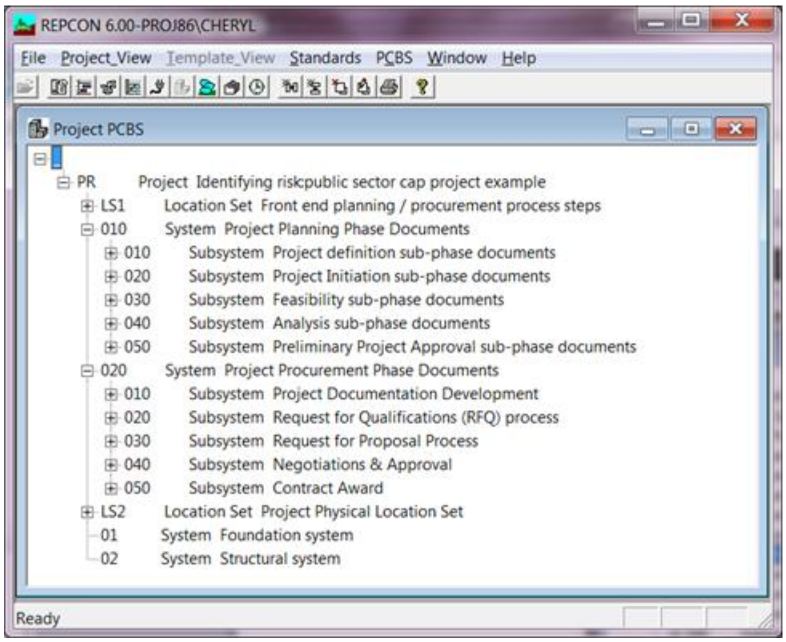
Relevant to the discussion herein are the four project views mentioned previously: physical (what is to be produced, where in physical or procedural space), process (activities required to produce the product), organizational / participant (the participants/groups involved), and environmental (the natural and man-made environments in which the product is produced) (Russell & Udaipurwala, 2004; Wang, 2005; De Zoysa, 2006). Use of these views is central to the development of a fifth view, namely the project risk view (De Zoysa 2006). Consistency of representation has been sought for all views in the form of hierarchical modelling, with the granularity of each view representation left to the user depending on the amount of information available and decision-making required. The ability to make associations amongst the views is supported, including the ability to link them with the risk view by way of risk driver – risk issue associations. The physical view treats both the modelling of a project in terms of physical locations as well as physical components, with a mapping between the two. The same set of locations provides the underpinning for the process and environmental views of the project. A knowledge management component allows for a cataloguing of lessons learned from past projects in terms of how best to represent each of the physical, process, participant/organizational, environmental and risk views.

Development of each of the project views is done incrementally as knowledge about the project scope and requirements at hand become available. In the early phases of a project, when key decisions are made and detailed project scoping information is not available each view is rather coarse grained. Nevertheless, what is known can be highly structured and in a readily accessible way. Assembling the four views in Step 2 of the risk management framework is a prerequisite to meaningful development of a comprehensive risk view of the project for the risk management process advocated.

7.5.1.1 Physical View

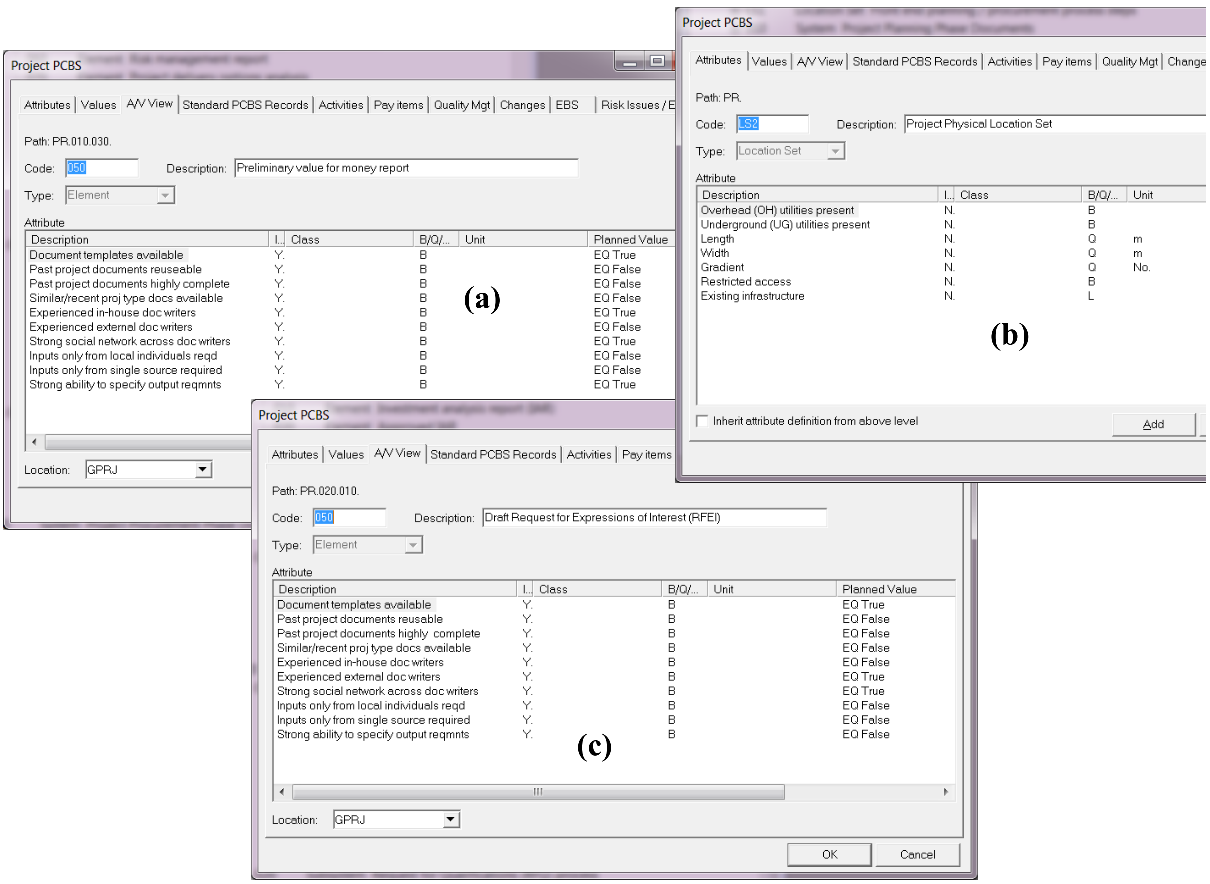
In this view, one first sets out the spatial context of the project termed the location sets and individual locations within a set. Secondly, one identifies components in terms of collections of components (systems, subsystems) then individual components (elements). Each component in a hierarchy can be described in terms of a number of data sets as well as associations with entities from other views. Key products should be identified including physical aspects of the project as well as process documents essential to the approval and delivery of the project. A somewhat simplified breakdown termed the physical component breakdown structure (PCBS) is provided in Figure 12 including a summary of what is produced (e.g. documents, products etc.) and where in the physical or procedural space. A detailed version is included in Figure 7.A.1. Physical components are mapped onto locations so that they may be placed in physical or procedural space. In addition, physical components can be associated with specific activities in the *Process view,* facilitating in part an integrated representation of the project.

Figure 12: Physical view - Overview of the Physical Component Breakdown Structure (PCBS) with an expansion of the component hierarchy shown in Appendix X)



Each component can be described in terms of one or more user defined component attributes and location specific values assigned to each attribute as shown in Figure 13 (a) through (c). Of particular importance here are attributes that may constitute a risk driver, given their value. Defining attributes at the parent level (e.g. location set, system) facilitates the definition of attributes at the component level (e.g. location element) through the use of inheritance (Figure 13 (c)). The user is also able to query the system to determine risk issues/events associated with a physical component. Attributes and their values are elaborated upon in Section 7.5.2 of this chapter. One of the contributions of this research is to determine what this attribute set should be, along with parsimonious vocabulary with which to describe values associated with the attributes

Figure 13: Characterizing physical components



7.5.1.2 Participant / Organizational View

In the Participant view, all organizations and individuals associated with the project are identified in a hierarchy of participant class, defined as a grouping of organizations which have similar roles and thus share similar attributes but different values, and individual participants within a class. As shown in Figure 14, stakeholders involved in the planning and procurement phases of the project when key decisions are made including the development of procurement documentation are illustrated. For each participant class (e.g. Project Senior Executives, Third

Party Stakeholders, etc.) attributes relevant to project delivery and specifically risk management are identified. These attributes can be inherited down to the individual participant level (e.g. Real Property Investment Board, Regional Organizations etc.), and then attribute values assigned. Figure 15 Participant View Attributes illustrates a list of attributes for participant class 'Project Senior Executive', deemed to be potential risk drivers, depending on the value assigned.

Figure 14: Participant view – Depicting participant classes and members of each class

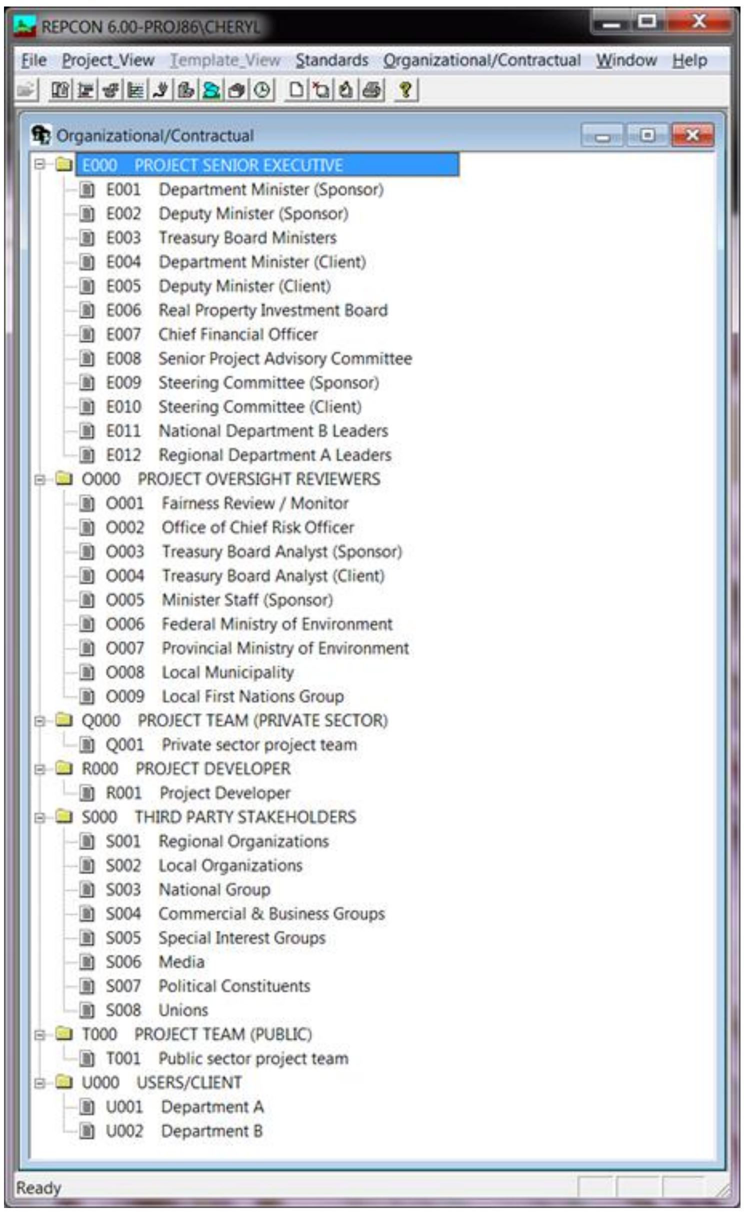
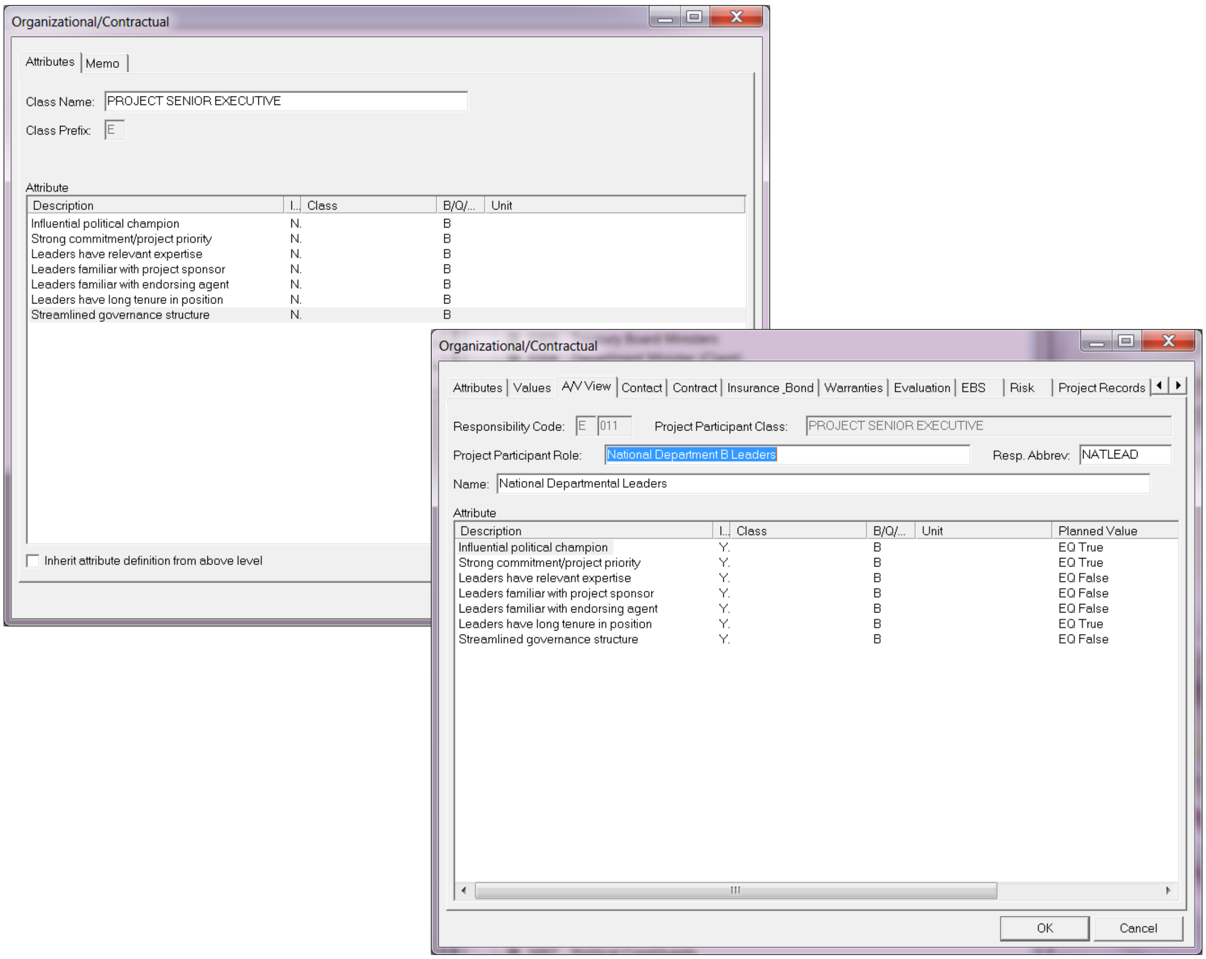


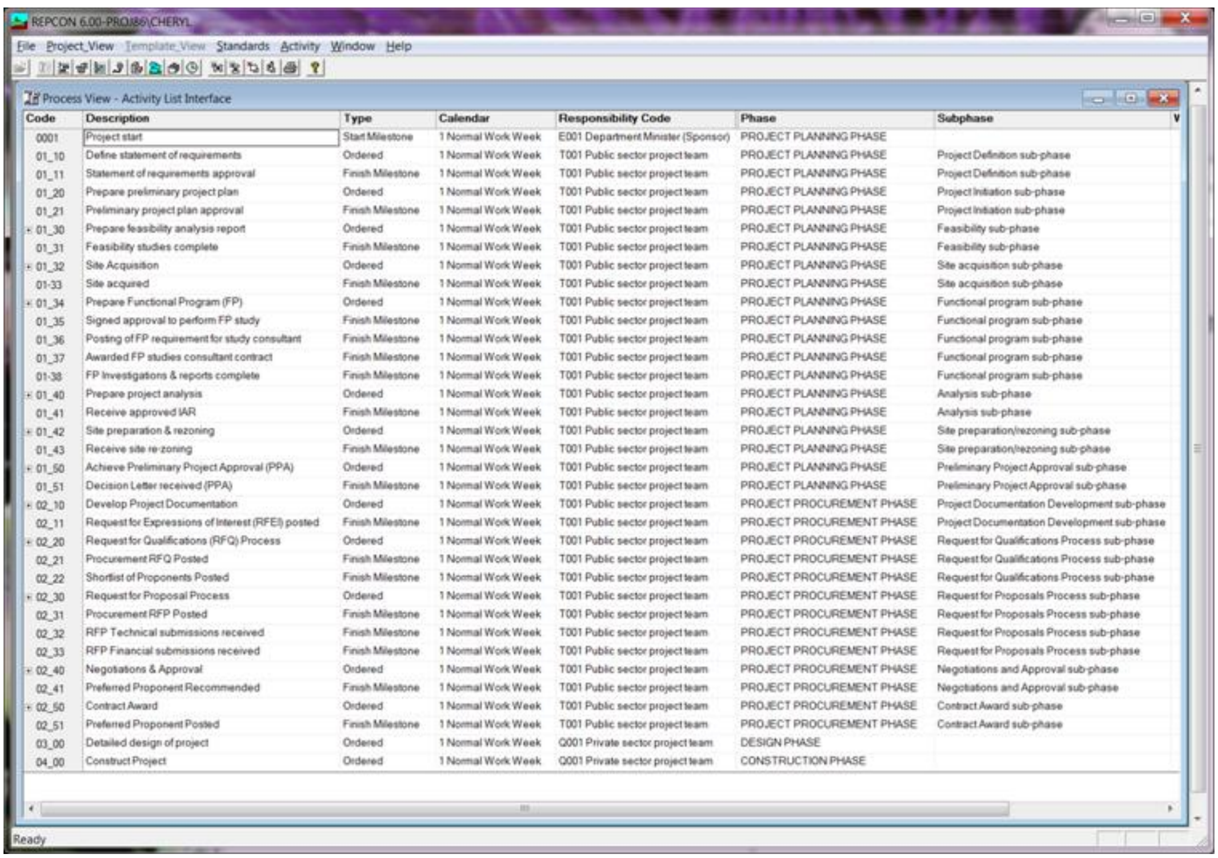
Figure 15: Defining attributes at the participant class level, and defining attributes and values and the individual participant level. Use of inheritance allows for the speedy definition of attributes at the individual participant level.



7.5.1.3 Process View

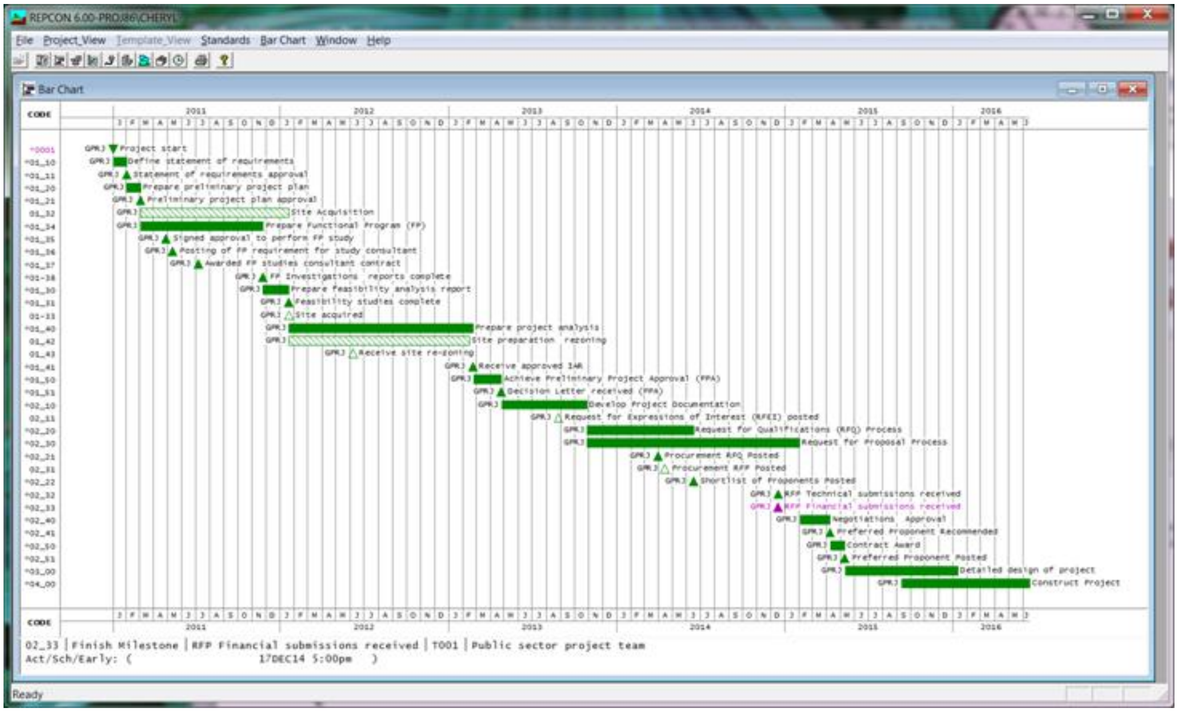
In the Process view, all activities, primary responsibility assignment and applicable project phase (or project sub-phase) associated with the project are identified, as shown in Figure 16 at the parent level (a hierarchical representation of activities is also supported). Depicted in Figure 17 is a process representation in the form of a gant or bar chart, again at the summary level. As discussed later, in terms of conducting a risk analysis, it is recommended that one work at a more summary level than a detailed level so as to not lose sight of the overall project. In Stage 3 of the framework, it is recommended that the facilitator of the risk workshop or interviewer use a coarse Process view illustrating project activities to step experts through the risk identification and elicitation of expert opinion in a systematic way. For each activity risk issues and corresponding risk events are identified. Alternative approaches such as direct use of the risk breakdown structure may be utilized to facilitate a structured identification and elicitation process; however, the use of process steps are advocated to ensure the project context is considered for a specific risk issue in a point in time.

Figure 16: Process view – Depicting an activity list at the parent level including activity type, responsibility code (see project participant list), project phase and sub-phase



Code	Description	Type	Calendar	Responsibility Code	Phase	Subphase
0001	Project start	Start Milestone	1 Normal Work Week	E001 Department Minister (Sponsor)	PROJECT PLANNING PHASE	
01_10	Define statement of requirements	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Project Definition sub-phase
01_11	Statement of requirements approval	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Project Definition sub-phase
01_20	Prepare preliminary project plan	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Project Initiation sub-phase
01_21	Preliminary project plan approval	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Project Initiation sub-phase
+ 01_30	Prepare feasibility analysis report	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Feasibility sub-phase
01_31	Feasibility studies complete	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Feasibility sub-phase
+ 01_32	Site Acquisition	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Site acquisition sub-phase
01-33	Site acquired	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Site acquisition sub-phase
+ 01_34	Prepare Functional Program (FP)	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Functional program sub-phase
01_35	Signed approval to perform FP study	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Functional program sub-phase
01_36	Posting of FP requirement for study consultant	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Functional program sub-phase
01_37	Awarded FP studies consultant contract	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Functional program sub-phase
01-38	FP Investigations & reports complete	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Functional program sub-phase
+ 01_40	Prepare project analysis	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Analysis sub-phase
01_41	Receive approved IAR	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Analysis sub-phase
+ 01_42	Site preparation & rezoning	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Site preparation/rezoning sub-phase
01_43	Receive site re-zoning	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Site preparation/rezoning sub-phase
+ 01_50	Achieve Preliminary Project Approval (PPA)	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Preliminary Project Approval sub-phase
01_51	Decision Letter received (PPA)	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PLANNING PHASE	Preliminary Project Approval sub-phase
+ 02_10	Develop Project Documentation	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Project Documentation Development sub-phase
02_11	Request for Expressions of Interest (RFEI) posted	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Project Documentation Development sub-phase
+ 02_20	Request for Qualifications (RFQ) Process	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Qualifications Process sub-phase
02_21	Procurement RFQ Posted	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Qualifications Process sub-phase
02_22	Shortlist of Proponents Posted	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Qualifications Process sub-phase
+ 02_30	Request for Proposal Process	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Proposals Process sub-phase
02_31	Procurement RFP Posted	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Proposals Process sub-phase
02_32	RFP Technical submissions received	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Proposals Process sub-phase
02_33	RFP Financial submissions received	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Request for Proposals Process sub-phase
+ 02_40	Negotiations & Approval	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Negotiations and Approval sub-phase
02_41	Preferred Proponent Recommended	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Negotiations and Approval sub-phase
+ 02_50	Contract Award	Ordered	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Contract Award sub-phase
02_51	Preferred Proponent Posted	Finish Milestone	1 Normal Work Week	T001 Public sector project team	PROJECT PROCUREMENT PHASE	Contract Award sub-phase
03_00	Detailed design of project	Ordered	1 Normal Work Week	Q001 Private sector project team	DESIGN PHASE	
04_00	Construct Project	Ordered	1 Normal Work Week	Q001 Private sector project team	CONSTRUCTION PHASE	

Figure 17: Process view – Depicted in the form of a Gant or bar chart at parent or summary Level. Appendix X illustrates all parent and child activities.



7.5.1.4 Environmental View

In the Environmental view, the project natural and man-made environments are identified in a hierarchy of datasets including class, sub-class and entities. In this view, features such as the physical, economic, political and regulatory environment of the project may be modelled as illustrated in Figure 18. Environmental component attributes can also be defined as illustrated in Figure 19.

Figure 18: Environmental view – Depicting the project natural and man-made environment

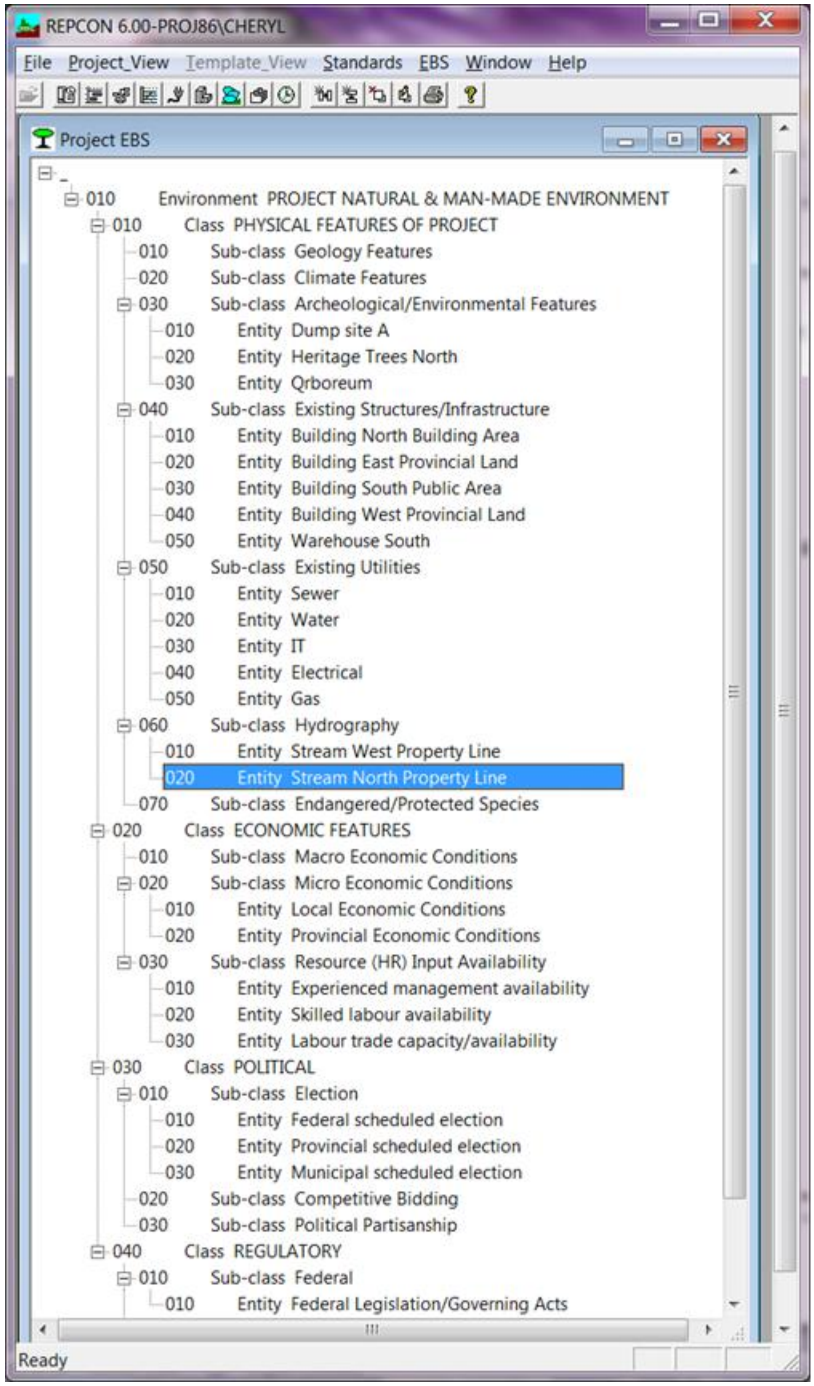
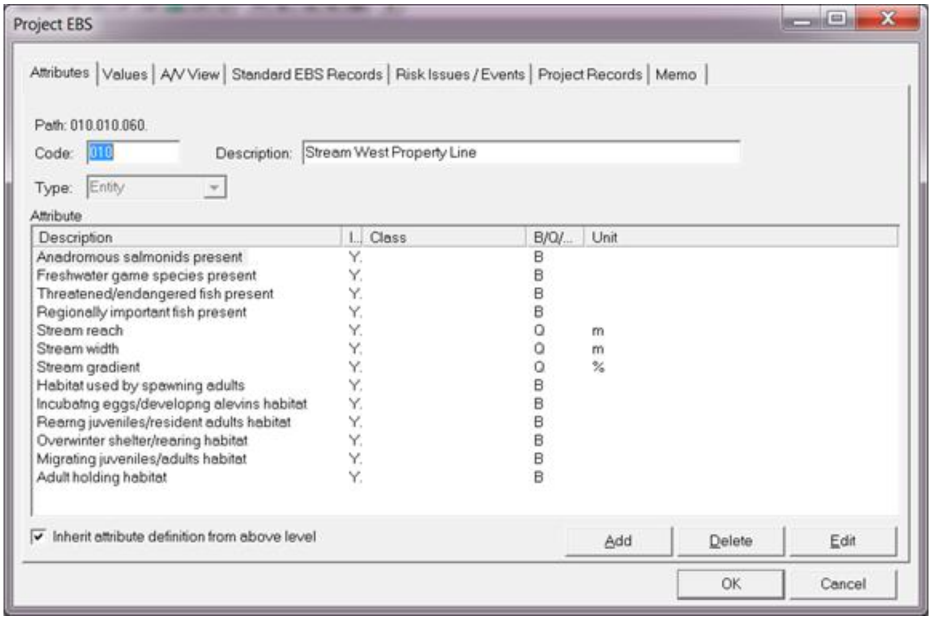


Figure 19: Environmental component 'Stream West Property Line' attributes and associated values metrics identified (Binary (B), Quantitative (Q) and unit of metric)

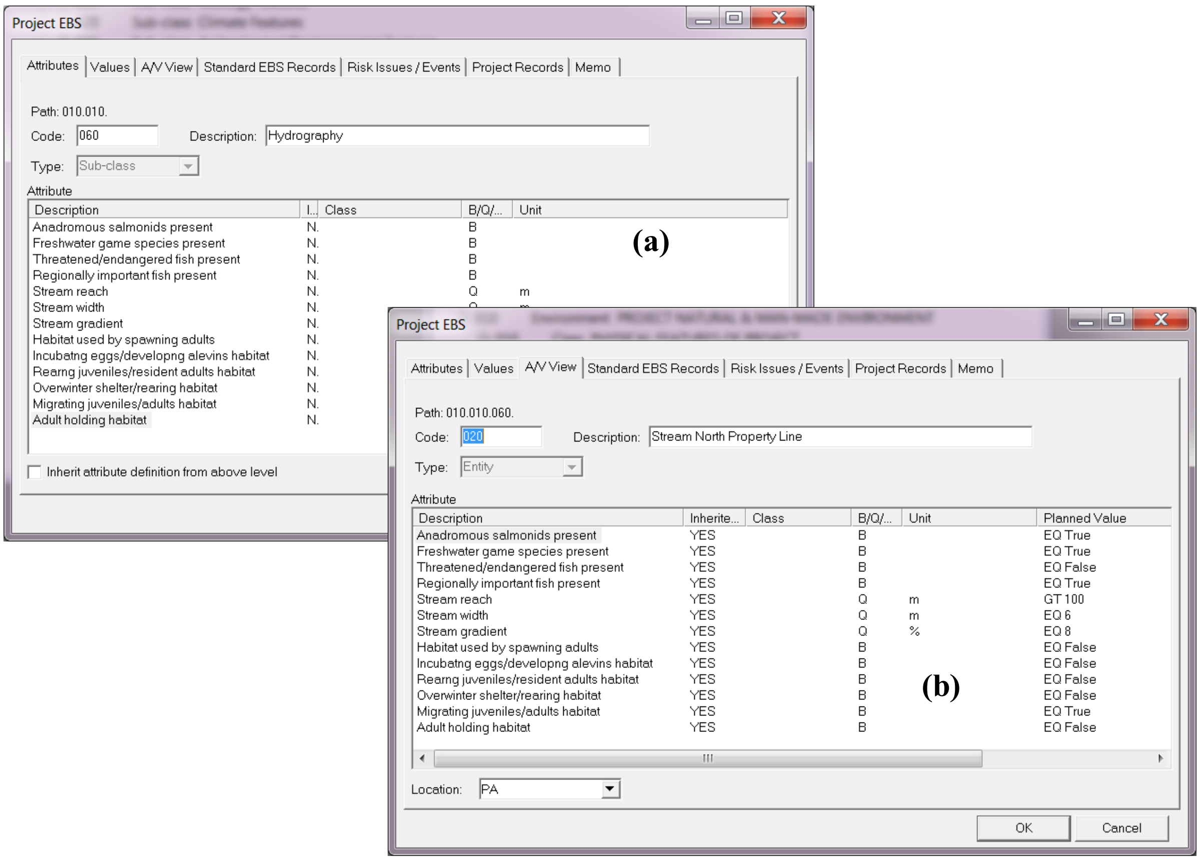


7.5.2 Characterizing Risk Drivers

Thoughtful definition of the components and associated attributes used to represent the various views of a project can provide valuable insights to Project Managers and improve the overall risk management process. Characterizing the different views in terms of user specified attributes and anticipated values are found, in the validation exercises conducted with senior project executive (detailed in Chapter 8), to be particularly useful for the identification of risk events and elicitation of quality risk information. Although there is no construction literature per se on characterizing as it relates to risk, there is a body of literature on factors that represent construction industry processes, participants or activities. Clark & O'Connor (2012) also identified the lack of literature on this topic in the field of information technology including that at present there is no comprehensive reference framework of the situational factors affecting the software development process. There are a number of relevant issues to consider when characterizing each project view including: (a) **identification** and **expression** of attributes **relevant** to risk identification / elicitation as well as other project management functions and assigning **values** to these attributes; (b) how **knowledge management** can ease the task of characterizing a project's context while capturing in reusable form the experience of an organization and findings by others; and, (c) **practical considerations** in terms of number and definition of attributes. First, a brief introduction to the concept of characterizing as it relates to defining project view component attributes is provided.

Component attributes can be described by way of a 2 by 2 matrix dealing with user vs. system defined attributes (e.g. user-defined attribute sets for different classes of project participants vs. schedule dates computed for activities), and user specified vs. system derived attribute values. An example of characterizing an environmental component is shown in Figure 20 (a) and (b) for the Hydrography component at the sub-class level and for the Stream entity within the class-subclass-entity hierarchy of the environmental view. Of particular interest for the case study project are attributes related to the type of fish and fish habitat. These attributes may have a positive, negative or no project impact such that some are risk drivers and others are not depending on participants involved (participant view), the design features (the physical view), regulatory constraints (part of the environmental view), and construction methods used and timing (system derived attribute values) of related activities (the process view). The ability to model and characterize project components and their attributes in the four views enables the user to link risk entities to the associated component and determine the temporal and spatial distribution of risks. How best to describe and structure the components of the various views and characterize them in terms of attributes and values has resulted in interesting research findings and presents interesting future opportunities.

Figure 20: Attributes at the sub-class and entity levels in the environmental view



In essence, the concept of characterizing in this research addresses two questions: What do I really need to know about the project in order to perform the task at hand? And, what attributes should be used to characterize project components such that one can better determine which attributes are risk drivers as a function of their value, what outcomes might they affect, and what responses might be appropriate? In pursuing answers to these questions, one should seek the minimal set of attributes, recognizing that data collection is costly and time consuming. Keeney

& Gregory (2005) recognize the importance of unambiguous and comprehensive attributes to measure objectives and highlight 'good' attributes as *unambiguous, comprehensive, direct, operational, and understandable*. To judge the relevance and usefulness of an attribute and its accompanying value identified in this research, it is helpful to apply a few key tests with consideration of the 'good' attribute properties identified by Keeney & Gregory (2005). Six tests have been formulated:

1. Support exists for the attribute from the literature and / or use in practice.
2. There should be no ambiguity as to what the attribute means – i.e. there needs to be a shared understanding by project participants / experts. This may require reviewing definitions with those involved in the risk management process and incorporating definitions into supporting software tools.
3. The attribute should be expressible in terse form.
4. There needs to be a plausible case for a link with risk (i.e. known cause and effect as a function of the value of an attribute or a combination of values across attributes).
5. Preferably the attribute will serve more than one function (e.g. risk management, diagnosis of as-built performance, etc.)
6. The value of an attribute must be expressible in a meaningful way, either objectively or subjectively in the form of binary, continuous or linguistic values. For values that must be gauged subjectively, a strong case is made to limit estimates to the upper or lower limits of a possible range of estimates or binary estimates in order to avoid difficult to interpret grey zones.

7.5.3 Characterizing Project Participants

Because project participants can be a significant source of risk for a project (Bourne & Walker, 2006; Doloi, 2011), the focus of the thesis is mainly on characterizing seven project participant classes or categories which form an integral part of any public large infrastructure project (selection of stakeholder categories is outlined in chapter 5). These categories are the Client/User, Project Team (Public), Project Team (Private), Project Developer, Project Senior Executive, Project Oversight Reviewers, and Third Party Project Stakeholders. The focus is at the category level, because from a system design perspective, the concept of inheritance can be used to define speedily the attribute set for members of a category. This is one example of the use of knowledge management. A caveat to specifying project participant attributes is consideration of the finite time, resources and limited information/data available to define them and assign values which are the practical realities faced by industry practitioners as highlighted in chapter 3. Therefore, one needs to consider carefully the incremental value received by adding another attribute for a particular category or individual member of a category in terms of better risk identification and elicitation or other project management processes. This caveat also applies to specifying attributes for the components that form other project views, which was not the focus of this thesis.

After the stakeholder categories applicable for a public large infrastructure project were finalized the construction management literature was reviewed to identify relevant stakeholder attributes. The literature review was further expanded outside of the construction management literature, which had limited consideration of select stakeholder categories (notably Oversight Reviewers, Client/ User and Project Senior Executives). Other relevant sources included project management literature in the fields of information systems (IS) and information technology (IT). IS/IT projects share similar characteristics to large infrastructure project in that they tend to be complex, involve a diverse set of stakeholders and require integrated risk management to achieve desired project outcomes. Research in the IS/IT field has included defining risk factors and the consideration of stakeholder expectations on project performance, which was relevant to the focus of the thesis.

The initial set of attributes to characterize each of the participant categories (stakeholders), identified in Figure 14, was developed based on a review of factors identified in industry project documents (e.g. Request for Qualifications (RFQ), Request for Proposals (RFP), Project Briefs, etc.), a review of project management literature in the construction, IS and IT fields and then validated by senior executives with significant expertise working with or as a member of each stakeholder category. Several distinct areas within the project management domain were explored in order to identify the attributes with which to characterize the project participant risk profile. These areas included general project management guidance and documentation, risk factors influencing project cost estimation and successful project implementation, project success factors, and factors affecting software development and information technology projects. Having identified a broad set of attributes, the information was distilled into a core set of attributes for each stakeholder category. Of course, not all of the factors identified in the literature relate to risk, nor is there a common lexicon for expressing factors, which poses some challenges for developing a common understanding of what terms mean. Attributes were first consolidated on a conceptual basis under each stakeholder category, definitions and potential omissions were reviewed based on my experience in planning and delivering large infrastructure projects and the application of the six attribute tests. After a number of iterations, the information was gradually revised into a consistent set of participant attributes. Each set of attributes was then presented to senior executive experts for feedback on the applicability of each of the attributes, their understanding of attribute definition, and comments on the best way to describe values of the attributes. Values were assigned according to a two point scale (e.g. true/false, yes/no, or positive and negative linguistic descriptors such as experienced/not experienced). The use of a two point scale is a practical approach applied in industry as per the PPP Construction Risk Index (S&P, 2007) which is widely adopted and developed specifically for large infrastructure projects where users score risks under the following categories: Project Preparations, Project Characteristics, Concession Agreement, Private Sector, Public Sector, and Political/Regulatory risk. Baloi & Price (2003) suggest the use of a fuzzy decision framework to address the ambiguity of linguistic terms commonly used on a two point risk management scale. Jin & Doloi (2008) use 2 point linguistics on a multi-point scale, quantitative and date measurements for classifying the risk environment and Barki et al. (2001) use a variety of measurement approaches including questions, 2 point linguistic scales and a 7-point Likert scale. Interestingly, each senior executive interviewed preferred a simple and speedy value assignment approach such as the 2-point scale equally through the use of a Boolean expression (true or false) or through the use of linguistic terms (e.g. low, high or minimal, strong) due to time constraints commonly experienced in risk workshops and the scale of the task at hand (i.e. a major infrastructure project may involve several hundred risks of significance). Industry's preference for simple risk management approaches concurs with the findings of Bannerman (2008) in the IS/IT field where organizations were found to lag in full application of risk management research. The experts' review of attributes resulted in minor changes to the attribute sets and raised the quality and relevance to improve risk identification and elicitation of expert opinion tasks in large infrastructure projects. Following the feedback from the senior executives and complemented by my practical experience working in the industry, attributes were revised as presented herein and summarized in Table 20.

Table 20: Summary of stakeholder category attributes identified

Project Team (Public)	Project Team (Private)	Third Party Stakeholders
▪ Influential political champion ▪ Strong commitment / project priority ▪ Experienced expertise in-house ▪ Strong project management leadership ▪ Established practices / procedures ▪ Reasonable performance expectations ▪ Project team has sufficient capacity ▪ Streamlined governance structure	▪ Strong local knowledge and experience ▪ Team has complementary experience ▪ Strong commitment / project priority ▪ Strong experience with client ▪ Strong technical capabilities ▪ Strong response to problem solving ▪ Strong collaborative communication style ▪ Strong project management skills	▪ Support project initiative ▪ Alliance/partnership building potential exists ▪ Able to mobilize strategic alliances ▪ Access to political/social support ▪ Access to technical / financial support ▪ Communications & media influence ▪ Stakeholder is perceived as credible ▪ Able to mobilize strategic alliances
Project Developer	**Project Senior Executive**	**Project Oversight Reviewers**
▪ Strong local knowledge and experience ▪ Strong similar asset delivery experience ▪ Strong experience with client ▪ Strong strategic commitment to region ▪ Strong collaborative communication style ▪ Internationally recognized management systems ▪ Strong project management skills ▪ Strong labor relations	▪ Influential political champion ▪ Strong commitment / project priority ▪ Leaders have relevant experience ▪ Leaders familiar with project sponsor ▪ Leaders familiar with endorsing agent ▪ Leaders have long tenure in position ▪ Streamlined governance structure	▪ Strong commitment / project priority ▪ Previous relevant experience ▪ Familiar with project sponsor department ▪ Established practices and procedures ▪ Familiar with project team personnel ▪ Sufficient in-house capacity ▪ Highly credible by market players

practices		
Users / Client		
▪ Strong support for project need ▪ Influential political champion ▪ Strong commitment / project priority ▪ Experienced expertise in-house ▪ Experienced capacity in-house ▪ Reasonable performance expectations ▪ Strong commitment of project funding ▪ Streamlined governance structure		

Discussion with one expert raised an interesting opportunity, which the prototype could accommodate in future research, which is to compare the value of attributes of individuals within a stakeholder category as well as across categories to assist in identifying risk drivers shared across participants and interdependencies of risk drivers (Figures 21 and 22). The use of Boolean expressions to treat attributes and associated values was therefore the preferred approach in the research prototype to facilitate consistent comparison across attribute values at both the category and individual level and speedy responses while maintaining user flexibility in modelling the risk profile of the project.

Figure 21: Comparison of participant value sets within stakeholder category

Attribute	Participant X	Participant Y	Participant Z
A_1	✓	✓	✓
B_1	✗	✓	✗
C_1	✓	✓	✓
D_1	✓	✗	✓
E_1	✓	✓	✗
F_1	✗	✓	✓
G_1	✗	✓	✓

✓	**TRUE**
✗	**FALSE**

Figure 22: Comparison of participant member values across categories

Attribute	Participant X
A_2	✓
B_2	✓
C_2	✗
D_2	✓
E_2	✓
F_2	✗
G_2	✓

7.5.3.1 Identifying and Expressing Participant Category Attributes

A number of authors have addressed the topic of identifying factors and/or criteria for the selection of construction industry practitioners such as the architect, project manager or contractor (e.g. Crawford, 2005; Rahman & Kumaraswamy, 2005; Ling, 2003; Hatush & Skitmore, 1997; Singh & Tiong, 2006; Crawford, 2000; and Ng et al., 2005). Rahman & Kumaraswamy (2005) compare the top five factors surveyed for selecting the contractor, consultants, subcontractors, suppliers and clients and illustrate how attributes of importance both differ and are similar. For example, contractor and supplier participants both shared the factors 'timely project completion/delivery' and 'quality of work/materials' in the top five factors of importance but differed with respect to three other factors. With respect to current practices by those in the construction industry as well as those that serve it, the equivalent of characterizing is done on an on-going basis. For example, the client in issuing a Request for Qualifications (RFQ) sets out attributes for which values are requested in order to assist the client in short-listing suitable consultants, contractors, suppliers or facility managers / operators for the project. And, surety companies conduct rigorous examinations of developers for surety products (e.g. performance bonds, prequalification letters, bid bonds etc.) and focus on attributes dealing with character, capacity, capital and continuity.

Several authors have also identified a series of risk or uncertainty 'factors' that have been drawn upon in relation to the identification of participant attributes. Ng & Loosemore (2007) highlight the source of risks needs to be assessed on a project by project basis with due consideration of resources and capabilities of the parties to a contract as this may vary considerably. In the IS/IT field, risk factors that contribute to the unsuccessful completion or performance associated participant attribute factors to the user, the project team, developers and senior executive (Schmidt, 2001; Jun et al., 2011; Clarke & O'Connor, 2012). In addition, situational factors affecting the software development process include characteristics of the IT product under development, team size, requirements volatility and personnel experience (Clarke & O'Connor, 2012). In the construction management field, Han et al. (2008) provides insight into the identification of participant attributes of importance in relation to risk for successful bidding in overseas projects. Baloi & Price (2003) identify general estimator, design, level of competition, fraudulent practices, construction, economic and political related risk factors that influence construction costs from project estimating through to completion. Key cost, time, quality, environment and safety risks identified by Zou et al. (2007) are linked to project participant attributes including procedures, abilities and competencies and Thomas et al. (2006) provide insight into the various subjective factors, largely driven by project stakeholders, influencing risk events and their inter-relationships in PPP projects.

Characterizing project stakeholders using techniques such as stakeholder mapping has been discussed in the construction literature as a means for project managers to identify stakeholders, their level of influence on the project and for improving risk and communication management. Newcombe (2003) discusses the importance of identifying project stakeholders and using stakeholder analysis or mapping techniques to analyze their power, predictability and interest to gain a better understanding of their expectations and impact on the project. Olander & Landin (2008) illustrate the use of stakeholder mapping on two case study projects and showed how the relevant stakeholders and the power and interest of these stakeholders changed over the course of the project and how this information may be relevant to the risk management process. Doloi (2011) stresses key stakeholders involved in project cost estimating (e.g. Business Development Team, Land developers, consultants, financiers, bidding team and project manager) influence the quality of project costing in different stages of project delivery. He proposes a soft system methodology to identify political, economic, financial, technical and attitudinal concerns factors given attributes such as lack of experience, market knowledge and competent project management practices lead to cost overruns. Characterizing project stakeholders is also broadly addressed in the construction literature in the identification of project success factors. Most success factors in the construction literature are broadly categorized as: project related, human-related, project procedures, external environment, project management system and structural and although factor sets vary, the importance of human-related factors is commonly agreed upon (Toor & Ogunlana, 2009). Factors identified by authors Chan et al. (2002) and Zhang (2005) were drawn upon for attribute sets developed for the Developer category while Chua et al. (1999), Koutsikouri et al. (2008), Toor & Ogunlan (2009), and Tabish & Jha (2011) provided further insight on attribute sets developed for the stakeholder categories Project Team (Public), Project Team (Private) and Project Senior Executive.

Of interest is the degree to which the key public sector stakeholder categories, identified in chapter 5, are highlighted and attributes described and/or associated with risk factors in the literature. Based on my review of construction and IS/IT project management literature, there are considerably more information sources for some stakeholder categories (Developers, Project Team (Public), Project Team (Private)) while others have limited to no reference (Third Party Stakeholders, Project Oversight Reviewers). The Developer and Project Team stakeholders have lead roles and responsibilities in the design and construction phase, yet in the planning and procurement phases, interests of other stakeholder categories arise as ‘key’. This illustrates an important gap in the research literature with respect to human related factors and risks associated with the planning and delivery of public sector large infrastructure projects for the key stakeholder categories identified in my research.

Each of the attributes identified were assessed with respect to the tests identified in Section 7.5.2. Industry support of the attributes identified was confirmed through discussions with industry practitioners in addition to asking whether or not the attribute could be expressed in terse form with no ambiguity as to the attribute’s meaning. A feature available within the research prototype includes an ability to define the attribute in a 'memo' section to ensure there is a shared understanding by project participants in the attribute definition. Information sources used to identify pertinent stakeholder category attributes are summarized under the appropriate headings as follows:

Developer

Developer attributes were identified based on literature from the IS/IT and construction management fields in addition to criteria in industry RFQ and RFP documents of PPP projects procured in Canada for both federal and provincial large infrastructure projects published on the websites of Partnerships British Columbia (www.partnershipsbc.ca) and Infrastructure Ontario (www.infrastructureontario.ca). The 'Developer' stakeholder category in this thesis is defined as the principal private sector stakeholder contracted for the co-ordination, planning and delivery of the project. It is important to note similar definitions used within industry and academic literature such as 'contractor' or 'consortium' were drawn upon where they were interpreted as having the same definition as 'Developer' used in the thesis. Public sector PPP Canadian large infrastructure RFQ and RFP criteria primarily focused on the Developer identifying its expertise, experience, capacity, familiarity with labour conditions and collaborative working approach to deliver the project (PBC, 2012; IO, 2012). DBRS, a credit rating agency, developed a methodology for rating Canadian Public Private Partnerships and identified the Developer's size, reputation and track record for completing similar projects on time and on budget and ability to perform some or all of the construction tasks as key attributes to evaluate in the project credit rating process (DBRS, 2011).

The attributes identified in the construction management literature drawn upon included attributes affecting bid decisions on overseas projects by Han el al. (2008) including personnel ability and expertise, current workload and familiarity and experience with the work. Zhang (2004) summarized tender evaluation criteria packages for PPP projects in general identifying attributes such as location of home office/main place of business, working relationships amongst participants, coordination system within the consortium, dispute resolution systems, project management skills, and risk management and procedure systems. Ng & Loosemoore (2007) identify risks associated with risk source and allocation including fault in tender specifications, delays in approval, and political interference that indirectly relate to public project stakeholders. Singh & Tiong (2006) identified selection criteria to assess the candidates during the selection process including a detailed list of sub criteria under the attributes detailing the company, past performance, financial capability, performance potential and project specific. Similarly, Sari & El-Sayegh (2007) identify construction management at risk selection factors associated with general factors associated with the organization (e.g. technical ability, previous relationships), construction management factors (e.g. project phase experience, similar and past experience) and general contracting factors (e.g. methods, resources and experience). Rahman & Kumaraswamy (2005), Ahadzi & Bowles (2004) and Hatush & Skitmore (1997) also identify similar attributes of importance when selecting the Developer. Shen et al. (2006) and Jin & Doloi (2008) identify developer attributes associated with project risks including experience, capability and effectiveness of communication.

The selection of attributes for Developer is based on findings in the construction and IS/IT literature, personal experience and feedback from senior executives involved in large infrastructure project planning and delivery. Findings from the literature search in support of specific attributes are summarized in Table 21. The attributes 'Strong local knowledge and experience' and 'Similar asset delivery experience' were identified most often in the academic and industry literature. Two attributes with limited academic reference included 'Internationally recognized management systems' and 'Strong labor relations practices'. These attributes were identified by a senior private sector PPP developer as important attributes and, based on personal experience, they were considered in the selection of the Developer in the planning and procurement phases of a large infrastructure project. The importance placed on these two attributes is associated with the nature of PPP procurement arrangements that are typically large in scope therefore requiring internationally recognized management systems and include a 'partnership' with public sector entities with some arrangements requiring the private partner to 'inherit' public sector union employees therefore requiring strong labor relations practices. The attribute 'Strong strategic commitment to region' was noted by the private sector PPP developer interviewed as an important attribute because an organization's strategic objective for a long term presence and commitment to the region of the project influences the perceptions of the organizations commitment to local public and private partners and the interest of local partners in expending monies and time to establish partnership relationships with the organization.

Table 21: Developer stakeholder category source of attributes

Developer	
▪ Strong local knowledge and experience	Zhang (2004), Rahman and Kumarswamy (2005), Shen et al. (2006), Singh and Tiong (2006), Sari and El-Sayegh (2007), Han et al. (2008), Jin and Doloi (2008), DBRS (2011), IO (2010), PBC (2010), Fidan et al. (2011)
▪ Strong experience with client	Zhang (2004), Shen et al. (2006), Singh and Tiong (2006), Sari and El-Sayegh (2007), IO (2010), PBC (2010), Fidan et

	al. (2011)
▪ Strong collaborative communication style	Zhang (2004), Rahman and Kumarswamy (2005), Shen et al. (2006), Singh and Tiong (2006), Jin and Doloi (2008)
▪ Strong project management skills	Zhang (2004), Rahman and Kumarswamy (2005), Singh and Tiong (2006), Sari and El-Sayegh (2007), IO (2010), PBC (2010), Fidan et al. (2011)
▪ Strong similar asset delivery experience	Rahman and Kumarswamy (2005), Singh and Tiong (2006), Sari and El-Sayegh (2007), Han et al. (2008), Jin and Doloi (2008), IO (2010), PBC (2010), DBRS (2011), Fidan et al. (2011)
▪ Strong strategic commitment to region	
▪ Internationally recognized management systems	Chan et al. (2004), Zhang (2004)
▪ Strong labor relations practices	Zhang (2004), Tabish and Jha (2011)

Client/User

'Clients/Users' are the stakeholders who will use or benefit from the product planned and delivered. Jun et al. 2011 note that user participation in project planning and delivery can improve the successful implementation of a project and user related risks cannot be controlled by a project manager but can be influenced. In terms of characterizing clients for PPP projects, in a recent Standard & Poor's report (S&P, 2007), they identified a number of client failings, which map onto attributes of interest for risk management. Attributes cited as important problem sources were capability, legacy, preparation, expectations, process, oversight, and change. Ahadzi & Bowles (2004) provide a comprehensive list of attributes relating to the public and private parties involved in the PPP negotiation process including attributes relevant to characterizing the client (expertise, capacity, level of commitment, and ability to absorb costs and risks) while Fidan et al. (2011) highlight vulnerability related factors associated with client conditions including the client's: lack of clarity of objectives, level of bureaucracy, negative attitude, poor staff profile, lack of financial resources, and technical and managerial incompetency. Considerable focus on the client/user stakeholder category appears in the IS/IT literature. Schmidt et al. (2001) identified risk factors associated to user buy-in to project, commitment, approval, experience and skilled personnel while Barki et al. (2001) and Jun et al. (2011) identify risk factors associated with user participation, experience, and support. McLeod & MacDonell (2011) conducted a comprehensive review of users and software systems and summarized how users affect the outcome of a project through their expectations, their attitude and involvement, and specific characteristics in how they use the product. Liu et al. (2010) identify a category of project risk factors associated with the project 'User' including: lack of cooperation and responsibility from users, users unrealistic expectations, excessive use of outside consultants, resistant to change, negative attitudes to the project, lack of adequate participation, conflicts between the user and developer group and/or within user departments, and underfunding.

The selection of attributes for Client/User is based on findings in the construction and IS/IT literature, personal experience and feedback from senior executives involved in large infrastructure project planning and delivery. The attributes 'Strong commitment / project priority' and 'Experienced expertise in-house' were most noted in both the IS/IT and construction literature. Of interest is that the attribute 'Strong commitment/project priority' was identified most often in literature with respect to the Senior Executive stakeholder category which may be associated with consideration of Senior Executives as a 'Client/User'. The attribute 'Influential political champion' was not identified in the literature reviewed; however, the importance of this attribute on project planning and delivery was identified by a senior executive interviewed in addition to my personal experience as critical in maintaining the prioritization of the project within the public bureaucracy where many projects are vying for competing available public funds. Although identified by only two sources, the attribute ‘Streamlined governance structure’ is considered an important attribute to ensure project objectives are met and highlighted in the industry S&P Report (2007) which drew upon interviews with PPP practitioners in the identification of critical attributes associated with project risks. Summarized in Table 22 is the literature in support of the Client/User attributes identified as most important.

Table 22: Client/User stakeholder category source of attributes

Users/Client	
▪ Strong support for project need	Liu et al. (2010), Schmidt et al. (2001), Barki et al. (2001), McLeod and MacDonell (2011) Jun et al. (2011)
▪ Strong commitment / project priority	Chua et al. (1999), Liu et al. (2010), Schmidt et al. (2001), Barki et al. (2001), Ahadzi and Bowles (2004), McLeod and MacDonell (2011), Jun et al. (2011)
▪ Experienced capacity in-house	Chua et al. (1999), Ahadzi and Bowles (2004), Liu et al. (2010), Fidan et al. (2011)
▪ Strong commitment of project funding	Ahadzi and Bowles (2004), Shen et al. (2006), Liu et al. (2010), Fidan et al. (2011)
▪ Influential political champion	
▪ Experienced expertise in-house	Chua et al. (1999), Schmidt et al. (2001), Barki et al. (2001), Ahadzi and Bowles (2004), Chan et al. (2004), S&P Report (2007), Fidan et al. (2011), McLeod and MacDonell (2011), Jun et al. (2011)
▪ Reasonable performance expectations	Chua et al. (1999), Chan et al. (2004), S&P Report (2007), McLeod and MacDonell (2011)
▪ Streamlined governance structure	Fidan et al. (2011), S&P Report (2007)

Project Team (Public)

The stakeholder category ‘Project Team (Public)’ includes those team members that are members of or related to the project sponsor organization responsible for the planning and delivery of the project. Jin & Doloi (2008) map attributes including the public partners experience in similar projects and attitude to project organizational risk categories. Shen et al. (2006) identify Project team (public) PPP risks related to attributes representing administrative interference, lack of project controls, changes in Government regulations and laws and delays in obtaining permissions. Ahadzi & Bowles (2004) identify attributes appropriate for negotiation of

PPP contracts including expertise, experience and ability to draw upon external resources. Project Team (Public) attributes associated with problems identified in design-build arrangements identified by Ling & Poh (2008) include lack of knowledge, experience, manpower and resources, procedures and poor communication. Liu et al. (2010) identify a risk factors associated with the project team including: lack of commitment, conflicts between team members, frequent turnover, not familiar with task, lack of skills and inadequate training. Vulnerability related factors identified by Fidan et al. (2011) include those related to managerial abilities, resource availability, and similar/related experience.

The selection of attributes for Project Team (Public) was developed based on findings in the construction and IS/IT literature, personal experience and feedback from senior executives involved in large infrastructure project planning and delivery. The attribute 'Experienced expertise in-house' was most noted in the literature reviewed in addition to the attributes 'Established practices/procedures' and a 'Streamlined governance structure'. Two attributes added based on personal experiences, which were not identified in the literature, include 'Reasonable performance expectations' and 'Influential political champion'. A senior public sector executive confirmed the relevance and highlighted that absence of these attributes are 'key sources of risk' with respect to this stakeholder category. The attribute 'Reasonable performance expectations' considers the cost, technical, schedule performance expectations and assumptions identified to which the team and the project proponent work towards. This attribute drives such activities as project planning assumptions and documentation development. The attribute 'Influential political champion' includes the influence of a participant within this stakeholder category and identified as critical to navigating the complex stakeholder network within which public sector projects are delivered and the political arena of public sector decision makers. Summarized in Table 23 is the literature in support of the Project Team (Public) attributes identified as most important.

Table 23: Project Team (Public) stakeholder category source of attributes

Project Team (Public)	Relevant Literature Source
▪ Influential political champion	
▪ Strong commitment / project priority	Jin and Doloi (2008), Ahadzi and Bowles (2004), Liu et al. (2010), Toor and Ogunlan (2009), Chan et al. (2004), Chua et al. (1999)
▪ Experienced expertise in-house	Jin and Doloi (2008), Ahadzi and Bowles (2004), Ling and Poh (2008), Liu et al. (2010), Fidan et al. 2011, Toor and Ogunlan (2009), Tabish and Jha (2011), Koutsikouri et al. (2008), Chan et al. (2004)
▪ Strong project management leadership	Liu et al. (2010), Toor and Ogunlan (2009)
▪ Established practices / procedures	Shen et al. (2006), Ng and Loosemoore (2007), Ling and Poh (2008), Toor and Ogunlan (2009),
▪ Reasonable performance expectations	Koutsikouri et al. (2008), Chua et al. (1999)
▪ Project team has sufficient capacity	Ling and Poh (2008), Fidan et al. 2011, Toor and Ogunlan (2009), Tabish and Jha (2011), Koutsikouri et al. (2008)
▪ Streamlined governance structure	Shen et al. (2006), Ahadzi and Bowles (2004), Ling and Poh (2008), Tabish and Jha (2011)

Project Senior Executive

The ‘Project Senior Executive’ are defined as the stakeholders that provide executive leadership, attend key project meetings and are generally responsible for the approval of recommendations made by the Project Team (Public). Liu et al. (2010) identify project risk factors associated with senior executives as: lack of top management commitment, change in senior management and failure to achieve project approval from all parties as factors of importance and from the perspective of a panel of both project managers and senior executives ‘lack of top management commitment' ranked highest of all risk factors identified. Bannerman's (2008) study of risk factors associated with software projects found within the key practice area of project governance that senior executive commitment involvement and their effectiveness in the support of the project were required. Schmidt et al. (2001) identify risk factors that relate to senior executive attributes including lack of top management commitment, change in management, new managers and turnover. Additional factors identified by Xu & Ramesh (2007) include factors associated with policy and procedures promoted while Dikmen et al. (2008) and Clark and O'Connor (2012) include management stability as key factors to consider.

The selection of attributes for Project Senior Executive, illustrated in Table 24, is based on findings in the construction and IS/IT literature, personal experience and feedback from senior executives involved in large infrastructure project planning and delivery. The attributes 'Strong commitment/project priority' and 'Leaders have long tenure in position' were most noted in both the IS/IT and construction literature. Two senior public sector executives noted 'Familiarity with endorsing agent', 'Streamlined governance structure' and 'Influential political champion' as attributes that are key in the assessment of this stakeholder category in public sector large infrastructure projects. Of note is the 'subjective' nature of each of these attributes and influence on project communications and partner relationships. The attribute 'Familiarity with endorsing agent' was noted as a particularly important attribute to consider in the planning and procurement phase (and not as relevant in the design, construction and operation phases) where projects undergo internal reviews and approvals. On the other hand, the senior executives highlighted the attribute 'Influential political champion' as a key attribute across all project phases and particularly important in public sector project delivery. The attribute 'Streamlined governance structure' was identified based on personal experience and confirmed by a senior public sector executive as a key attribute in the planning and procurement phases of a public sector project due to the level of influence and time requirements for approval, consultation and review by senior executives on project matters.

Table 24: Project Senior Executive stakeholder category source of attributes

Project Senior Executive	Relevant Literature Source
▪ Influential political champion	Bannerman (2008)
▪ Leaders have relevant experience	Toor and Ogunlan (2009), Koutsikouri et al. (2008)
▪ Leaders familiar with endorsing agent	
▪ Streamlined governance structure	Xu (2007)
▪ Strong commitment / project priority	Liu et al. (2010), Bannerman (2008), Toor and Ogunlan (2009), Tabish and Jha (2011), Schmidt et al. (2001), Chua et al. (1999)
▪ Leaders familiar with project sponsor	Bannerman (2008), Koutsikouri et al. (2008)
▪ Leaders have long tenure in position	Liu et al. (2010), Bannerman (2008), Schmidt et al. (2001), Dikmen et al. (2008), Clark and O'Connor (2012)

Project Team (Private)

The 'Project Team (Private)' is defined as the project stakeholders retained by the public sector Project Team (Public) to provide professional services in the planning and delivery of the project and defined in some literature as 'Consultants'. Shen et al. (2006) identify Project team (private) PPP risks related to attributes representing a lack of experience and communication abilities across parties. Li et al. (2011) suggest critical project management factors for project success associated with the level of skill, experience, motivation, commitment, communication and feedback mechanisms and procedures for project planning and control and similar in findings of

Rahman & Kumarswamy (2005). Fidan et al. (2011) project vulnerability factors include those related to cultural differences and technical, managerial and financial incompetency. Ling and Poh (2008) identify a series of problems faced in design build arrangements associated with the project team's lack of experience, knowledge, relevant manpower and resources, and processes.

The selection of attributes for Project Team (Private) is based on findings in the construction and IS/IT literature, personal experience and feedback from senior executives involved in large infrastructure project planning and delivery. The attributes 'Strong technical capabilities', 'Strong collaborative communication style' and 'Strong project management skills' were most noted in the literature reviewed. The attribute 'Strong local knowledge and experience' was identified both in this stakeholder category and that of the category 'Developer' and noted most frequently in discussions with senior executive practitioners and review of industry procurement documents. A senior executive noted a very important attribute in forming the Project Team (Private) as 'Team has complementary experience' in creating a "winning team, you need to ensure that your team has complementary experience particularly as this is often assessed in the Request for Qualifications period by the Project Sponsor". In addition, although limited reference in the literature, the attribute 'Strong response to problem solving' was identified by the senior executive as a key attribute and based on personal experience I also agreed. This attribute was identified based on relevance to the ability of a team to respond to complex project interactions across project schedule, budget and scope which often arise in large infrastructure projects and without strong problem solving skills larger problems may arise. Summarized in Table 25 is the literature in support of the Project Team (Private) attributes identified as most important.

Table 25: Project Team (Private) stakeholder category source of attributes

Project Team (Private)	Relevant Literature Source
▪ Strong local knowledge and experience	Chua et al. (1999), Shen et al. (2006), Zhang (2004), Ling and Poh (2008), Rahman and Kumarswamy (2005), IO (2010), PBC (2010), Fidan et al. (2011)
▪ Strong commitment / project priority	Chua et al. (1999), Zhang (2004), Rahman and Kumarswamy (2005), Ling and Poh (2008),Toor and Ogunlan (2009), Li et al. (2011)
▪ Strong technical capabilities	Chua et al. (1999), Zhang (2004), Rahman and Kumarswamy (2005), Ling and Poh (2008), Toor and Ogunlan (2009), Koutsikouri et al. (2008), Fidan et al. (2011), Li et al. (2011)
▪ Strong collaborative communication style	Chua et al. (1999), Zhang (2004), Rahman and Kumarswamy (2005), Shen et al. (2006), Toor and Ogunlan (2009), Fidan et al. (2011), Li et al. (2011)
▪ Team has complementary experience	Zhang (2004)
▪ Strong experience with client	Zhang (2004), Toor and Ogunlan (2009), IO (2010), PBC (2010), Fidan et al. (2011)
▪ Strong response to problem solving	Rahman and Kumarswamy (2005), Li et al. (2011)
▪ Strong project management skills	Chua et al. (1999), Zhang (2004), Rahman and Kumarswamy (2005), Shen et al. (2006), Koutsikouri et al. (2008), Toor and Ogunlan (2009), Li et al. (2011)

Third Party Stakeholders

Third Party Stakeholders are defined as the stakeholders considered external to the project sponsor and client teams, have limited to no role and/or responsibility in project planning and delivery but whom may affect or be affected by the project. The findings of Cleland (1999) noted that the strength of an oppositional stakeholder may be based on such factors as political alliances, public support, quality of strategies, dedication of members to their concerns/issues, availability and effective use of resources. These factors were drawn upon to identify attributes of ‘Third Party Stakeholders’ and supplemented by the findings of Newcombe (2003) and Olander & Landin (2005). Chan et al. (2011), Ng & Loosemoore (2007) and Baloi & Price (2003) each make limited reference to third party stakeholder related risk factors associated with political interference, power groups and delays due to third parties, all of which were considered in the attribute development. Overall, there was limited reference to the third party stakeholder category in construction and IS/IT project management literature although it is widely acknowledged that this stakeholder category can highly influence the success and/or failure of a project (Bannerman, 2008).

The selection of attributes for Third Party Stakeholder is based on findings in the construction and IS/IT literature, personal experience and feedback from a public sector senior executive involved in large infrastructure project planning and delivery. There was relatively less reference to attributes associated with this stakeholder category compared to others despite the reference in the literature and by identification by senior executives of this stakeholder category’s level of influence and source of risk to project objectives and outcomes. Attributes project initiative and access to political and social support were most frequent in the literature and confirmed as most relevant by a senior public sector practitioner. The attribute ‘Communications and media influence’ was observed to be a critical attribute for assessment of this stakeholder category by two senior public sector practitioners and highlighted by Olander & Landin (2008) as influencing the perceived ‘success’ of a public sector project. Both public sector senior executives also noted the attribute ‘Alliance/partnership building potential exists’ as a key consideration. Summarized in Table 26 is the literature in support of Third Party Stakeholder attributes identified as most important

Table 26: Third Party stakeholder category source of attributes

Third Party Stakeholders	Relevant Literature Source
▪ Support project initiative	Baloi and Price (2003), Zhang (2004), Walker et al. (2008), Olander (2007), Olander & Landin (2008)
▪ Able to mobilize strategic alliances	Olander & Landin (2008), Aoltonen and Sivonen (2009)
▪ Access to technical / financial support	Newcombe (2003), Olander (2007), Aoltonen and Sivonen (2009)
▪ Stakeholder is perceived as credible	Olander (2007), Aoltonen and Sivonen (2009)
▪ Alliance/partnership building potential exists	Aoltonen and Sivonen (2009)
▪ Access to political/social support	Baloi and Price (2003), Newcombe (2003), Olander (2007), Ng and Loosemoore (2007), Olander & Landin (2008), Aoltonen and Sivonen (2009)
▪ Communications & media influence	Olander & Landin (2008)

Project Oversight Reviewers

Project Oversight Reviewers are defined as top-level organizational members who must be consulted or validate for approval project tasks. Attributes for the stakeholder category Project Oversight Reviewers were developed based on a review of the industry procurement documentation, personal experience and discussions with senior executives. It is interesting to note that after a thorough review of the construction management and IS/IT literature there was no mention of this stakeholder category as a ‘key stakeholder’ or associated with project risks. In part, this may be because public sector infrastructure projects are a neglected area of research (Tabish & Jha, 2011) and specifically insight in the procedures and practice in planning and procuring of these projects is lacking versus the design and construction phases which are heavily researched. It is during these early phases of project delivery in which Project Oversight

Reviewers take a predominant stakeholder role as approvers and validators of a project in reaching the contract award milestone. Attributes developed for this stakeholder category reflect those attributes developed for the Project Team (Public) and Project Team (Private). One distinctive attribute is 'Highly credible by market players' because this stakeholder category role and responsibility is primarily the approval or validation of public sector practices in accordance to policies, regulations and legislation necessitating credibility as an entity to other project participants.

The attributes selected for the stakeholder category 'Oversight Reviewers' were drawn upon attributes identified for other stakeholder categories notably the Project Team (Public), Project Senior Executive, and Developer in addition to personal experience and feedback from senior executive. The three attributes: 'Familiar with project team personnel', 'Highly credible by market players', and 'Previous relevant experience' are distinct relative to attributes identified for other stakeholder categories selected based on personal experience and feedback from a senior public sector practitioner. The attribute 'Familiar with project team personnel' relates the issues of trust and collaborative communication between the oversight reviewer and project participants performing the work. 'Highly credible by market players' was selected because an oversight reviewer viewed as 'credible' provides a level of reassurance to stakeholders on the validity of their recommendations and that their participation will result in a fair and accountable project planning and delivery process. The attribute 'Previous relevant experience' is similar to attributes identified for 'experience' attributes for stakeholder categories 'Developer', Project Team (Public) and Project Team (Private) and relates to the 'Oversight Reviewers understanding of 'hot button' issues in the project similar to those identified in the past. Relevant attributes are summarized in Table 27, as well as a brief description of their sources. As observed previously, no body of literature addresses the role of oversight reviewers and attributes of importance to effective execution of that role.

Table 27: Project Oversight Reviewers stakeholder category source of attributes

Project Oversight Reviewer	Relevant Literature Source
▪ Strong commitment / project priority	Drawn upon attributes from Project Team (Public)
▪ Familiar with project sponsor department	Drawn upon attributes from Project Senior Executive
▪ Familiar with project team personnel	
▪ Highly credible by market players	
▪ Previous relevant experience	
▪ Established practices and procedures	Drawn upon attributes from Project Team (Public)
▪ Sufficient in-house capacity	Drawn upon attributes from Project Team (Public)

7.5.3.2 Attributes as Risk Drivers

In terms of acting as a risk driver, the kind of thought process required is to examine each attribute in turn with its limiting values (the two point scale previously discussed – i.e. true/false; good/ bad, etc.), and assess which, if any, performance variables are affected. For example, consider the Public Sector Client attribute 'established practices/procedures'. If faced with a project such as the case study where the Project Sponsor is using a design-build-finance-maintain (DBFM) procurement mode for the first time, then the attribute value is likely to be minimal. Then one posits the question: What are the consequences if {Public Sector Client} attribute {established practices/procedures} is {minimal}? For this scenario, there is a reasonable likelihood that the duration of related client activities especially at the project's front end (process view) could be extended resulting in both time and cost risk events for the public and private sectors. Hence, the attribute is a potential risk event driver and should be included. In summary, for those attributes identified as possible risk drivers, depending on the value assigned to an attribute, by itself or in combination with the attribute values for other project view components, a potential risk can be identified, its likelihood and outcome(s) assessed as an implicit function of attribute value, and responses identified. For the case at hand, the most appropriate client risk response might be to retain the services of a firm well-versed in DBFM, thus minimizing the risk potential very early on in the process.

Shown in Figure 23 are the user-specified definition of attributes for participant classes and members of seven of these classes (see Figure 14) for the case study project, as entered into the research prototype in accordance with Table 20. Figures 23(a) and 23 (b) show attributes of two members of the Senior Executive Stakeholder Category, in this case ‘Regional Department A Leaders’ and ‘National Department Leaders’. Project Team (Public), Project Team (Private) and Project Developer attributes and values are depicted in Figures 23 (c) through (e). Examples of members of Stakeholder Category Oversight Reviewers are shown in Figures 24(f) and 24(g) for members ‘Federal Ministry of Environment’ and ‘Fairness Reviewer/Monitor’. Special interest group attributes and values under Third Party Stakeholders are shown in Figure 24(h), and last but not least, Department A attributes and values under participant class Users/Client are presented in Figure 24(i). Note that attribute definitions can be shared across members of a stakeholder category through the mechanism of inheritance (however, additions or deletions can be made to individual members of a category) and the research prototype allows the user to specific attribute value metric differences at the individual member level. The mechanism of inheritance facilitates the speedy definition of attributes to members of a class.

Note in Figure 23 and 24 the ability to define quantitative (Q), linguistic (L), Boolean (B) and Date (D) valued attributes. Both expected value and actual value fields accompany the definition of attributes for the various views of a project. It is important to note that attributes in the system are user-specified, and can be readily changed. While such flexibility is desirable, especially in a risk workshop for a project, a case needs to be made for adding or deleting an attribute, and care should be taken to minimize the number of attributes as a practical matter.

Figure 23: Attribute definitions and values for different participant categories and members of a category

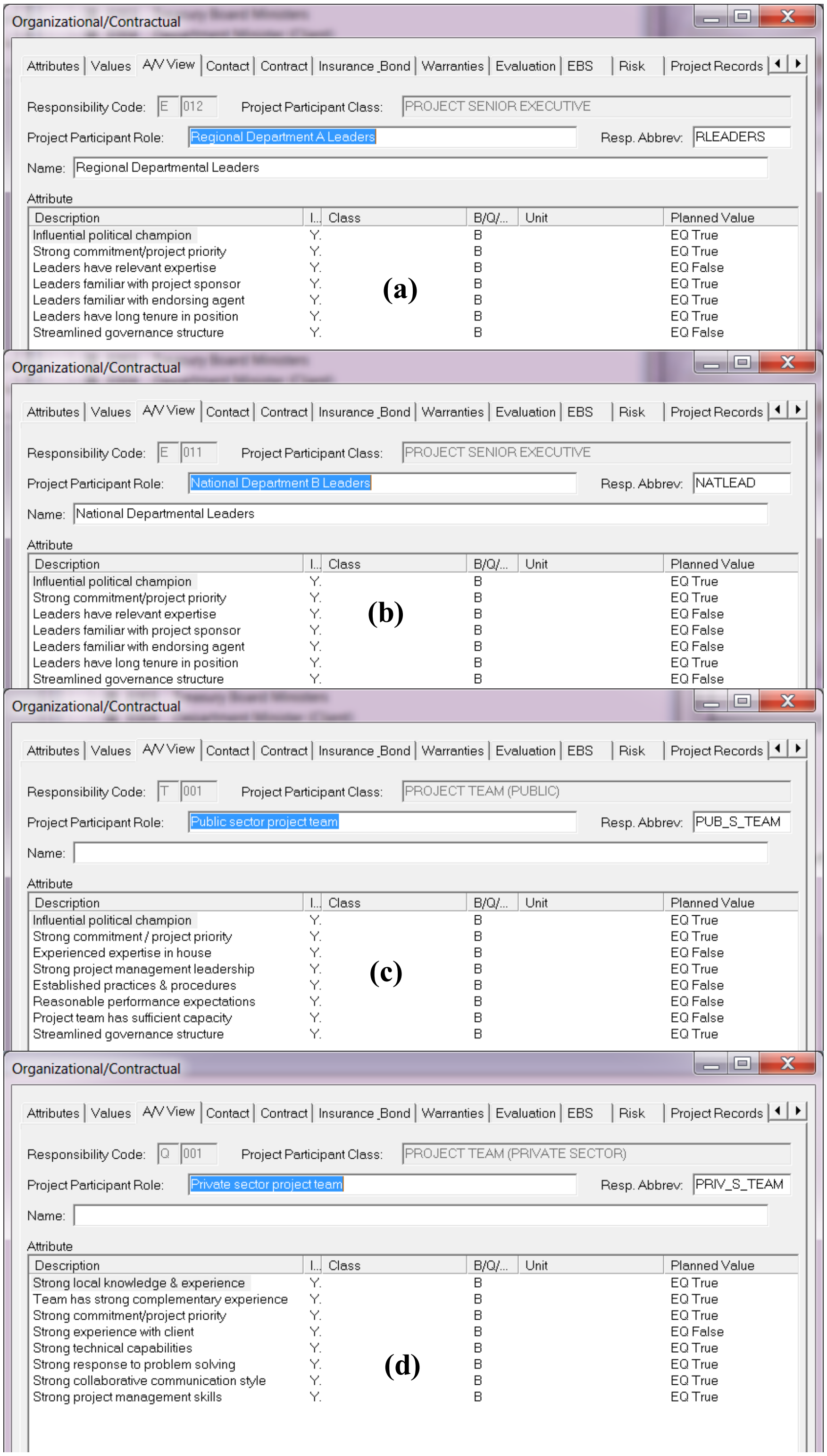
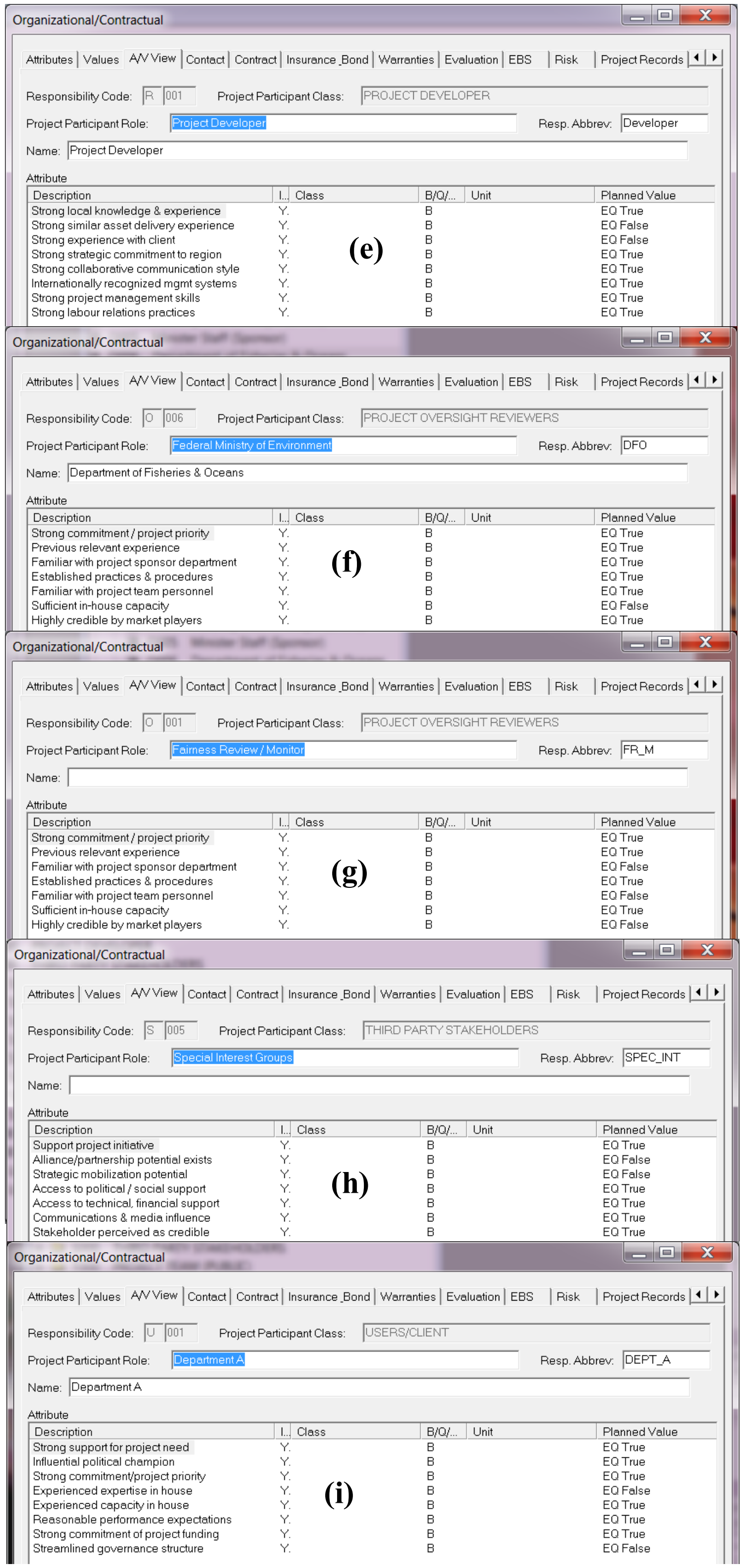


Figure 24: Attribute definitions and values for different participant categories and members of a category (continued)


Organizational/Contractual
Attributes | Values | A/V View | Contact | Contract | Insurance_Bond | Warranties | Evaluation | EBS | Risk | Project Records
Responsibility Code: R 001 Project Participant Class: PROJECT DEVELOPER
Project Participant Role: Project Developer Resp. Abbrev: Developer
Name: Project Developer
Attribute
Description | I.. | Class | B/Q/... | Unit | Planned Value
Strong local knowledge & experience Y. B EQ True
Strong similar asset delivery experience Y. B EQ False
Strong experience with client Y. B EQ False
Strong strategic commitment to region Y. B EQ True
Strong collaborative communication style Y. B EQ True
Internationally recognized mgmt systems Y. B EQ True
Strong project management skills Y. B EQ True
Strong labour relations practices Y. B EQ True
(e)
Organizational/Contractual
Attributes | Values | A/V View | Contact | Contract | Insurance_Bond | Warranties | Evaluation | EBS | Risk | Project Records
Responsibility Code: O 006 Project Participant Class: PROJECT OVERSIGHT REVIEWERS
Project Participant Role: Federal Ministry of Environment Resp. Abbrev: DFO
Name: Department of Fisheries & Oceans
Attribute
Description | I.. | Class | B/Q/... | Unit | Planned Value
Strong commitment / project priority Y. B EQ True
Previous relevant experience Y. B EQ True
Familiar with project sponsor department Y. B EQ True
Established practices & procedures Y. B EQ True
Familiar with project team personnel Y. B EQ True
Sufficient in-house capacity Y. B EQ False
Highly credible by market players Y. B EQ True
(f)
Organizational/Contractual
Attributes | Values | A/V View | Contact | Contract | Insurance_Bond | Warranties | Evaluation | EBS | Risk | Project Records
Responsibility Code: O 001 Project Participant Class: PROJECT OVERSIGHT REVIEWERS
Project Participant Role: Fairness Review / Monitor Resp. Abbrev: FR_M
Name:
Attribute
Description | I.. | Class | B/Q/... | Unit | Planned Value
Strong commitment / project priority Y. B EQ True
Previous relevant experience Y. B EQ True
Familiar with project sponsor department Y. B EQ False
Established practices & procedures Y. B EQ True
Familiar with project team personnel Y. B EQ False
Sufficient in-house capacity Y. B EQ True
Highly credible by market players Y. B EQ False
(g)
Organizational/Contractual
Attributes | Values | A/V View | Contact | Contract | Insurance_Bond | Warranties | Evaluation | EBS | Risk | Project Records
Responsibility Code: S 005 Project Participant Class: THIRD PARTY STAKEHOLDERS
Project Participant Role: Special Interest Groups Resp. Abbrev: SPEC_INT
Name:
Attribute
Description | I.. | Class | B/Q/... | Unit | Planned Value
Support project initiative Y. B EQ True
Alliance/partnership potential exists Y. B EQ False
Strategic mobilization potential Y. B EQ False
Access to political / social support Y. B EQ True
Access to technical, financial support Y. B EQ True
Communications & media influence Y. B EQ True
Stakeholder perceived as credible Y. B EQ True
(h)
Organizational/Contractual
Attributes | Values | A/V View | Contact | Contract | Insurance_Bond | Warranties | Evaluation | EBS | Risk | Project Records
Responsibility Code: U 001 Project Participant Class: USERS/CLIENT
Project Participant Role: Department A Resp. Abbrev: DEPT_A
Name: Department A
Attribute
Description | I.. | Class | B/Q/... | Unit | Planned Value
Strong support for project need Y. B EQ True
Influential political champion Y. B EQ True
Strong commitment/project priority Y. B EQ True
Experienced expertise in house Y. B EQ False
Experienced capacity in house Y. B EQ True
Reasonable performance expectations Y. B EQ True
Strong commitment of project funding Y. B EQ True
Streamlined governance structure Y. B EQ False
(i)

The attributes presented in Table 20 and shown in Figure 23(a) to Figure 24(i) have been reviewed and tested with senior industry practitioners as part of the validation interviews conducted (outlined in chapter 8) to be unambiguous, expressed in a meaningful way with a plausible cause and effect link with risk – i.e. they fulfil a number of the tests posed previously. A tension exists between seeking thoroughness through a comprehensive set of attributes and practicality in use, especially when considering the number of participants in the organizational / contractual (participant) view of a project as well as the number of components in other project views that need to be described for large infrastructure projects. As discussed, the process to develop Table 20 was iterative and included best judgement based on a review of the literature, feedback from the senior executives and complemented by my practical experience working in the industry. Therefore, in its current form, Table 20 is considered reflective of pertinent attributes to be considered in defining the seven participant classes and may be further refined in an actual project setting in real time to suit project context and user preferences.

7.6 **Identifying and Representing Risks**

In this section and related subsections, two risk examples are introduced for the purpose of demonstrating how the research prototype works, the integration of the research concepts, and most importantly, the significant contribution that stakeholders can make to a project's risk profile. Each example illustrates how one may explicitly define project context and its contribution to improved identification of risk events and elicitation of expert opinion. The first example makes use of an environmental component, a stream that crosses part of the project site to illustrate features of the research prototype and how project views including the participant view can be characterized. The second example relates more directly to the earlier part of this chapter that outlined the attributes of key stakeholder classes involved in public sector infrastructure delivery as a source of risk to project delivery and reflects the complexity of the public sector context. The two examples illustrate the unique scope of risks that are managed on public sector infrastructure projects in the planning and procurement phases and multiple stakeholders that contribute to the risk profile. Taken together, these examples present aspects of a 'walk through' of how a facilitator of a risk workshop would use the research prototype and associated input information with an individual or group of risk workshop participants as per the processes Step 2 'Risk Management Task Preparation' (including process steps 'Define Project Context' and 'Prepare Key Risk Management Documentation') and Step 3 'Conduct Workshops and Interviews with Experts' (including process step 'Perform the Risk Identification and Expert Opinion Elicitation Process) of Table 19.

7.6.1 Example 1 – Characterizing the Environmental View of the Project to Illustrate Use of the Prototype System

This example, used to illustrate features of the prototype risk management system, involves consideration of a stream that crosses part of the site of the case study project. Inhabiting this stream is a number of fish species, not all of which are known with certainty, given a relatively cursory examination of the site in the early stages of site acquisition. Understanding the risks that may arise due to the presence of endangered or protected aquatic species was important to project decision makers who were considering options for the orientation of the project on site, hard landscaping features (for physical security, auxiliary services, etc.) and civil infrastructure (roadways, parking, etc.). The example demonstrates that a risk event can arise from a confluence of factors, including presence of an environmental feature, the timing of work that has to be carried out on site and how that timing does or does not interact with natural events, and lastly the role of selected stakeholders in performing the work to detect the presence, providing oversight and those with a special interest in the protection of the environmental features including aquatic species present. Treated in turn are the following: the project risk register, a multi-view representation of project views to facilitate elicitation of risk events as part of an interactive risk identification session, and how project components are characterized to assist in these activities as well as serve knowledge management functions.

After modelling the project context, the project risk view is developed. The risk view functions as what is commonly referred to in industry as a project risk register. A risk register is a comprehensive list of anticipated risk events and the associated consequences and mitigation measures identified on a project and is under ideal conditions considered a 'living document'; that is to say it is constantly reviewed, updated and revised over the lifecycle of the project as the project risk profile changes (see chapter 3 for further detail). It has become standard practice in Canada for both the public entity and private sector proponents bidding on a PPP project to each develop a comprehensive risk register to assist them in their pricing, monitoring and transfer of risk. An on-going problem with these registers, and also addressed in the literature (Hillson, 2000), is the confusion of risk driver and impact. Other issues relate to the cryptic representation of project and risk components providing minimal assistance with the identification and elicitation of risk properties, issues responded to in the framework and prototype. As seen from Figure 25 the basic construct for the risk view is a risk register in which risk can be categorized in the form of a hierarchy (category, sub-category, class, issue, event), which facilitates ease of navigation. Not treated in this thesis is how best to categorize risks, a topic of considerable practical interest, especially in the context of PPP projects (Zou et al. 2007). The structure advocated for the risk framework approach introduced is to break down the register in terms of project time phases (categories) and risk issues within each phase. The prototype is flexible to accommodate an organization's categorization approach or built on past experience augmented by the specifics of the project at hand.

In the risk register format presented in Figure 25, the risk issue construct corresponds to topics or keywords of like kind, of direct relevance to the project and around which there is a degree of uncertainty and thus associated risk events. For the current implementation, the approach advocated is that potential risk drivers are first associated with each of the risk issues. These drivers are drawn from the components that comprise each project view. They can always be edited (augmented, deleted) as the project is examined on an activity by activity basis as more in-depth consideration is given to risks that could occur. Shown in Figure 26 is an assessment of the likely drivers of risk under the issue of Cultural and Environmental Risks. Potential risks may occur at various locations that describe the project (see Physical View drivers), arise from different natural/man made features of the site (see environmental view drivers), be associated with one or more activities (see process view where both parent and child activities are listed), and relate to several organizational entities drawn from a number of participant classes (see Organizational view).

Figure 25: Risk register with definition of risk events in progress

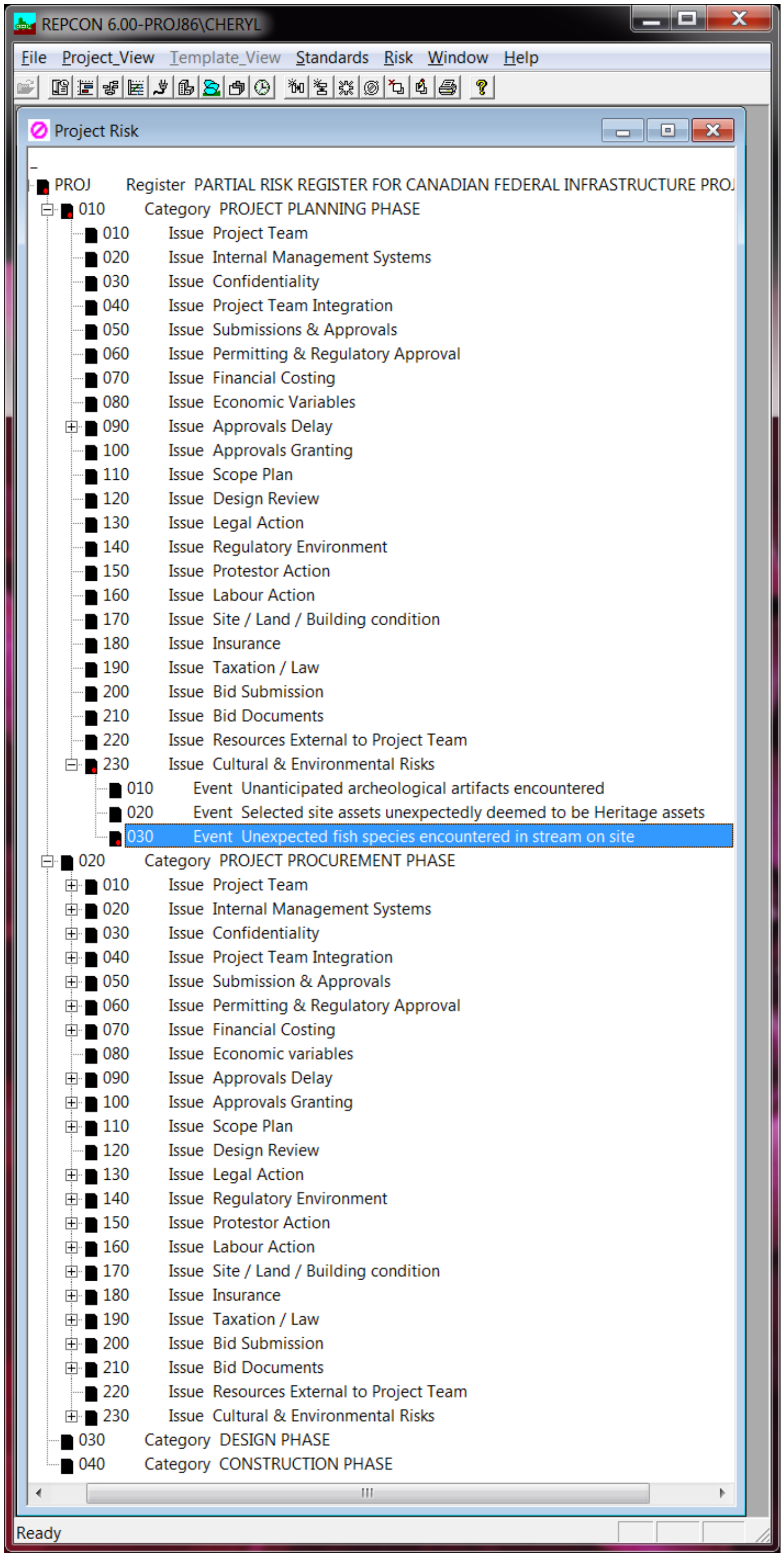
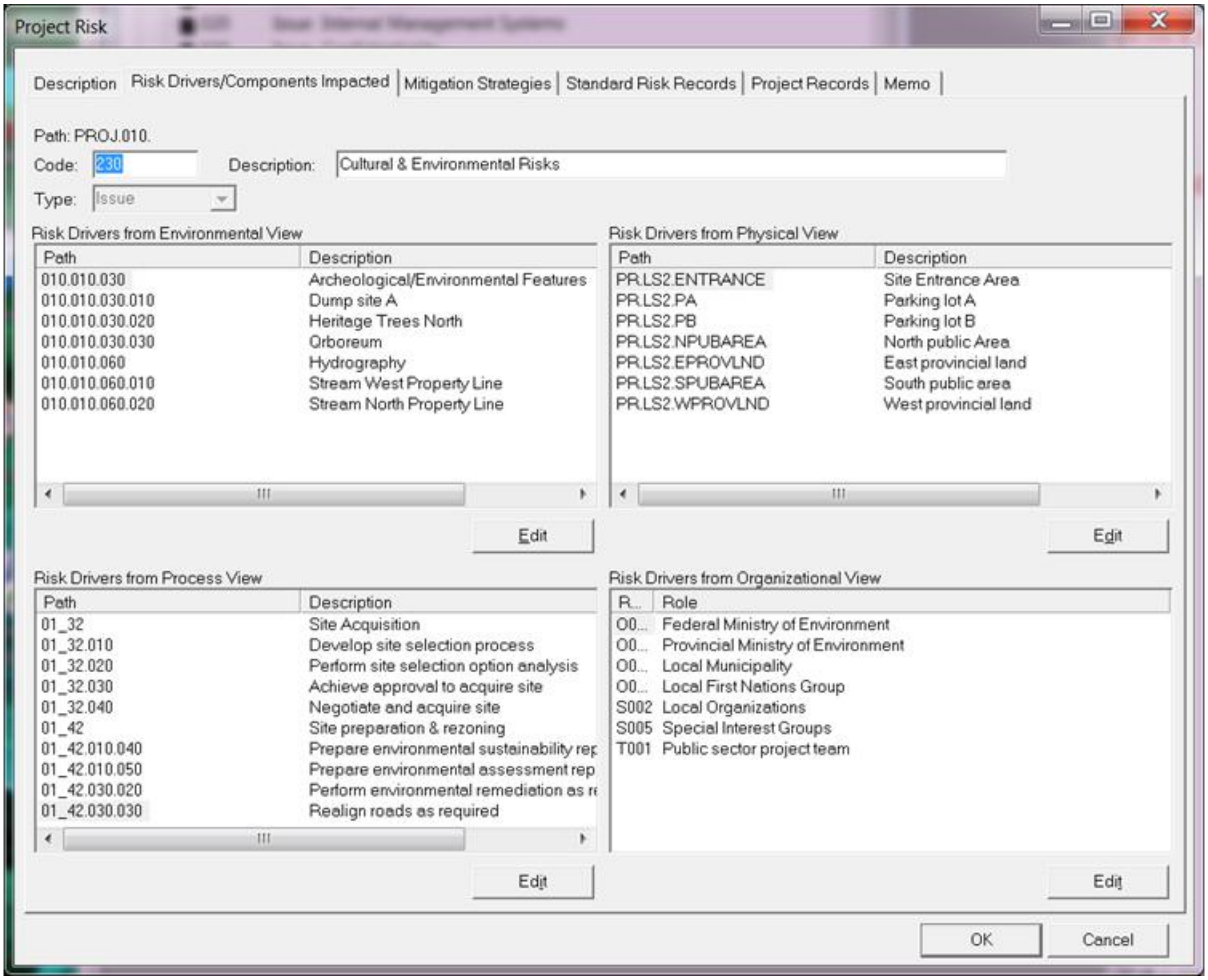
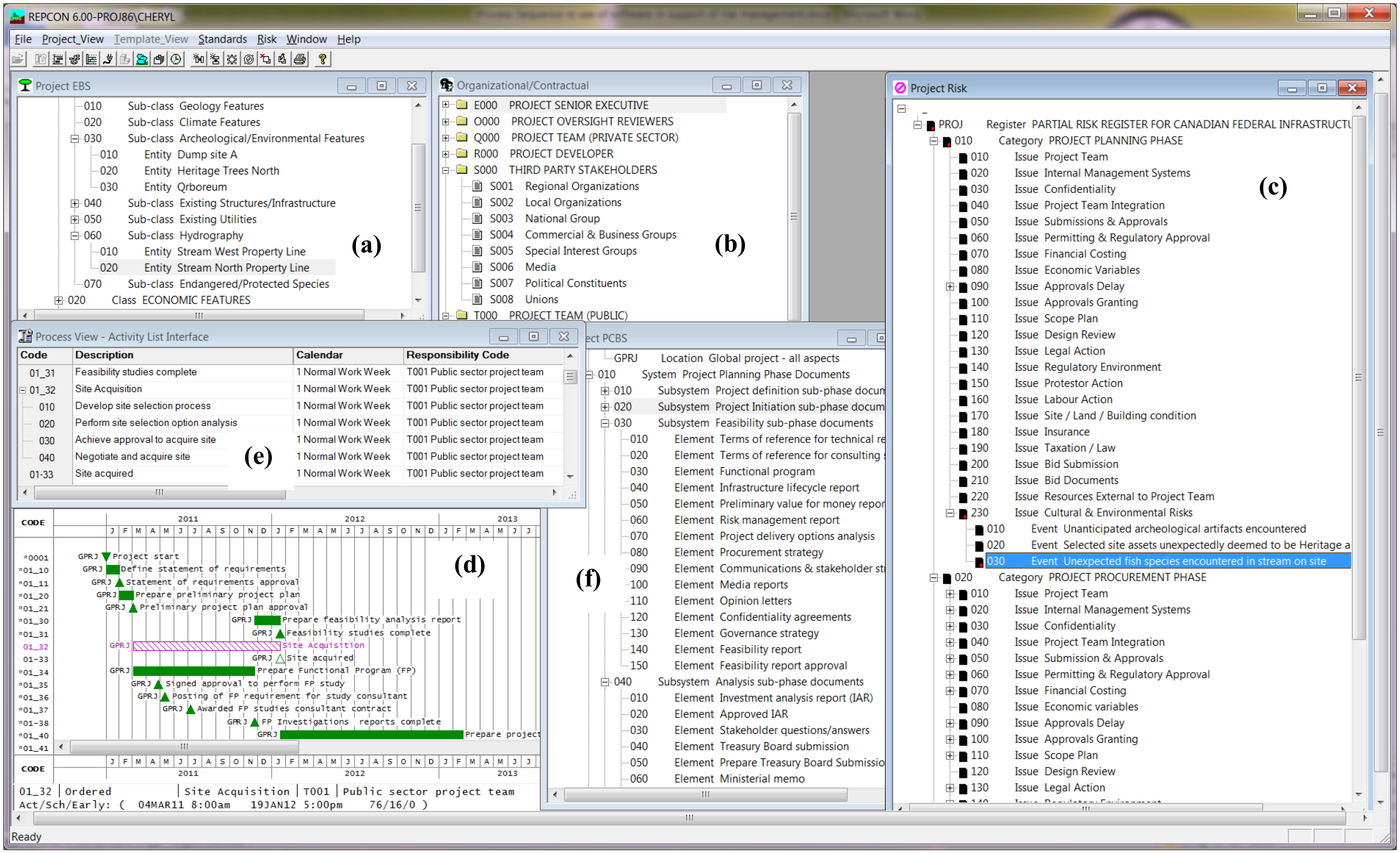


Figure 26: Risk Drivers at the risk issue level – Depicted are both parent and child level items; for the process view, the focus is mainly on parent level activities



The multi-view project interface shown in Figure 27 depicts several aspects of the project views as implemented. Shown across the top of Figure 27 are partial project views in the form of hierarchies for each of the environmental (27a), participant (27b) and risk views (27c) for the case study project. Across the bottom of Figure 27 is part of the process view shown in the form of a bar chart (27d) and activity list (27e) highlighting the participant responsible for each activity. In addition, Figure 27(f) is a partial view of the physical view highlighting the documents created in the planning and procurement phases of the case study. The integration of views within one system allows for changes in the project context such as regulatory and scope changes to be reflected throughout the other views, including the risk view. More importantly, in a risk identification elicitation session, it is possible to show aspects of each view simultaneously, helping with risk session participant thought processes and a consistent/uniform view of the project context across participants to minimize differences in understanding. Risk events are therefore not considered in isolation but as events that may be interrelated. As noted in Chapter 1, traditional risk registers, either in paper-based form or in the form of spread sheets or databases are poorly suited to accommodate changes in the risk profile as a result of changes in the project context and objectives. These risk registers do not incorporate an explicit representation of the project, and given that the circumstances of a project change, for example due to a change in regulations or change in project stakeholder makeup, the users of a risk register have to manually identify risks that were related to the original state of affairs, eliminate the risks that are no longer applicable, and then identify new risks that relate to the changed circumstances. Additionally, the large number of risks and the significant number of information elements associated with each risk tend to make the use of a paper-based or spread sheet based form of a risk register extremely difficult to record information and navigate.

Figure 27: Multi-view representation illustrating ability of user to facilitate risk workshops highlighting different views of the project to improve the identification and elicitation of expert opinion. In this example, Risk Event 'Unexpected fish species encountered in stream' is illustrated and relevant project views (a) through (f).



Having assigned potential risk drivers to the risk issue Cultural and Environmental Risks for the Project Planning Phase as well as for other risk issues, the task then becomes one of identifying risk events relevant to each risk issue. Here is where the interface shown in Figure 27 is of particular use. It is advocated that one 'walks through' the Process view (the bar chart) activity by activity and poses the question: *What risk events may be relevant to this activity, given that this activity has been identified as a potential driver for one or more risk issues?* This is a particularly useful approach in a risk identification/elicitation workshop session. Figure 28 shows an example of this for risk drivers from each of the four Project views (Environmental 28(a), Physical 28(b), Process 28(c), and Organizational (Participant) 28(d) for the risk event '*Unexpected fish species encountered in stream on site*' as per the risk register risk issue Cultural and Environmental Risks in Figure 25 under the Site Acquisition sub phase of the Project Planning phase of the project. Note that the drivers for this risk event are a subset of those shown in Figure 26 Risk events arise from the values of the attributes of the components in one or more project views which are risk drivers, the presence of which, either singly or in combination with other risk drivers, lead to the potential for a risk event occurring. These attributes can be considered implicitly or explicitly. Here the latter approach is adopted. In actual risk identification sessions, a combination of approaches may be used. Quick reflection on some components might suffice to indicate their role as a risk driver (e.g. soil condition) whereas for others, it is important to examine component attributes values in order to both confirm the component's role as a risk driver as well as assist in targeting the most appropriate risk response strategies. To demonstrate the foregoing in use, consider once again all of the contents of Figure 28. By examining the Process (schedule) view (Figure 27 (d) and (e)), it is observed that the preliminary schedule indicates **Site Acquisition** work (parent activity 01_32) is to be carried out in a ten-month time frame March 2011 to January 2012. For the stream component 'Stream North Property Line' of the environmental view, the value for each of the attributes of threatened/endangered fish present and regionally important fish present are identified as 'True' in Figure 28(e), suggesting the potential for the adverse risk event, *Unexpected fish species encountered in stream on site.* The user then can examine other views to assess the potential for other drivers to contribute to the occurrence of the risk at hand. To note, seven stakeholders have been identified in Figure 28(d) as potential risk drivers. In this case, the characteristics of project stakeholder 'Project Team (Public)', who is responsible to carry out or coordinate the investigation of whether or not unexpected fish species are on site, can be assessed to determine whether or not they drive this risk event or a related one. Highlighted in Figure 28 (f) are the attributes of this participant. One observes that the attribute 'Project team has sufficient capacity' has been identified as 'False' and 'Experienced expertise in house' is also identified as 'False'. The 'False' attribute values give rise to concern that perhaps this participant who is responsible for performing this activity may not have the experience or capacity to review or conduct analysis or tests that sufficiently identifies in a timely manner the potential for this risk event to occur. This is a particular concern because in the period of ten months (Site Acquisition period noted above) the Project Team (Public) would need to carry out a number of activities, identify where they do not have capacity or experience and tender for services of other professionals to perform work otherwise conducted in-house. The tendering process itself is an activity, which takes time and resources. In addition, responding to other stakeholder interests and communication, and consultation requirements would require time and resources of the Project Team (Public). Regarding the risk drivers from the Physical view, one notes that Parking Lot A is a potential risk driver because alignment of the associated roadway and necessary paving required as part of the 'Site Preparation Work' where an 'unexpected fish species' such as a 'threatened/endangered species' is present results in additional time and resources to accommodate regulatory requirements, construction mitigation measures, design fees and fulfilling stakeholder communication and consultation requirements. In summary, the ability to integrate information from various views of a project within a single system facilitates the task of risk identification, along with allowing the ready documentation of related risk drivers.

Once the risk drivers have been identified, including specific risk driver attributes if appropriate, then one needs to identify the performance dimensions that could be affected should the risk event occur, the likelihood of its occurrence, and the likely quantum of impact in terms of the performance measures identified. Provided here for completeness is a brief overview of the tasks involved – they are not considered core to the focus of this thesis, hence their abbreviated treatment. Through consultation with in-house expertise or knowledge specialists in attendance at a risk work shop, it is determined that should the risk event be realized, then time, front-end cost and service delivery/usage would likely be impacted. This is shown on the left hand side of Figure 29 (a). Other data fields shown in this figure relate to knowledge management aspects of the system which have not been utilized for this example. Depicted in Figure 29 (b) is an assessment of the likelihood of occurrence of the risk event '*Unexpected fish species encountered in stream on site'*. A total of 5 estimates of occurrence are possible: qualitative (pre and post mitigation), quantitative (pre and post mitigation), and actual (the event did or did not occur). The choice made here is one of a qualitative assessment, but with risk workshop participants being calibrated in terms of the probability ranges that correspond to the linguistic estimates of Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH). Also, as this example is concerned with an initial assessment, one is considering the pre-mitigation situation. Shown in Figure 29 (c) is an estimate of the quantum of the time impact, should the risk event occur. Again, the choice is made to use a qualitative assessment of impact based on prior calibration of what the linguistic descriptors mean. For each and every risk event in the risk register, the process illustrated in Figure 29 takes place. Partially addressed in Figure 30 are candidate mitigation strategies that could lessen the likelihood of occurrence of the risk and/or the potential impact on the performance measures of time and front-end cost if the risk event of '*Unexpected fish species encountered in stream on site'* is realized. Not treated are mitigation strategies related to service delivery/usage. The intent of Figure 30 is to give the reader more insight on the information that can be associated with a risk event. Interestingly, knowledge management can play a significant role with respect to capturing and selecting the most appropriate mitigation strategy (more appropriately referred to as risk response) as a function of the performance measure of interest.

Figure 28: Risk Drivers for the risk event '*Unexpected fish species encountered in stream on site*'

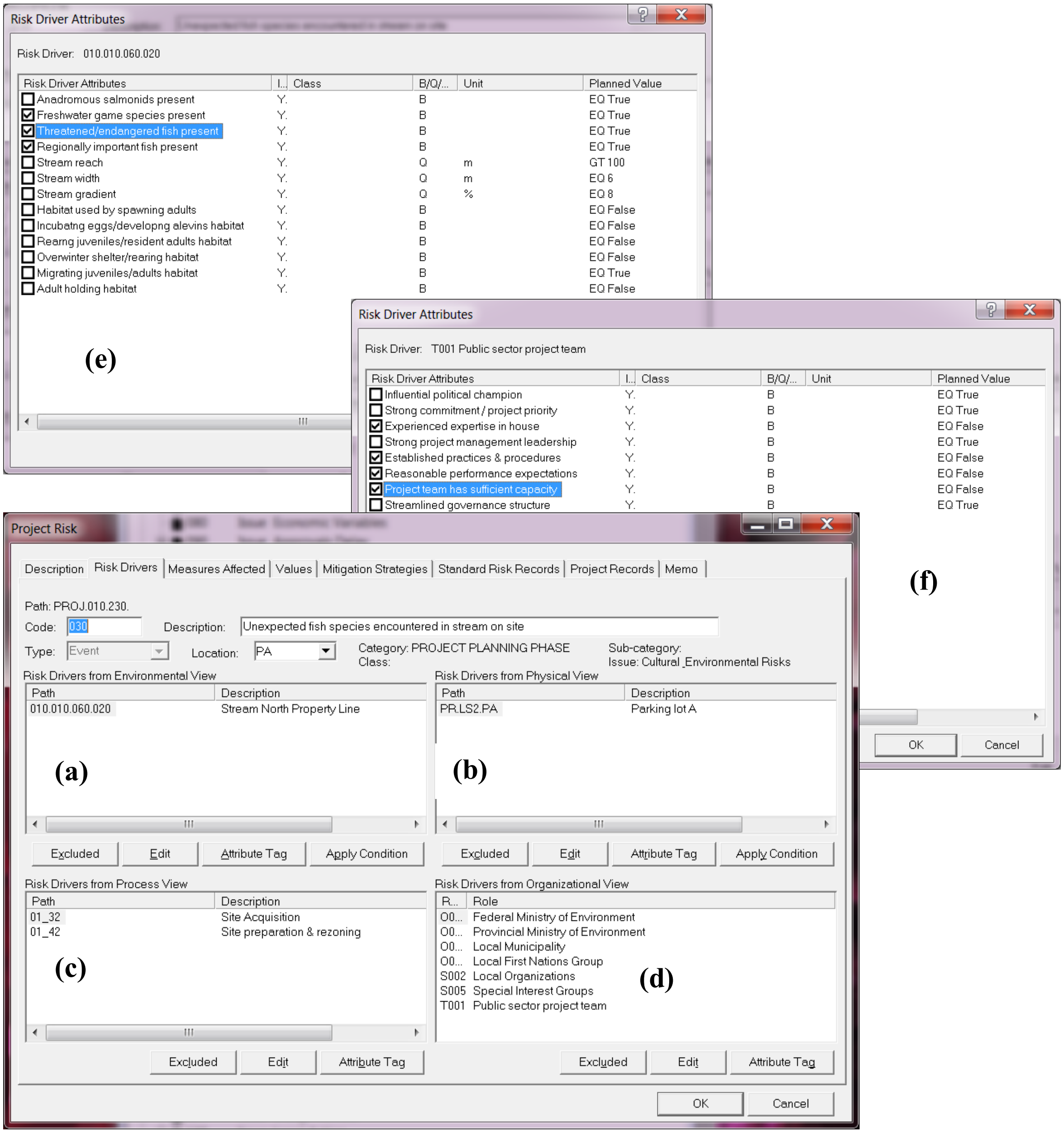


Figure 29: Performance measures potentially impacted if risk event occurs, assessment of likelihood of risk occurrence, and impact on time performance if risk event occurs

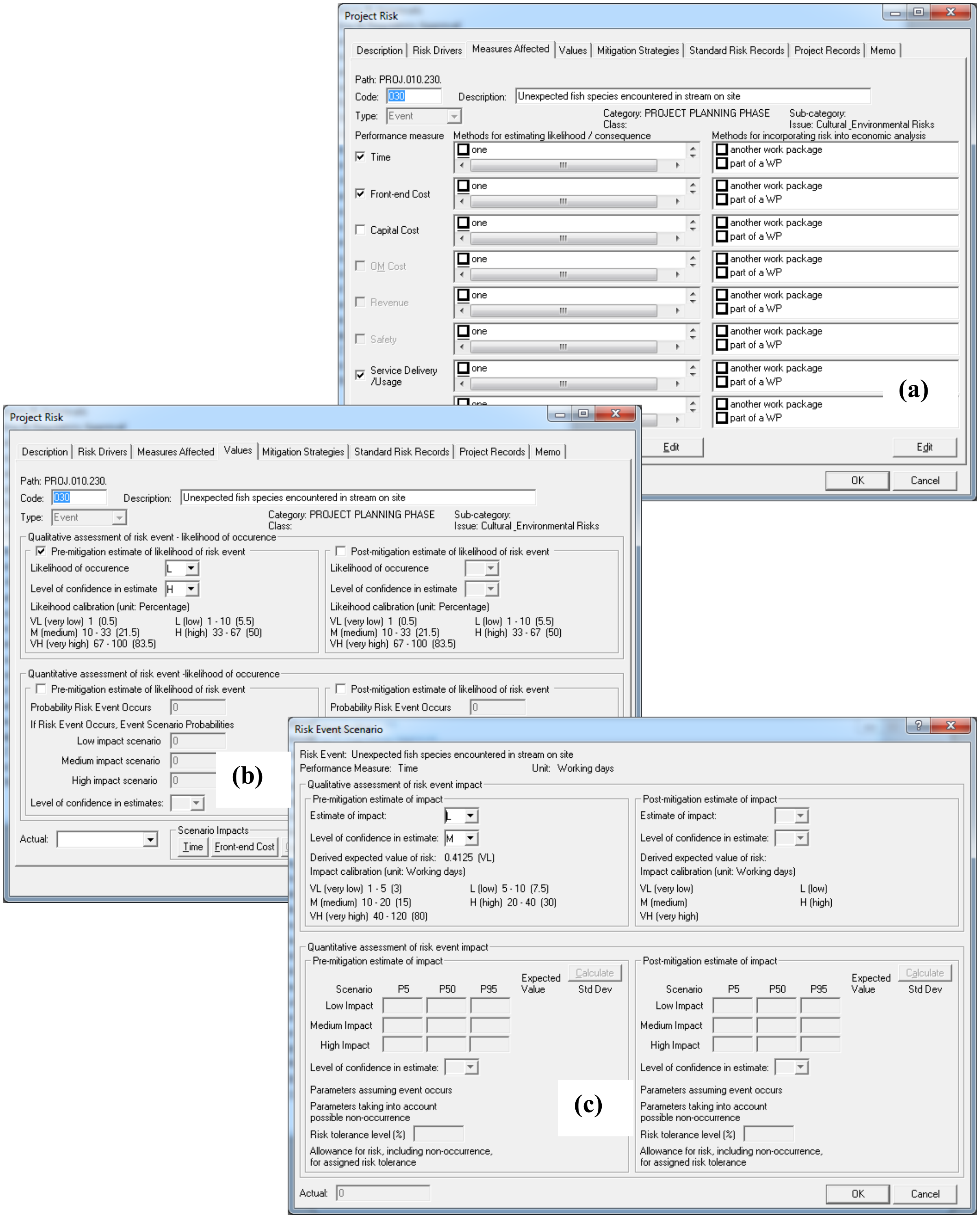
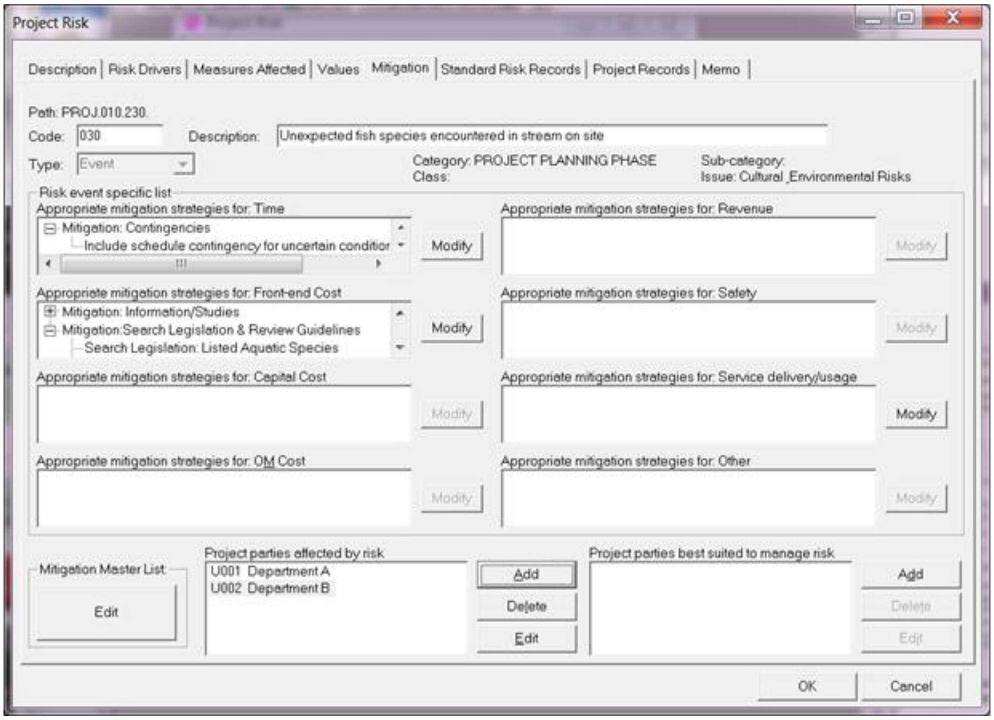


Figure 30: Potential risk response strategies for time and front end cost performance measures



7.6.2 Example 2 – Illustrating Participant Risks Related to Early Project Approval

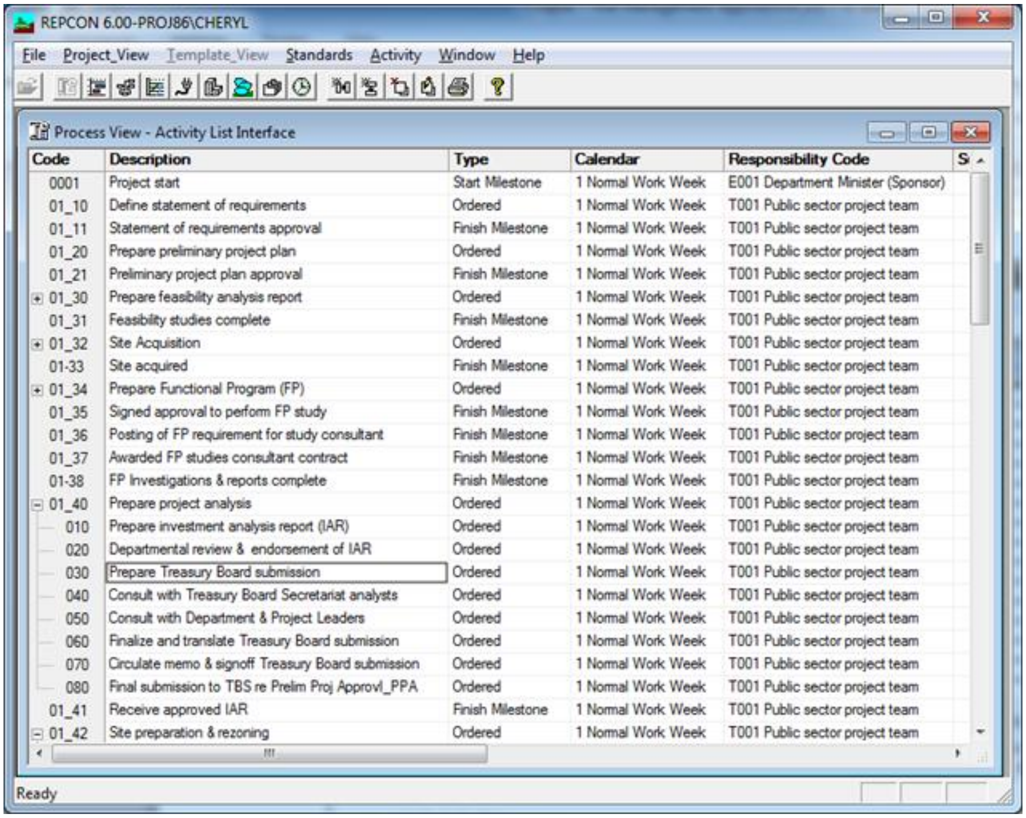
Public sector large infrastructure projects have unique characteristics including a diverse set of stakeholders involved in project delivery which in turn involves extensive planning, approval and meeting consultative requirements. The unique characteristics and complexity of the associated decision making environment in the planning and procurement phases of public sector large infrastructure project delivery have been outlined in Chapters 2 and 3. The following example illustrates how multiple project stakeholders can be a source of risk and the value add of explicitly recognizing stakeholder attributes and associated values in improving both the identification of risk events and the elicitation of expert opinion.

Understanding the risk associated with the delay in submission of Treasury Board documents in the planning phase of project delivery is the example considered. The example is that of a nonlinear risk event, because in missing a scheduled deadline for submitting project documents for approval by a matter of a week or even just a day, the time impact can be measured in terms of months because of predetermined agendas, scheduled approval committee meeting dates such as meetings of the federal Treasury Board responsible for both project and funding approval and re-prioritization of projects which compete for available funds of the governing party. The impact of the example risk event *'Treasury Board submission approval documents delayed from scheduled date'* is of interest, in particular to senior decision makers, because a very small delay in meeting the scheduled submission date has multiple impacts on performance objectives. These objectives include: time (anticipated project date of completion delayed, delays to concurrent procurements etc.), financial (scope creep, construction cost escalation, internal/external resources on-hold status, etc.), service delivery (project 'need' to address public service requirement delayed) and reputation (trust diminished by other or related public sector entities, general public, and private project delivery partner). These impacts affect both federal sponsor and client organizations involved in the delivery of the project. Similar to the previous example, this example demonstrates that a risk event can arise from a confluence of factors and result in a number of adverse impacts as perceived by stakeholders.

A representation of the project has been treated along the lines of what has been previously described in Example 1. Aspects of this representation are first presented to establish context for the risk event *'Treasury Board submission approval documents delayed from scheduled date'*. This is followed by an in-depth examination of the example risk event, with emphasis on the project risk register, an extended description of the risk event, and the potential risk drivers. Primary emphasis of the example is on how project participants can be significant drivers of risk, independent of other risk sources, and on the complexity of the context of public sector infrastructure development process and stakeholder involvement.

Shown in Figure 31 is the Process view in the form of an activity list with the activity of interest (01_40_030 Prepare Treasury Board Submission) highlighted. Also of interest, as will be noted later are selected predecessors of this activity, in particular activities 01_30, 01_32, and 01_34. Delay in one or more of them could drive the risk event.

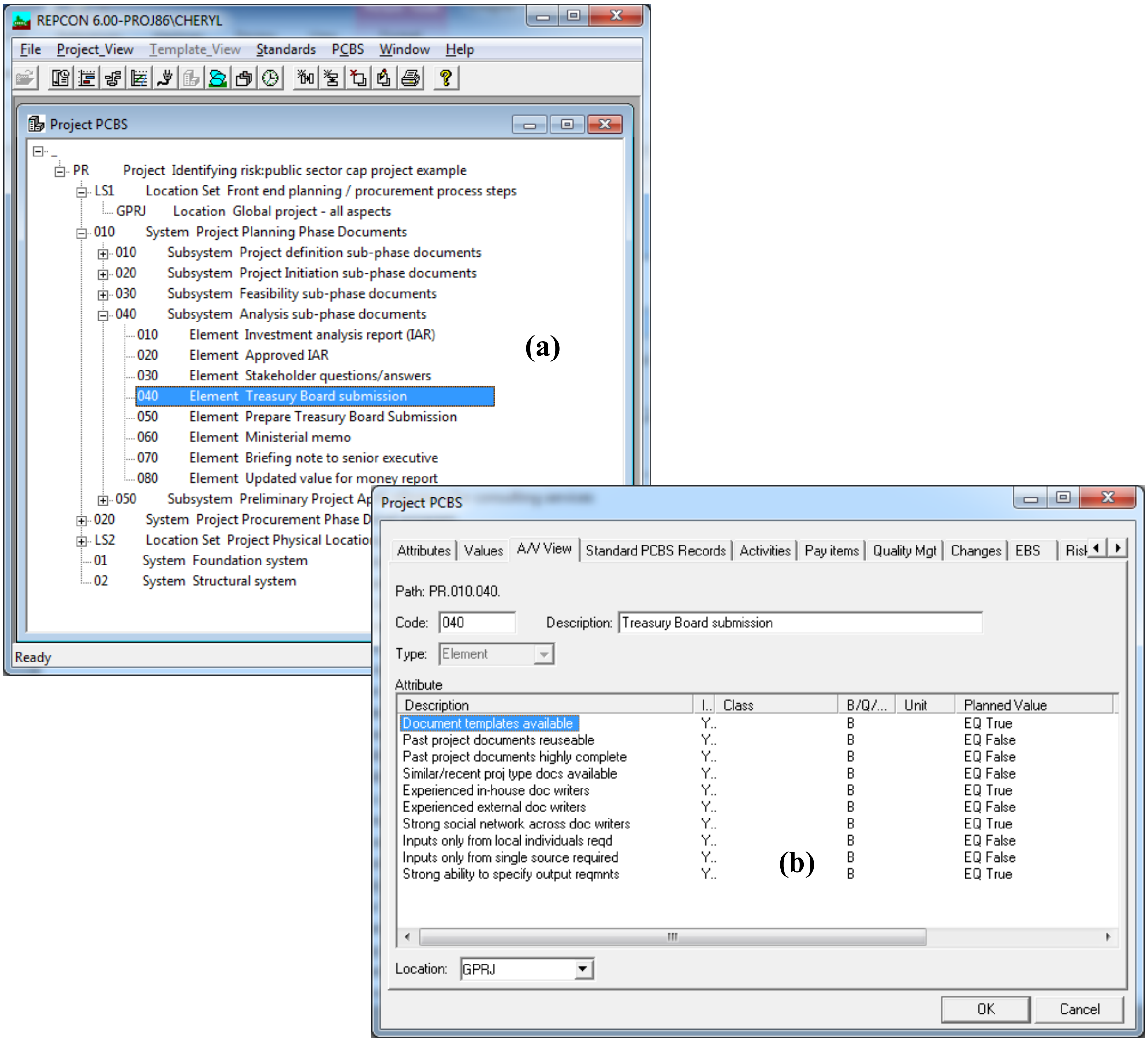
Figure 31: Partial project process view in form of an activity list. Depicted of interest is parent activity 01_40 and child activity 01_40_030



Code	Description	Type	Calendar	Responsibility Code	S
0001	Project start	Start Milestone	1 Normal Work Week	E001 Department Minister (Sponsor)	
01_10	Define statement of requirements	Ordered	1 Normal Work Week	T001 Public sector project team	
01_11	Statement of requirements approval	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_20	Prepare preliminary project plan	Ordered	1 Normal Work Week	T001 Public sector project team	
01_21	Preliminary project plan approval	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_30	Prepare feasibility analysis report	Ordered	1 Normal Work Week	T001 Public sector project team	
01_31	Feasibility studies complete	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_32	Site Acquisition	Ordered	1 Normal Work Week	T001 Public sector project team	
01-33	Site acquired	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_34	Prepare Functional Program (FP)	Ordered	1 Normal Work Week	T001 Public sector project team	
01_35	Signed approval to perform FP study	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_36	Posting of FP requirement for study consultant	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_37	Awarded FP studies consultant contract	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01-38	FP Investigations & reports complete	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_40	Prepare project analysis	Ordered	1 Normal Work Week	T001 Public sector project team	
010	Prepare investment analysis report (IAR)	Ordered	1 Normal Work Week	T001 Public sector project team	
020	Departmental review & endorsement of IAR	Ordered	1 Normal Work Week	T001 Public sector project team	
030	Prepare Treasury Board submission	Ordered	1 Normal Work Week	T001 Public sector project team	
040	Consult with Treasury Board Secretariat analysts	Ordered	1 Normal Work Week	T001 Public sector project team	
050	Consult with Department & Project Leaders	Ordered	1 Normal Work Week	T001 Public sector project team	
060	Finalize and translate Treasury Board submission	Ordered	1 Normal Work Week	T001 Public sector project team	
070	Circulate memo & signoff Treasury Board submission	Ordered	1 Normal Work Week	T001 Public sector project team	
080	Final submission to TBS re Prelim Proj Approvl_PPA	Ordered	1 Normal Work Week	T001 Public sector project team	
01_41	Receive approved IAR	Finish Milestone	1 Normal Work Week	T001 Public sector project team	
01_42	Site preparation & rezoning	Ordered	1 Normal Work Week	T001 Public sector project team	

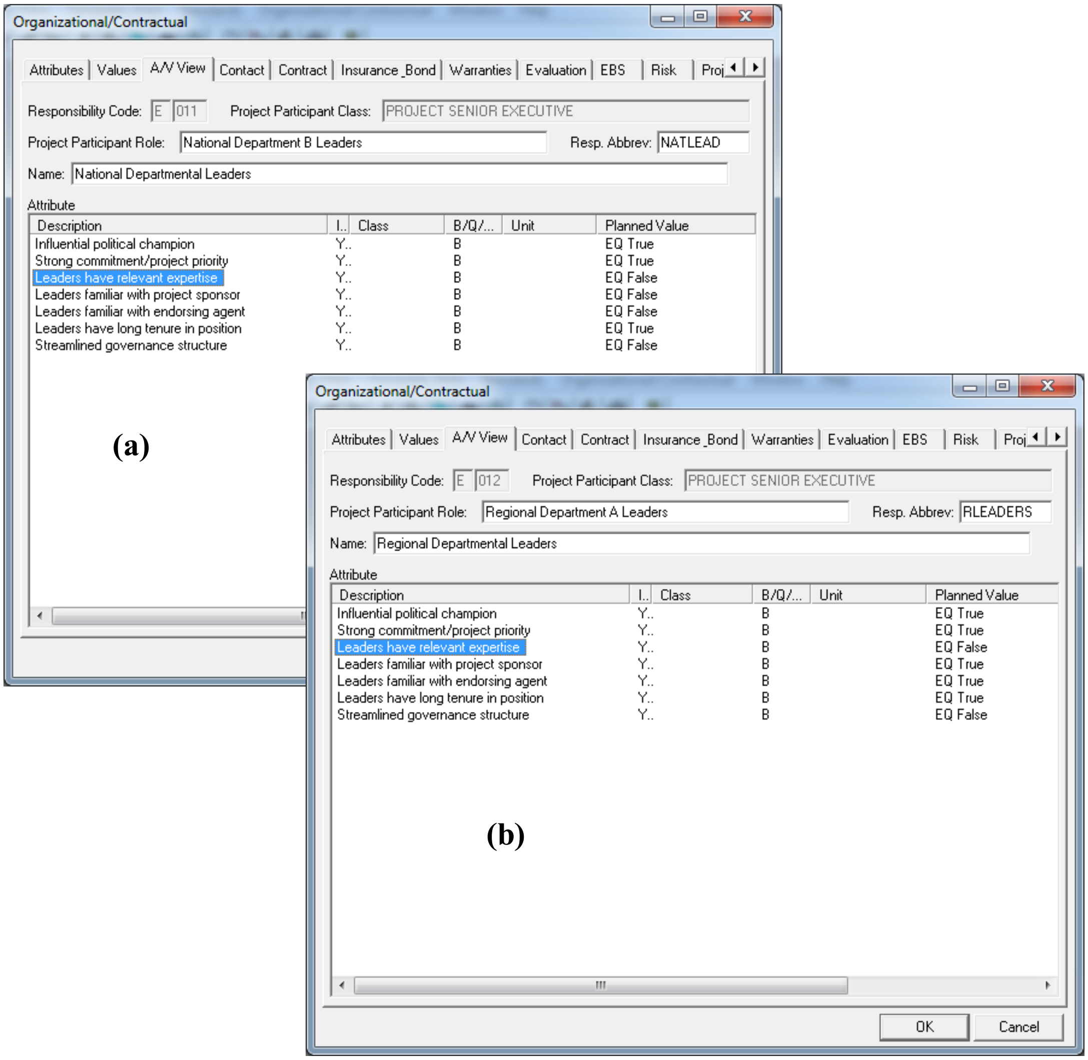
Illustrated in Figure 32 is part of the Physical View, with the focus being on the submission to Treasury Board. Documents are not unlike physical components of a project, in that they have attributes that could suggest potential risks. Attributes of interest along with an assessment of values are depicted in Figure 32(b). Both on a preliminary basis when establishing project context and then later when conducting a risk assessment, project personnel and/or risk workshop participants can assess the potential for risk drivers associated with the related documents produced and attributes assigned as per Figure 32(b). There is a number of attributes of documents for 'Treasury Board Submission' highlighted as 'False' which singly or in combination result in a risk driver. The 'False' value associated with the attributes 'past project documents re-usable', 'past project documents highly complete', and 'similar and recent project type documents available’ are of concern because there are no precedent and or similar examples to draw upon for format and content that have been vetted through the multiple stakeholders involved in the approval governance structure of a Treasury Board submission. In addition, although the attribute is noted as ‘True’ for ‘experienced internal writers’ this is not the case for the attribute ‘experienced external writers’, raising concerns about the ability of the project team to draw upon additional resource capacity external to the public entities internal writers. The complexity involved in the co-ordination and communication of documentation requirements across multiple stakeholders is illustrated by the attributes ‘inputs solely from local individuals required’, and ‘inputs solely from single source required’ both noted as ‘False’. Co-ordination of documentation input and review with multiple stakeholders across organizations including those either in regional or national offices poses a significant challenge and driver to the risk event.

Figure 32: Physical view including attributes of Treasury Board submission document



With respect to the Organizational/Contractual (Project Participant) view of the project, highlighted in Figure 33 are the attributes and associated values of two project participants (category members) ‘National Department B Leaders’ and ‘Regional Department A Leaders’ from the stakeholder class ‘Project Senior Executive’ actively involved in the development and submission of the Treasury Board submission. (As noted later, other project participants could also contribute to the Example 2 risk event.)

Figure 33: Attributes and values for key participants related to Example 2 risk event

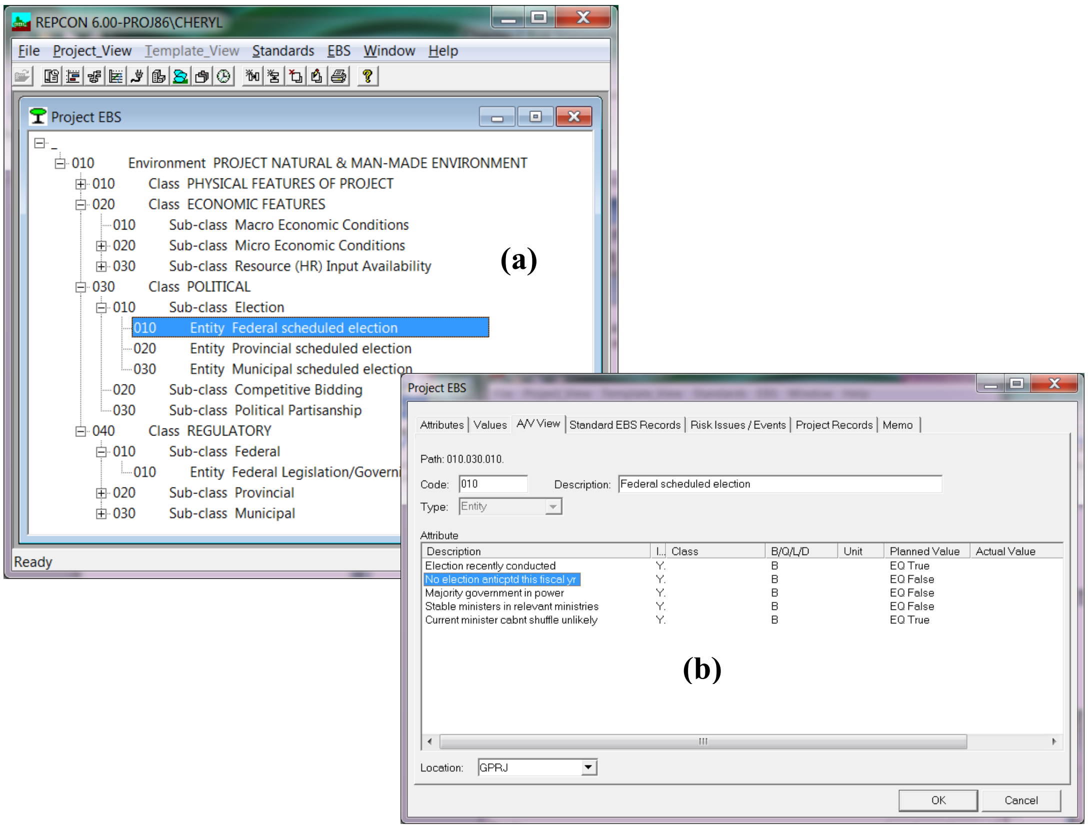


Of particular interest is that the attributes 'Leaders have relevant experience' and 'Streamlined governance structure' have been assessed as 'False' for both members. A 'False' value for both participants concurrently raises concerns in terms of the level of risk response required to appropriately communicate, train and respond to queries on the project objectives and delivery process (including associated timelines and market expectations) to ensure these members are informed and confident in their decision making. This is particularly the case where one senior project member may rely on their colleague for advice based on their precedent experience or the governance process their organization carried out. This lack of experience and/or governance structure can result in a risk event driver. Furthermore, project members in other stakeholder classes may also have these attributes with values assigned as 'False' further compounding the participants as a risk driver. The lack of a streamlined governance structure in this stakeholder class is of concern because key internal department stakeholders may not be consulted with appropriately and there may be limited clarity on the roles and responsibilities of project stakeholders. As a result, delayed accommodation of stakeholder communication and consultation requirements, their review and feedback potentially results in project re-work (such as work associated with re-scoping, project need confirmation and verification, etc.). Under-estimating the importance of appropriate stakeholder communication and consultation through poor processes, exclusion of necessary stakeholders (deliberate or not) can have major implications on successful project approval and ministerial acceptance and adversely affect relations across organizations, trust of individuals along with other 'soft' undesirable implications. Performance metrics such as time, cost and reputation are impacted and potentially the ultimate cancellation of the project.

With respect with other project participants potentially associated with the Example 2 risk event, relevant previous experience, and resource capacity are other attributes associated with stakeholder classes Project Team (Public) and Project Oversight Reviewers where if assigned a value of 'False' is of concern to project decision makers (see Figures 23(c), 24(f) and 24(g)). Lack of experience and capacity may both result in delays in document creation, clear communication and/or response to queries for accountable decision making. Lack of experience is of concern including the potential for errors and omissions in scope definition, the budget assigned is not sufficient to meet project requirements, funding is timed inappropriately, consultants hired do not have appropriate skill sets to define project requirements etc. In the case of Oversight Reviewers with the attribute 'Familiar with Project team personnel' assigned 'False' is of concern because this stakeholder may obstruct the approval process and distrust the findings and supporting documents of the submission under review.

Figure 34 highlights part of the environmental view along with attributes and values regarding prospects for a federal election or changes in cabinet Ministers as part of the class Political and sub-class Election, which help define aspects of the man-made environment that can impact a project. Federal election related attributes (e.g. election recently conducted, majority government in power) speak to the urgency with which submissions to Treasury Board need to be made if one wishes to avoid an extended delay. The other two attributes deal with the stability of the decision making authority for the Ministries involved – changes can be very detrimental to project time lines. For the case study at hand, the attributes 'Majority government in power', 'Stable ministers in relevant ministries', and 'No election anticipated this fiscal year' have each been assigned the value 'False'. Although the attribute 'Election recently conducted' has been assigned the value 'True' which signals that at least in theory another election is not forthcoming for a number of years, the other attributes in combination indicate that an election may occur. An upcoming federal election is of concern because decision makers within the public entities can adopt a 'wait and see' approach to the potentially new government priorities and delay any decision making with concern it would be reversed by the new government (of course, the opposite is also true). In addition, Ministers may change and require a new briefing process to be carried out and concurrence with the alignment of the project, organization and government wide objectives resulting in further delays to a scheduled submission and adverse implications on project performance measures.

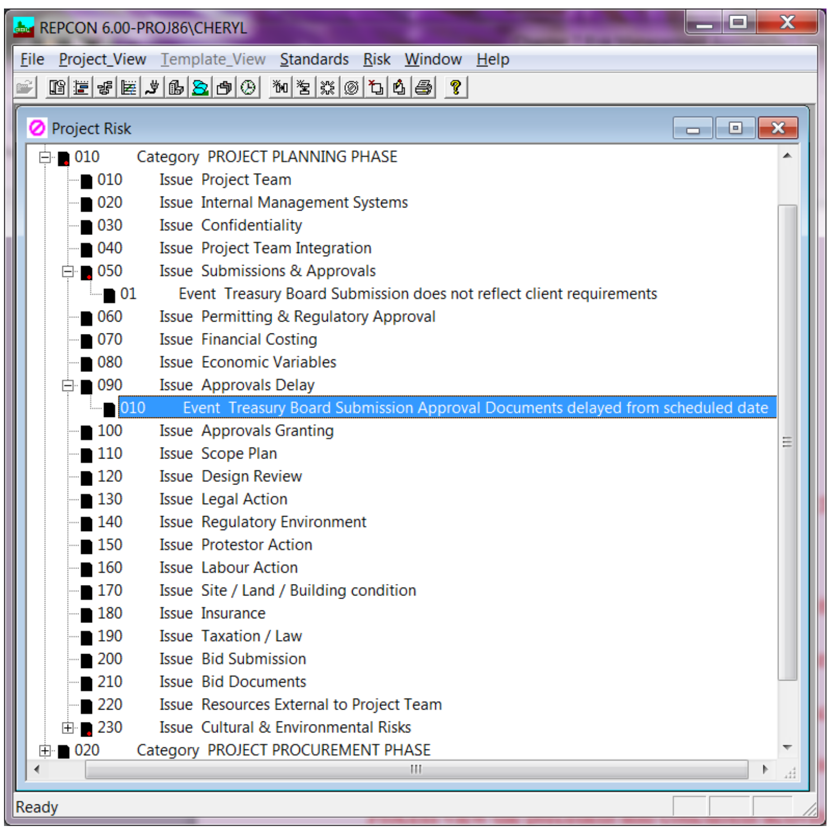
Figure 34: Political aspects of the project environment



With the project context represented, as described earlier in the chapter, development of the project risk register can proceed. The status of the risk register as shown in Figure 25 is amended version as shown in Figure 35. Focus is on Risk Issue *010_090 Approvals Delay* and Risk Event *010_090_010 Treasury Board Submission Approval Documents delayed from scheduled date.* This risk event has been identified as a possibility as part of the risk elicitation process when considering process activity 01_40_030 Prepare Treasury Board Submission or its parent 01_40 Prepare Project Analysis. As a note in passing, observe that in Figure 35 that there are two risk issues with attendant risk events, namely 010_050 Submission and Approvals, and 010_090

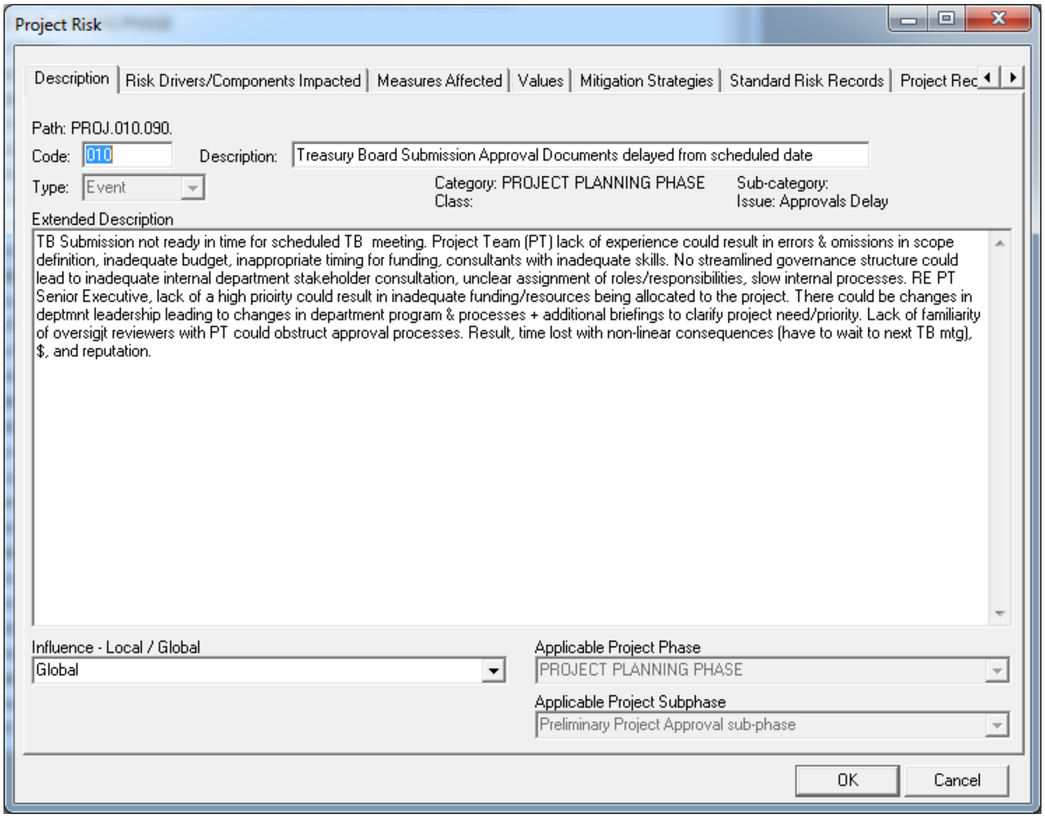
Approvals Delay. Good practice would dictate that these two Risk Issues could usefully be merged into one and simply labelled Submissions and Approvals. One should strive to avoid a proliferation of risk issues as well as risk events. As noted previously as being outside the scope of the thesis work, formulating risk categories needs to be done carefully in order to facilitate navigation of a risk register, and more importantly, to be able to generate insights into a project's risk profile. In practice, the tendency by risk workshop participants to proliferate risk categories or issues is strong, and needs to be resisted. The foregoing example is used to illustrate this point.

Figure 35: Amended risk register with attention directed at the risk issue/event 010_090_010



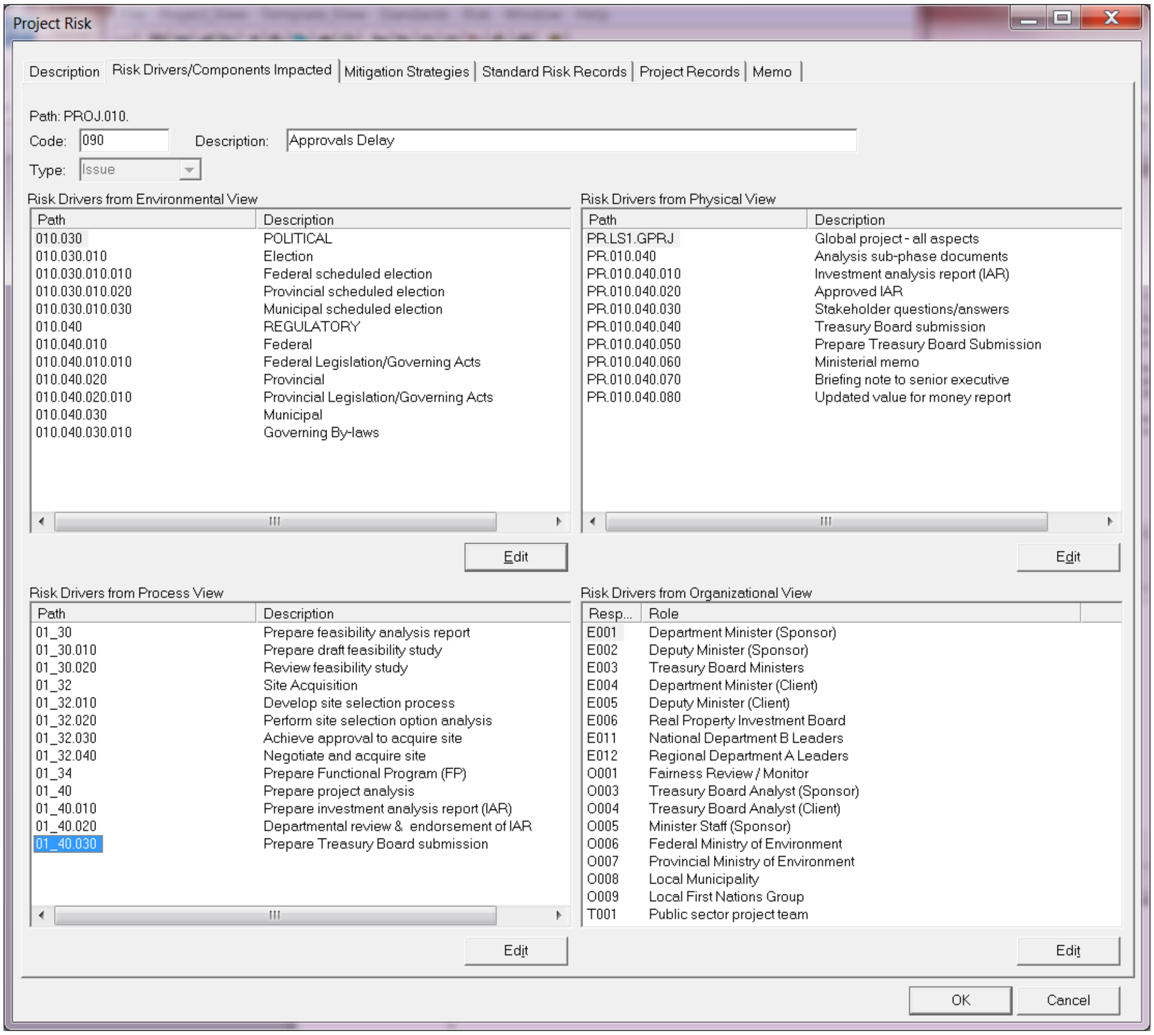
To facilitate communication amongst project personnel/workshop participants and to maintain a memory trace, in many cases it is useful to capture a reasonably detailed description of what is meant by a risk event description. This is done for the example risk as shown in Figure 36. An even more extended description can be captured in an open-ended Memo field featured as part of the prototype system. Important to note from Figure 36 is the characterization of the effect of the risk should it occur as being Global. What is implied by this characterization is that if a delay occurs, basically all future aspects of the project are affected. Documentation of the risk event not only serves a knowledge management function for future project re-use and reference to meet accountability requirements it also provides a memory trace for situations where personnel change or there is a transition of the project between teams. Documentation can also assist risk workshop participants come to agreement on the properties of the risk event. In fact, documenting the risk event and associated drivers explicitly and with a description in 'black and white' brings the necessary discipline to the project team to ensure assignment of responsibility for an appropriate response. Also important to note is the capacity of the research prototype to enable the Memo field in other project views to define an attribute and its associated value of a project component to ensure clarity of meaning amongst project participants and for future reference.

Figure 36: Definition of risk event along with extended description



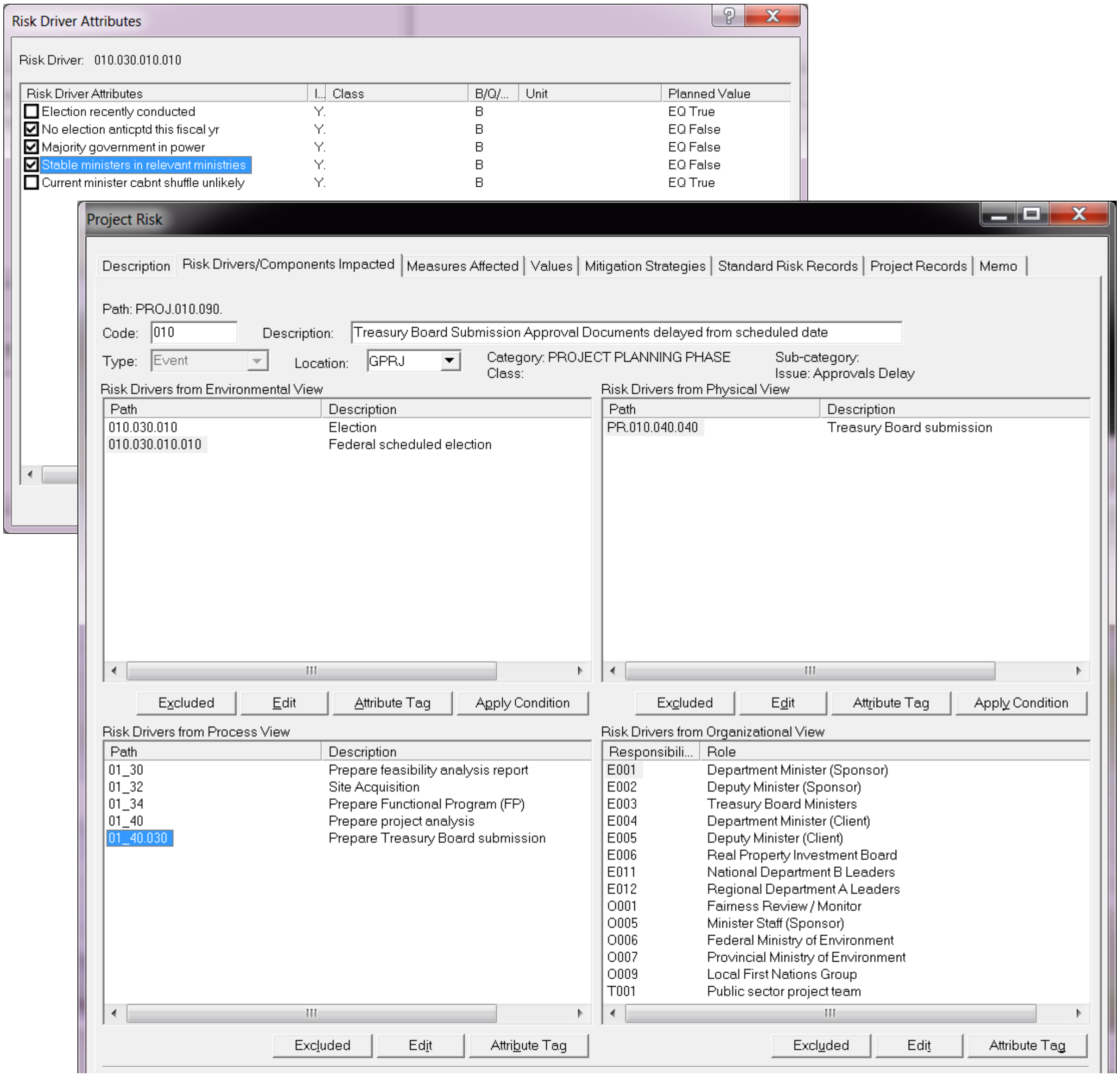
Shown in Figure 37 is an initial assessment of the likely drivers of risk under the risk issue of Approvals Delay (the items in each view can be amended as a more in-depth exploration of the project is made by project personnel/workshop participants). As shown, the number of items is quite extensive, especially in terms of the number of project participants that can influence approvals. Risk drivers include: in the Physical view the documents that serve as input into the Treasury Board submission approval documentation, in the process view the precedent and concurrent activities associated with the activity ‘Treasury Board Submission’, in the organizational view the participants involved in the development, consultation, review or approval of the documentation and finally in the environmental view the macro/micro environment such as the potential for a federal election.

Figure 37: Potential risk drivers for risk issue ‘Approvals Delay’



Finally, for the risk event itself, drawing from the list of risk drivers assembled under the risk issue, relevant drivers are as identified in Figure 38. As noted previously, items can be amended. Also shown, as an illustrative example is access to the attribute list for the environmental risk drivers 010.030.010.010 Federal scheduled election, which was a genuine cause for concern for the case study project. Access to such information that comes from preparatory work directed at describing project context in succinct form can be very useful during a risk identification/property elicitation session. The use of the ‘Stakeholder Management Framework’ and 'A Decision Process Support Approach for the Identification of Project Objectives and Improved Decision Making' support tools described in chapters 5 and 6 provide a structured 'how to' for practitioners to perform this necessary preparatory work including a description of the project context such as a list of pertinent project stakeholders and their objectives.

Figure 38: Drivers for risk event 'Treasury Board Submission Approval Documents Delayed from Scheduled Date'



7.7 Knowledge Management

Knowledge management concepts can also be exploited to assist with characterizing each project view given ever present time constraints and the level of effort required to develop a comprehensive representation of a project. A knowledge management feature, called the

Standards Side of the system (DeZoysa, 2006) was designed and implemented to assist users capture in a reusable form the experience of an organization and findings by others. While not shown, the ability exists to define an organizational / participant master template or list which has not been conducted by past researchers. The comprehensive list of stakeholders involved in public sector large infrastructure projects, outlined in chapter 5, serves as a master list in addition to the attributes and values defined for select stakeholder classes and members in this chapter. Although individual members of a class may not be known for a specific project, classes of participants that are common to all projects can be readily defined a priori along with relevant attributes for each class (and possibly default values), which in turn can be inherited down to the individual member level, either on the Standards Side if the type of member is known but not the specific firm identity – e.g. Architect, or on the project side when the template is copied over in whole or in part. Thus the user of the prototype can draw upon an organization's experience accumulated over previous projects and documented in standardized master lists, speeding the representation process for a new project, while reducing the potential for omissions. This feature is of particular use for consistency in the definition of attributes and associated values of risk drivers, risk categorization etc.

7.8 Next Steps and Future Research

The application of the risk management framework and the research prototype together on an actual project would provide further insight into how these tools improve practitioner risk identification and associated tasks under the time, resource and evolving project information project environment. As discussed, the risk management framework developed is intended to be iterative and particularly suited for the planning and procurement phases of project delivery. A review of this framework and application of the prototype in other project delivery phases would provide interesting research opportunities. Further work on how to treat attributes and associated values from other project views is recommended for future research. The series of tests applied to judge the relevance and usefulness of an attribute and its accompanying value (Section 7.5.2) can be asked of practitioner's in an actual project to provide further feedback and confirmation of applicability. Of particular interest would be to verify practitioner feedback (described in following Validation Chapter 8) that the prototype facilitates consistent and speedy responses while maintaining user flexibility in modelling the risk profile in an actual project. From a system design perspective, a goal to enhance usability is to provide as much assistance to users as possible. For the current implementation, users are required to identify project view components that are related to a risk issue class. Given values for the component attributes selected, a feature could be added to have the system automatically screen for relevance of a component by examining the attribute values assigned. If a component has no negative ('False') ratings for any of its attributes, then it could be eliminated from the list, thus helping the user to focus on the most likely source of risk events for the issue class under consideration. As described in Section 7.5.3, another goal to enhance usability of the prototype is to develop a feature to facilitate the comparison of attribute values across members within a stakeholder category as well as across categories to assist in identifying risk drivers shared across participants and interdependencies of risk drivers. A visual representation of shared attributes with 'False' value ratings would enable users to quickly and explicitly assess multiple contributors to a specific risk event and therefore improved the qualitative and/or quantitative performance assessment assigned.

7.9 Conclusions

Described in this Chapter are a systematic risk management framework and aspects of this framework incorporated in a project management research prototype to improve the tasks of risk identification and elicitation of expert opinion in large infrastructure project delivery. The three step process framework provides guidance on how one may perform risk identification and elicitation of expert opinion tasks in consideration of the time and resource (financial and human) constraints, constant evolving organizational and project information environment and the public sector governance requirements realized by practitioners of large infrastructure public sector projects. The framework has been developed and discussed relative to its application in the project planning and procurement phases of large infrastructure public sector projects although it is applicable in its current form for implementation in other project phases. Adaptations to suit the nuances of the project delivery phase and organizational requirements in an actual project could be assessed in future research. The framework refers to the support tools, introduced in Chapters 5 and 6, to aid practitioners define and model the project context and a structured process to perform the tasks associated with an explicit and comprehensive identification of project risks and elicitation of expert opinion.

Thoughtful definition of the components and associated attributes used to represent the various views of a project can provide valuable insights to Project Managers and improve the overall risk management process. The concept of project component characterization was introduced and attributes for seven key stakeholder categories involved in the delivery of public sector large infrastructure projects were developed based on a thorough literature review, experience, and feedback from senior industry practitioners. The ability to model and characterize project components and their attributes in the four project views enables the user to link risk entities to the associated component and determine the temporal and spatial distribution of risks, therefore, improving the identification of risks and associated properties.

Following the description of the risk management framework and concept of project component characterization, use is made of two examples of key risks of a public sector large infrastructure case study to highlight features of the research prototype, the research concepts discussed and the significant stakeholder contribution to a project's risk profile. The first example involved the consideration of an environmental feature on the case study site in the planning phases of the project (site acquisition planning). This example illustrated how the user of the prototype could determine the impact of values associated with an environmental features attribute on site preparation and construction activity options together with the attribute value of the key project stakeholder responsible for the project delivery. The second example involved a key risk associated with delay in receiving project funding approval a common and often realized risk on large public sector infrastructure projects. This example highlighted how stakeholders can be a significant source of risk and that the explicit identification of their characteristics in combination with the definition of attributes of key components from other the physical (project documentation) and environmental view (political aspects of the project) improved the identification of this risk event and associated properties.

The two risk examples highlight a number of benefits of the prototype and research concepts to improved risk identification and elicitation of associated properties. Primary benefits include: (a) the development of a shared image of the project context amongst those charged with developing the project's risk profile from the perspective of a particular participant; (b) a direct linkage between project context and risk profile; and (c) the ability to document the linkage in the form of risk drivers. Large infrastructure public sector project delivery is complex and includes navigating the requirements of the multiple stakeholders involved in consultation, oversight, review, and approval in addition to meeting the technical requirements (design, engineering, construction, etc.) of the project.

The thesis clearly highlights the multi-stakeholder environment involved in public sector projects and the associated risk in orchestrating these stakeholders, with varying capacities and abilities, to deliver to necessary timelines and requirements. Few, if any, project stakeholders have a complete understanding of the project context due to the scope and complexity of these large infrastructure projects. The prototype allows for the modelling of project context simultaneously helping with risk workshop participants thought processes and with a shared vision of the project context to discuss issues, pertinent project risks and associated properties. Risk events are therefore not viewed in isolation but as events that may be interrelated. The prototype also provides a memory trace of the thought process leading to identification of a risk event and associated values assigned. Too often the hand off between those identifying and valuing risks and determining risk allocation strategy and those responsible for managing the project is less than perfect, creating difficulties for accountable and effective project management. Senior decision makers require a structured approach to record keeping and project decision making to meet corporate governance and accountability requirements, which the framework and prototype offer. Other benefits of the prototype include access to and easy use of past experience for knowledge management and improved management of future projects.

The framework and research prototype contribute in filling the gap identified by practitioners regarding the lack of tools and support aids for the risk identification and elicitation of expert opinion tasks. The ability to model and characterize project components and their attributes in the four project views enables a more fulsome assessment of project risk and associated properties. Finally, the knowledge management capacity of the prototype is of direct use in assisting stakeholders to meet accountability and governance requirements while also assisting in the documentation of project information for project personnel or transitions of project teams across project delivery phases.

Chapter 8: **Validation**

This thesis aims at developing a risk management framework and associated tools to improve the risk identification and the elicitation of expert opinion of risk properties in large infrastructure public sector projects in the project planning and procurement phases. The previous chapter introduced the research prototype in a real world case study as an example of the application of research concepts. This chapter examines the perspective of potential users of the research prototype and research concepts introduced in this thesis and their view on the application of the research prototype to improve risk identification and elicitation of risk properties. Potential users interviewed are public and private sector senior executive (Chief Executive Officer, Partner, Director General, etc.) active within the field of large infrastructure project delivery in Canada and responsible for overseeing, delivering or providing advisory services on multi-million dollar projects and/or programs. A series of research test questions (introduced in Chapter 1) to assess the quality of the research prototype and concepts were asked of these senior executives and relate to generality, integrative, transparency and their newness or value add. Interviews with these senior executives provide additional insights and validation of the research contributions. Noted are the executive's responses to how the research tests are satisfied and the concepts and prototype are workable for application in meeting industry challenges in performing risk identification and elicitation of expert opinion. The views of experts outlined herein do not touch upon their perspective of stakeholder attributes addressed in Chapter 7; however, during these interviews stakeholder attributes were discussed and concurrence with the final attributes identified in Table 20 (Chapter 7) was performed.

8.1 **Research Test Questions**

A series of tests, expressed as questions, have been developed to apply to the research prototype and concepts developed through this research in order to test the fit with shortcomings of current industry approaches and the unique characteristics and requirements of the industry. These industry characteristics have been described in Chapter 2 and requirements of a risk management support tool have been described in Chapter 3 including identification of stakeholders and their requirements, tracking project information changes, knowledge management capabilities, consensus across project participants of project context, and a flexible structure to accommodate terminology and information needs for project participants across disciplines and experience. The attributes of the research tests for assessing whether the prototype addresses the identified weaknesses of current state of the art risk management aids are defined as generality, integrative, transparent and new. The research test attributes, questions and their metrics used in the validation exercise are outlined below.

8.1.1 Generality

The approach can be considered general if it has the ability to be applied across a variety of problem scenarios such as across a range of project types and project delivery mechanisms.

Questions:

- Do you see opportunity to apply this tool on your projects and across a variety of project types (Real Property, IT, other)?

Metrics:

- Subjective rating by experts about the ‘generality of the approach’
- Number of project types that can apply the approach with respect to project size, delivery approach, and types.

8.1.2 Integrative

The approach can be considered integrative if it has the ability to foster the integration of data currently available to project personnel into the approach and data entry fields are unambiguous to individuals across disciplines.

Questions:

- Are the data fields comprehensive to meet your needs?
- Do you feel that you can input available project data into the system?

Metrics:

- Subjective assessment by the experts about the usability of data fields for integration of current information available.

8.1.3 Transparent

The approach can be considered transparent if the approach fits with processes and practices performed by practitioners including the ability to accommodate multiple linguistic styles, values and means of expression by individuals across disciplines.

Questions:

- Do you feel users across disciplines would be able to use the system?

Metrics:

- Subjective rating of experts about the 'fit for purpose' of the approach for practitioners across disciplines.

8.1.4 New

The approach can be considered new if it is assessed as adding value such as providing insights not readily available from current practice.

Questions:

- Does the approach offer value relative to current practice?

Metrics:

- Subjective rating of the experts on the 'value' and 'newness' of the approach;
- Number of tasks or process steps assisted by the experts that are not explicitly carried out in current practice.

8.2 Validation Approach

The research prototype and concepts introduced were tested with senior industry executives involved with large infrastructure project delivery, to determine whether predefined research test attributes were met. All experts interviewed had both broad and significant experience in the delivery and/or oversight of large infrastructure projects and programs. Predominately, the experience of these experts was in the planning and delivery of social infrastructure including public office buildings, high security facilities and hospitals. Selection of senior executive interviewees was based on their extensive experience delivering Canadian PPP projects in all phases involving the public entities and their reputation in the Canadian construction industry as 'subject matter experts' or 'thought leaders' in their field. Each expert interviewed is frequently invited to speak at national and international conferences on the subject of PPP and infrastructure program delivery and occupy senior executive positions within their organizations (e.g. Chief Executive Officer, Partner, Director General, etc.). Each of these senior executives was approached and asked to be interviewed or to nominate a member of senior management to participate in the research validation exercise. In each case, the senior executives wished to participate based on their interest in the research topic. To gather a representative view of the public sector, senior executives from three levels of the Canadian government (Municipal, Provincial and Federal) and those with experience working for or within other public institutions (Universities, public agencies, etc.) were interviewed. In addition, private sector PPP consortium contractors were interviewed whose firms represent a substantial portion of the Canadian PPP contractors and also interviewed were executives from global management consulting firms who advise both private and public sector entities on large infrastructure delivery and facilitate project risk management to meet governance requirements. Although the research is focused on improving risk identification and elicitation of risk properties in the planning and procurement phases of large infrastructure public sector projects, the perspectives of both public and private sector project participants were sought because each are stakeholders in achieving project success and have inherent interests in implementing quality risk management processes and contribution to a 'successful' project.

8.2.1 Interviews with Expert Practitioners

Senior executives responsible for project delivery, management and/or oversight are difficult to access due to the time demands imposed by their organizations and the projects they oversee. Their insight, however, is particularly useful in bridging the gap on identified needs to improve risk management practices and commenting on the practicality of approaches and concepts introduced through academic research.

Interviews with 16 experts representing Canadian organizations across Canada (11 public and 5 private sector senior executives) involved in the delivery of large infrastructure projects were conducted. Table 1 shows the profile of each of the experts engaged in the validation exercise. Interviewee depth and years of experience in infrastructure delivery is significant; each of the public sector executives interviewed have 15+ years of experience (majority 20+ years) while private sector executives each have 10+ years of experience (majority 15+ years). The interviews were carried out applying a semi-structured interview process, facilitated by either a soft or hard copy presentation. The presentation included slides that illustrate the complexity of large infrastructure PPP delivery, the research hypotheses, the risk management research prototype and concepts introduced, the application of the research prototype on a case study project and description of key features of characterizing project elements with specific emphasis on the stakeholder view. Each interview lasted between one and two hours.

Table 28 Senior executive profile involved in validation exercise

Expert	Position in the Organization	Infrastructure Project or Program Level Experience
Public Sector Expert Interviews		
A	Director General (Federal)	Senior executive responsible for the oversight of the design, build, and operation of a $7b infrastructure portfolio across Canada applying a range of project delivery mechanisms and reporting to the Assistant Deputy Minister of one of the largest Canadian federal ministries.
B	Project Director (Federal)	Senior executive with significant experience in the management of major federal office and special purpose facility projects ($200m+) including the planning, delivery and major retrofit.
C (Group)	Department National Experts (Federal) • Policy Director, • Program Director, • Project Director • Director of Project Management Centre of Expertise • Strategic Performance Reporting	Senior executives responsible for the planning, delivery, oversight, performance reporting and policy development of a $2.5b real property program for one of the largest Canadian federal departments.
D	City Manager (Municipal)	Seasoned expert in both municipal and provincial levels of Canadian government including responsibility for the oversight of PPP projects in excess of $500m and major provincial and municipal infrastructure programs.
E	Chief Executive Officer (CEO) (Public Institution)	Senior executive responsible for leading the development, construction and marketing of residential and institutional buildings for a large public academic institution. Land development and infrastructure construction and management experience for both public and private sector entities.
F	Chief Executive Officer (CEO) (Provincial Agency)	Senior executive with expertise managing the delivery of major international and national transportation projects and oversight of the delivery of public capital assets and PPP projects to municipal, provincial and federal public sector clients.
G	Regional Director General (Federal)	Senior executive responsible for the oversight of project and program delivery

Expert	Position in the Organization	Infrastructure Project or Program Level Experience
		within one of four regions of a $7b real property and procurement program and reporting to the Assistant Deputy Minister of one of the largest Canadian federal departments.
Private Sector Expert Interviews		
H	Managing Director (International Construction Firm)	Senior expert responsible for the financing and planning of PPP projects internationally and in Canada (typically >$500m) for one of the largest global construction firms.
I	Partner (Global Management Consulting Firm A)	Partner of infrastructure financing and project delivery services for a global management consulting firm with expertise in both transportation and social infrastructure project planning and delivery providing advisory services to public and private sector parties.
J	Associate Partner (Global Management Consulting Firm B)	Associate Partner of infrastructure financing and delivery for a global management consulting firm and experience in over 20 PPP projects across sectors and regional head of PPP advisory services. Significant experience advising both public and private sector on the structuring of PPP deals.
K	Director (Global Management Consulting Firm C)	Senior executive with experience in the planning and delivery of large social infrastructure projects for both public institutions and private sector contractors involved in PPP delivery and delivering advisory services to both public and private sector entities.
L	Managing Director (Global Infrastructure Equity Investment Firm)	Senior executive and Canadian lead of PPP projects representing one of the largest international firms delivering PPP and large infrastructure projects. Experience in leading PPP consortiums for large infrastructure projects in Canada and internationally.

To prepare for the interviews, I met with an industry expert in the field of PPP delivery and requested his feedback on the validation presentation. This step was carried out to ensure I made best use of each of the expert's time in the interviews. This individual has over 30 years of experience providing advisory services on large infrastructure project delivery to both the public and private sector entities. The individual was asked to review the presentation to ensure clarity of concepts and provide feedback such that the presentation could be refined to improve the quality of interaction with the experts and best use of their time as follow up interviews would be difficult to arrange.

Interviews were conducted over the months of August 2011 and June 2012 at meeting locations suggested by the respective expert. One–on-one interviews were conducted with eleven of the experts in addition to a group interview with five experts from one Federal department. The group interview provided a unique opportunity to receive feedback on the research prototype and concepts through an interactive interview with all individuals responsible for the planning, management, best practice development and performance reporting for a federal department infrastructure program. The group interview included experts responsible for one of the largest federal departments national real property major capital project delivery, policy, program, performance reporting, and center of expertise on project management. Experts interviewed in both the group and one-on-one sessions were presented research findings and they were requested to provide feedback on the research prototype, concepts, practical use and application from their experience and responses to the research test questions. In addition, experts were asked to provide feedback on additional factors that could also be included in the approach.

8.3 Validation Results

The comments on the research prototype and concepts in addition to each senior executives response to the research test questions include:

Expert A – Director General (Federal)

Comments on the Concepts

Expert A highlighted that the integrated representation of profiled project context could substantially improve the processes of risk identification and elicitation of expert opinion. The approach was noted to have the potential to help uncover issues not thought of before and facilitate discussion of the ‘elephant in the room’. Expert A emphasized the following:

> *With the information upfront in black and white, it helps reveal insecurities, it forces the project team to face up to weaknesses…there is no running when you put the information up on the board and it is in black and white.*

Other benefits noted included the prototype facilitated the compilation of project information in a more organized format than standard approaches (such as spreadsheets and word documents) and forced participants to pre-populate the prototype with project information and therefore arrive at risk workshops better prepared for meaningful discussions. Expert A also noted the value of characterizing stakeholders and their explicit treatment in the approach. Expert A discussed recent experiences participating in the risk workshops of a major capital real property procurement (Capital Build >$100m) in which the predominant risk events identified were risks driven by third party stakeholders impacting qualitative project objectives such as those related to reputation and communications. Although third party stakeholders drove these risks, there was a general reluctance by workshop participants to discuss detailed management approaches to address the concerns and interests of these stakeholders. The impact of these risks on Project objectives would require the involvement of senior bureaucrats and political officials and were therefore deemed highly undesirable. Expert A suggested that the research approach presented could potentially improve the response to these stakeholder risk issues because the approach served to structure information in an organized format, treated stakeholders explicitly and provided a platform to view the full project context to improve discussions amongst risk workshop participants.

Concerns raised about the prototype included the potential to get into too much detail and the tradeoff of time to value for information modeled. In addition, Expert A suggested the expectation for specific training on both the use of the research prototype and the facilitation of risk workshops using the approach would assist industry users.

Research Test Questions

In response the research test questions the following points were made:

- The modeling of project context was identified as a collaborative method to arrive at consensus opinion, which would be beneficial to project delivery.
- An opportunity to apply the both the prototype and approach to other sectors outside of the infrastructure sector was noted, although no specific examples were provided.
- The expandability and comprehensive features of the different views and representative models in the prototype was identified as beneficial and would meet all requirements for data availability/input requirements. Concerns were expressed about participants getting into too much detail and the need for appropriate training.
- The approach was applauded for the identification and posting of information in 'black and white' facilitating the clarification of project issues and putting these issues directly on the table for discussion.
- The approach and the treatment of stakeholders was identified as new and an improvement to current practices.

Expert B – Project Director (Federal)

Comments on the Concepts

Expert B noted that individuals don't tend to consider the project context when they identify risks in a project and therefore the expert considered the approach to model project context a 'very comprehensive way of doing things'. Overall, the approach was noted to improve communication and identification of non-technical risks otherwise not identified explicitly in practice. Through the expert's experience, risk identification workshops involving the participation of multi-disciplinary project team members were highlighted as the best approach to identify a comprehensive list of risk events. Expert B noted the benefit of the research prototype and modeling project context in facilitating these workshops and reporting to clients in the following comment:

> *If you are given something to react to, the process will be much better, this tool could also help in the communication process with the client because it documents where the risks are and how they are intended to be managed.*

Predominant benefits of the approach highlighted by the expert centered on improved communication amongst project stakeholders across disciplines and ability to document and report on findings.

Concerns raised included the anticipation that special expertise would be required to input the information into the tool and there would be a need for training on gathering and inputting information. Specifically, Expert B asked what questions could be asked to get participants to disclose risk events and after they have been identified how these risks are managed both when they are realized and when they disappear.

Research Test Questions

In response to the research test questions the following points were made:

- The approach illustrates more information than standard spreadsheets applied in industry and the opportunity to include information in an iterative fashion was found to be both new and of value.
- The structured treatment of stakeholders was identified as 'new' relative to industry practice and that 'stakeholders are all the risk, when we are at the table, it is good to know why, most times it is more important than the technical risks but we often do not consider this specifically'.
- The approach could be used to improve the facilitation of risk workshops involving individuals across disciplines and the different project views were seen as comprehensive to accommodate the input requirements of individuals across disciplines. The integration of project cash flows into the approach was suggested.

Expert Group C – Department National Experts (Group Interview, Federal)

Comments on the Concepts

The group interview allowed for questions during the presentation as well as after over a two hour interview period. One expert highlighted the standard processes to risk identification and elicitation of risk values is performed intuitively and there is a lack of tools or approaches that are structured to assist. This expert identified that there were inherent benefits of the approach and breaking down the project into the different views (environment, organizational, process, product, and risk) and termed these different views 'nice buckets'. The 'buckets' were deemed to be particularly helpful to assist the identification of a holistic set of risk issues and conduct necessary related risk management tasks such as risk mitigation and assignment of project team members roles and responsibilities. This expert also noted that the modeling of project context and characterizing different project components forces the individuals responsible for managing a project to go through a structured process with rigor that results in an output (i.e. the research prototype facilitates processes required to meet internal accountability requirements). Another advantage identified by this expert and concurred with by the others was that the approach facilitates the visualization of all the project information into one picture. This unified picture was discussed by the group as much better than reviewing individual pieces and visualization of this information in an IT environment was seen as preferable to reviewing information on multiple pieces of paper and outputs of spreadsheets. Spreadsheets are typically used by these experts as the tool to document risk issues, however, these spreadsheets were not seen to facilitate the integration of different views allowing the user to see more risk events than without the multiple views.

Each of the experts said the inclusion of a stakeholder view was important for the appropriate management of risk in a project. In a recent department project the experts noted that a stakeholder group was the source of considerable time delays and cost overruns on the project yet stakeholders had not been identified or considered as a source of risk. They indicated if they had used the research prototype and characterized stakeholders they may have identified the risks driven by stakeholders and project implementation personnel would have been better prepared. One expert noted:

> *For our organization, there are other things that we must consider, it may be hard in weighting, but strength is in awareness, and attributes identified forces you to think.*

Many projects go off the rails because of the soft issues – stakeholder issues. It is very important to understand the major political, social and natural context of the project.

One expert also noted the value of project knowledge management. This expert highlighted that the stakeholder group that drove the risk in the project identified would probably not be considered in future projects because there are limited existing tools available, project participants change and move across departments and/or projects, resulting in a loss of corporate memory and experience. The expert noted that if this stakeholder group was characterized once and included in a template, then future project leaders may be aware and identify stakeholder related risk events. This Department portfolio consists of approximately 2500 real property and IT assets valued at over $2.5b. Although some projects delivered may be classified as large infrastructure with capital costs exceeding $100m, the majority of projects are real property projects that are <5000m^2 and capital costs less than $10m. The group therefore commented on the benefit of the approach and opportunity, yet potential challenge, to scale down the approach for smaller sized projects.

Concerns expressed related to the skill set required to collect and input information in the approach.

Research Test Questions

In response the research test questions the following points were made:

- The approach was identified as new, useful and applicable to responding to the project and program management challenges experienced in the Department. The approach was seen to create a deliverable and force a process, dialogue, and identification of issues that would otherwise get buried and not be considered.
- The project views or 'buckets' were seen as comprehensive in meeting the data input requirements of the organization for a risk management process.

- The experts identified strong interest to test the integration of data captured by the Department's current information and financial management systems and link this information into the approach presented.
- Opportunities were identified to link the outputs of the approach with organization and enterprise performance management.
- The group of experts identified that the application of the approach could be broadened to assist with the management of the full portfolio of project and other Departmental Programs outside of real property program management. Specifically, the group suggested interest and viability of the approach on large communication and IT projects that were run out of the Chief Information Officers Office.
- Suggestions were also made that the approach could be tailored for application on a program of smaller capital real property projects.

Expert D – City Manager (Municipal)

Comments on the Concepts

Expert D highlighted that there is a need to consider the 'strategic risks', which may occur in each of the views (process, environment, physical and participant). The expert discussed that although 80-90% of risk events are technical in nature, the remaining 10-20% are the strategic risks, which can make or break a project. The approach was seen to facilitate the review and consideration of these strategic risks that are typically not identified. Further, the expert discussed the scenario of planning and implementing a large health project delivered through a PPP and the impact of stakeholders on its delivery. The expert highlighted that there is a risk that the health unions adversely react to the project based on the project sponsor's selection of the delivery mechanism with higher private sector involvement in the operations and maintenance phases of delivery over more traditional project delivery approaches. The expert noted:

> *If you have a large PPP project, there is a risk that the unions adversely react to the project. The union can constitute 100,000 individuals in the Province. If the election is*

close, the Minister or Deputy Minister may slow the project, until after the election due to concern about the risks that are driven by this particular stakeholder group.

Expert D was clear that stakeholders may be the source of risk events with considerable impacts on the successful delivery of a project. Although emphasis and consideration of stakeholders with respect to the risk management process was considered critical, rarely are stakeholders explicitly identified in the risk management process. The ability to consider and address the interests of stakeholders using the structured characterization approach and research prototype was seen as beneficial and new.

Research Test Questions

In response the research test questions the following points were made:

- Expert D said that in performing the quantitative risk management exercise one wants to ensure that the quantum is based on a sound methodology. The research approach was highlighted as being such a methodology. Further, it was felt that senior executive decision makers (bureaucrats and politicians) whose project team utilized this structured approach to substantiate recommendations would feel confident in approving these recommendations. The approach was therefore seen to have the potential for broad applications in portfolio and program management in addition to project management.
- The approach was seen to improve the ability for the user to visualize the accruing of risks.
- The opportunity to visualize the stakeholder attributes was identified as new, helpful and useful.

Expert E – Chief Executive Officer, Public Institution

Comments on the Concepts

Expert E discussed two key risk issues that his institution are most concerned with and which he noted do not tend to be managed well in the industry. The first risk issue included the inadequate budget allocation for facility and preventative maintenance by decision makers who did not see much value in the allocation of funds to perform this function relative to the expert advice given in his agency. The second risk issue highlighted included the influence of external stakeholders such as users and the general public who make use of social media and/or media outlets to manipulate the communication messages about the project to others (whether or not these messages were 'true' or 'fictional'). We discussed how different decision makers have different value systems and the challenge in communicating differences in the risk exercise. One fact noted was the importance of considering consequences of risks using metrics other than dollars including 'reputation' as per what is outlined in Chapter 6 in understanding decision maker objectives.

Research Test Questions

In response the research test questions the following points were made:

- Expert E highlighted he would embrace the new technology and the approach but would want to ensure in some way that users were not just 'checking the box' for the sake of performing the exercise for transparency or accountability requirements. Expert E suggested users must clearly understand the consequences of a poorly performed approach and how information modeled and outcomes identified could help reveal project 'problems' that required addressing. The users were therefore recommended to be trained why performing the exercise is important. In addition, Expert E suggested that a different person prepare the model of the project context than the individual who facilitates a risk session using the approach. The separation of individuals preparing versus performing ensures individuals with different competencies and values are involved and information presented is not manipulated to bias others.
- The approach is 'absolutely a new and novel approach in particular the focus and consideration of characterizing stakeholders'. Although Expert E identified great potential value in the approach and prototype he noted 'it is all in how it is used, but it

could very well be coupled with a decision making tool to improve the identification of the big issues to concentrate on'.

- Expert E noted that the approach could be applied across project types and recommended an organization best learn to use the approach on small, simple projects and then consider its application on the larger more complex projects.
- Expert E felt that the information categories presented were 'too comprehensive' although noted that at first one would need a comprehensive list of data fields which could then be reduced as applicable to the project context.
- Individuals across disciplines could use the approach; however, it was noted that individuals need to be able to quickly assess information to identify risk issues and noted that individuals needed to somehow be driven to be responsible for the output such that errors of omissions were less than that of commission which was identified as coming with experience.

Expert F – Chief Executive Officer (Provincial Agency)

Comments on the Concepts

Expert F has both experience in managing the implementation of large infrastructure projects in both the public and private sector at a senior level. Overall, Expert F found that the approach was fulsome and more detailed than that which was carried out in practice. There was concern that the level of information modeled and the number of risks identified may be too much for users to manage and that they may be overwhelmed. An example was provided where in a project the expert found that a project team member used a simplified schedule that highlighted the 'map of the world' with respect to the project key milestones versus the detailed schedule created through a commercial scheduling program that was an itemized list of multiple activities on a number of pages.

Attributes identified as critical to a risk management approach were that it was user friendly, outputs could be used for multiple stages of the project and assist with the identification and management of the ‘big’ risks versus the numerous small events ‘fluff’ which are often repetitive and duplicative.

Research Test Questions

In response to the research test questions, the following points were made:

- The identification and treatment of stakeholders in the risk management process was considered relatively new to industry practice where project leaders often create a communication plan as an activity for stakeholder management but these individuals are often ‘not thinking about the strategic stakeholder management aspects’.
- The identification of stakeholders would assist in the early management of select risks and may help project leaders identify a person or group otherwise not considered along with attributes of interest, and serve as an early warning system or constant reminder to improve management.
- The consideration of project context was considered to be implemented in practice in a more simplified manner by industry professionals where they quantify risks through scenario analysis. Although this approach is typically performed in a more simplified, ad hoc fashion through expert experience, it was found to be sufficient if performed thoughtfully and with experienced personnel.

Expert G – Regional Director General (Federal)

Comments on the Concepts

Expert G highlighted that the approach and tool responded to the question of ‘how does one foster prudent risk management in an organization and apply it across project funding levels’. Expert G noted the modeling of project context, in particular characterizing stakeholders, was a significant improvement over current practice and highlighted that he ‘would like to see this as a de-facto tool and approach for risk management in my organization’ in particular the opportunity for improving the management of stakeholders. Discussion with Expert G focused on his interest in how the approach could assist in stakeholder mapping in a project. Expert G identified stakeholders as a primary source of a number of risk events in public infrastructure projects and the explicit characterization of stakeholders was applauded as a necessary approach that could help identify potential 'political' risk events such as 'stakeholders impeding project approvals' or 'changes in government'. Expert G was asked whether characterizing stakeholders would be a concern for project leaders to carry out given the potential for project documents to be accessed via freedom of information disclosure legislation and Expert G responded that this should not be a concern of project leaders because by not performing this exercise one would not be prepared, mitigation approaches may not be identified and stakeholder interests would not be served.

Research Test Questions

In response to the research test questions, the following points were made:

- The extensive thought to improve the risk identification process and characterization of stakeholders was identified as extremely helpful to project leaders. It was noted that it would assist project leaders and senior management to 'zero in' on project issues that require the most attention over the different phases of project delivery and approval.
- Expert G identified that the modeling of project context was applicable across all projects in real property and could be of assistance for strategic leadership of an organization in the delivery of a program.
- The data fields and flexibility were noted and identified as very comprehensive.
- The approach of modeling different project view and linking these views with a risk view was seen as common sense that individuals across disciplines could very easily understand and apply.

Expert H – Managing Director (International Construction Firm)

Comments on the Concepts

Expert H noted that the approach was both sound and holistic. Although the expert felt that there were opportunities for application in the private sector, the approach was noted as having greatest opportunity to improve industry practice if implemented by the public sector. The rationale being one that the expert felt that many projects are initiated and brought to market by the Public sector based on political support and desire versus their technical or feasibility in implementation merits. Further, the expert felt that political support can be so strong, that public sector decisions to move forward in the planning phase are not objective. The approach was identified as an exercise of objectivity or a reality check of sorts on the feasibility of project and its associated risks. The approach would help to inform project participants of the issues, eliminate surprises, and provide a rationale or excuse to stand up against the political support or drivers moving an unsustainable project forward into the market place. As a private sector lead consortium member, the expert noted:

> *I would be well comforted if this was carried out by the public sector both to eliminate the possibility of surprise on costing and as a reality check on feasibility of the project itself.*

The lead of a private sector consortium bidding on a PPP is concerned at the forefront on whether the project to which they are bidding and incurring costs for a project team will go ahead as per the schedule released to the bidding community, that there will not be substantial delays in reaching project milestones in the procurement phase, and finally that risks are identified by the public sector and allocated appropriately for effective negotiations across shortlisted proponents. Having confidence that the risks were adequately identified and communicated across levels of bureaucracy was considered the key issue for this Expert.

Research Test Questions

In response the research test questions the following points were made:

- The approach is an improvement to existing tools in capturing and retaining knowledge on a Project and using this knowledge for future projects.

- The approach would assist in training individuals to become a better procurer of assets because the approach forces discipline and the individual to go through a series of steps and consider a range of aspects.
- The consideration of stakeholders is critical and the most important part of the approach.
- The approach is a better way than established practices in determining whether a project is doable or not based on objective analysis versus driven by political support.
- The approach could be applied to a range of projects and delivery types.

Expert I – Partner (Global Management Consulting Firm A)

Comments on the Concepts

The approach was discussed as a considerable improvement relative to current practices implemented by Expert I. Expert I discussed that in facilitating a risk workshop for a large infrastructure project (typically with construction costs exceeding $300 million) a formatted risk register with headers/rows for information input in a spreadsheet format is used and over the course of the workshop, the register is slowly populated with estimates. There are few, if any, additional reference project context documents brought to these workshops for reference. Expert I said "We get a bunch of people in a room, a blank register and we brainstorm – this approach would be easier to pull information from these folks who are reluctant to be present in the first place". Expert I also indicated that many of these workshop participants tend to focus on mitigation strategies and struggle or are uncomfortable with assigning a value to the risk (likelihood or cost impact). Providing the integrated view of the project and information would help facilitate better inputs and a better idea of what the issues are. Having a better idea of the project context, a reminder of sorts, would assist in quantification and provide greater confidence in the values assessed.

Research Test Questions

In response to the research test questions, the following points were made:

- The approach would enable greater confidence in the quantification of outputs and brings a lot of value relative to current activities performed.
- The approach would be applicable on any large infrastructure project or procurement, but is particularly useful for the PPP approach because it is robust.
- The four different views linked with the risk view was considered the right level of detail required to facilitate risk workshops and the approach appears to be flexible to add additional detail as required.
- The approach does not appear to require significant training to implement effectively and would therefore be considered worthwhile for application on industry projects.

Expert J – Associate Partner (Global Management Consulting Firm B)

Comments on the Concepts

Expert J identified a number of large water, hydro and transportation infrastructure projects in the region that had failed over the last decade due to stakeholder opposition and associated influence on decision makers. Third party stakeholders (traditional groups, local residents and unions) were identified as having the greatest influence on the failure of these projects. Expert J further highlighted that project team executive tend to underestimate stakeholder influence and lack an understanding of different stakeholder roles and interests in projects across sectors. Further, Expert J commented that there is a recent movement in the industry to recognize and include stakeholders because they are recognized as a difficult driver of project risk, which often the project team cannot control. The research prototype, in particular the ability to characterize stakeholders at different phases in the project and integrate risk and project information using multiple views was identified as highly applicable and timely with current interest in the industry to identify and manage stakeholders. Expert J highlighted a large utility project where the public sector client developed incentives within the project agreement for project proponents to be at the “front line” and manage stakeholders appropriately while also requiring the identification of trigger points to transfer primary stakeholder management roles and responsibility tasks back to the public sector client. The research prototype was identified as a useful and suitable tool to assist in developing these trigger points including the characterization of stakeholders to bring client and proponent members in agreement on key stakeholder driven risks for consideration and negotiation of appropriate assignment of project participant roles and responsibilities.

Research Test Questions

In response to the research test questions, the following points were made:

- The opportunity to "slice, dice and organize data" was identified as new and a key feature of the tool and specifically to drill down into one aspect of the project to review overlapping issues including the influence of stakeholders on risk issues.
- Expert J felt that once you have modeled the project in one sector, there was sufficient generality and commonalities across sectors that the model could well be used as a template. The opportunity to capture lessons and leverage learning from one sector to another was identified as a desirable feature currently not facilitated by approaches applied by industry practitioners.
- The tool was seen to have sufficient flexibility in the naming and hierarchical information modeled to adjust for qualities and characteristics unique in each sector and with participants involved in populating it.
- The information modeled in the research prototype is straight forward in the sense that Expert J felt that junior project team members would be able to populate the model appropriately and that time required to input information was the least concern.

Expert K – Director (Global Management Consulting Firm C)

Comments on the Approach

The modeling of project context was identified as a thorough and structured approach to assist with the risk identification process and improve the quality of risk workshops and therefore the quality of project risk management. Overall, the use of the research prototype to facilitate the risk identification and elicitation of expert opinion was commented as an improvement over current approaches applied and indicated stakeholder identification was often not carried out but a much needed exercise to be integrated with the risk identification and elicitation of expert opinion. Expert K indicated that many seasoned professionals who have had significant project experience 'on the ground' would not use the research prototype themselves because they would perform the modeling of project context intuitively and typically do not go into great detail in their analysis of risks because "they just tend to know the key issues and price them accordingly based on experience". Expert K continued to comment that these seasoned professionals would most likely have a greater level of comfort with the knowledge that their junior advisors were forced to apply the research prototype including a holistic consideration of risk issues and events relative to the particulars of the project from the four different project views. Interestingly, this observation of importance and comfort in a structured process undertaken is consistent with that of other experts interviewed. Overall, Expert K provided positive feedback on the value of the concepts introduced and the research prototype as an improvement to current practice and the opportunity to consider the use of the research prototype as a training tool for less experienced infrastructure practitioners.

Research Test Questions

In response to the research test questions, the following points were made:

- The modeling of project context in the research prototype provides a framework to assist users and participants in risk workshops think through the actual project versus considering the standard 'bucket list' of risk events considered in a repeat format in risk workshops. The application of a process that is structured was seen to be both new and would provide opportunity to improve current risk identification practices.

- Forcing project participants to consider and/or model the different project views was identified as a good educational tool for less seasoned practitioners. This was particularly identified for large infrastructure projects involving project advisors across disciplines where few have significant project management experience or experience across project phases. The application of the research prototype including stakeholder characterization and project modeling concepts were seen to be most beneficial and practical for application on large complex projects across sectors.
- The data fields within the research prototype were identified as both comprehensive and flexible to adapt to terminology readily applied by organizations. The capability to model a high level of detail was seen as beneficial such that users could easily 'edit out' information not considered pertinent.
- Expert K, a Certified Financial Analyst, indicated that the approach and concepts are applicable and understandable across disciplines and highlighted as an example analysts familiar with measuring stock volatility should consider similar issues.

Expert L – Managing Director (Global Infrastructure Equity Investment Firm)

Comments on the Concepts

Overall, the concept of modeling of the project context and the availability of the tool were identified as improvements to current risk identification practice. Expert L noted that there would be opportunity to apply the approach in large infrastructure projects in particular by individuals or organizations with limited experience delivering projects. Expert L highlighted the degree to which private sector individuals are required to 'cover their back' to meet public accountability requirements is limited; the approach was identified to help current practitioners improve consideration about the different dimensions of a project, where they may 'cross' to result in an undesirable situation. The modeling of project stakeholder characteristics was noted as an important feature of the approach and related the characteristics of stakeholders such as 'relevant experience', 'political champion', and 'previous experience' to those intuitively considered in decision making to bid or not to bid on a project.

Research Test Questions

In response to the research test questions, the following points were made:

- The approach was identified as new and offering potential value to individuals within Expert K's organization. The modeling of the project context in the different views was identified as a helpful tool for new comers to the industry in thinking through the different dimensions of a project. Characterizing the different project views was also identified as a good approach that could be adapted in the form of a checklist of issues or a guideline of questions to ask by senior management or internal risk analysts who review and provide oversight of internal decision making within the organization. Expert L noted that modeling and characterizing project context was of primary assistance and value to individuals who were not 'seasoned' in the field of infrastructure delivery.
- Expert L noted that the approach was suitable for any project considered by lenders that had 'multi-dimensions' or was 'complex'. Projects that were small in scope, delivered recently by the organization and had limited stakeholder involvement were identified as projects not suitable to apply the approach.
- The tool and characterization of stakeholders was noted as comprehensive and information fields easily understood by individuals within the lending community.
- Expert L discussed how modeling the different views of a project, most notably the stakeholder view and environmental view could assist decision makers in the consideration of 'insolvency risk' of project partners. Insolvency risk was highlighted as a difficult and multi faceted risk to think through but considered in all projects by Expert L.

8.4 **Conclusion**

The validation results illustrate that the concept of an integrated model of the project context and the characterization of stakeholders with the risk identification tasks are an improvement over traditional industry public and private sector practices and that there are broad opportunities for its application in a range of sectors with various dimensions and complexities. Each of the experts highlighted that the approach was both new and highlighted the potential to garner insight on project risk identification through the characterization of stakeholders. Experts highlighted the usefulness of stakeholder characterization and interest to adopt the approach to assist in structuring what is currently carried out intuitively. They highlighted a structured approach such as what was introduced and the opportunity to template lessons learned from one project to the next in an IT environment improves current practices including: (1) a more fulsome identification of project risks; (2) the identification of multiple sources of project risks across the different project dimensions; and (3) the identification of a more appropriate list of risk mitigation solutions. In addition, a number of experts noted the opportunity to draw upon the approach and outputs including the model of project context and characterization of the different views as a training tool for less seasoned professionals in infrastructure delivery and as a template of issues to consider for those performing an oversight or governance function on project risk management. With respect to the research areas of interest the following summarizes the experts comments:

Generality

- Each of the experts noted that the approach could be applied across a range of project types (real property, IT, and other) delivered using a variety of project delivery mechanisms. To note, a number of experts identified the approach and prototype tool applicable for performing risk identification and related tasks in the management of an organizations' real property program and the management of a portfolio of projects. Projects that are 'complex' in nature were identified as most suitable for using the approach and prototype tool although one of the experts noted the need to simplify the approach for small scale, less complex projects.

Integrative

Each of the experts noted that the data fields are comprehensive to meet their needs and the skill sets across individual disciplines involved in the planning and delivery of large infrastructure projects. The data input format of the prototype tool was identified as having sufficient flexibility that each of the experts felt confident that project data could be inputted. A number of experts noted that they would draw upon junior staff to input with more seasoned professionals carrying out the review function. A majority of experts highlighted that they anticipated staff would be required to be trained on the use of the prototype and others noted the opportunity to use the approach of modeling project context and characterizing components as a structured form of training for less seasoned infrastructure professionals.

New

The approach and prototype tool were identified as new and offering value relative to current risk identification practice by each of the experts. Characterizing stakeholders was noted as a key improvement by each of the experts as it was noted that this is rarely performed explicitly in practice. Each of the experts noted that they would expect improved insights on both the identification of risks and appropriate mitigation approaches if they used the approach and the prototype tool in their projects. In addition, a number of experts noted value of a structured process to improve documentation of risks identified, changes in project information and assisting in meeting accountability and governance requirements of oversight agencies and/or departments.

Transparent

- The approach was found suitable for use by practitioners representing the range of professional disciplines involved in the delivery of large infrastructure projects. A number of experts each identified the modeling of project context and input fields within the prototype made ‘common sense’ and brought structure to an otherwise adhoc process performed intuitively by seasoned professionals.

Although the validity of the concepts introduced was confirmed with respect to the research test attributes generality, newness, integrative, and transparent a number of issues were raised during the validation process:

Many of the experts suggested the need for training on how to use the approach. The training was suggested for both the IT prototype tool itself (including the project views modeled and characterized) and the facilitation skills required to capture information to input into the prototype. Chapter 5 and 6 introduce approaches to capture information to characterize stakeholders and project objectives which assist in training individuals on approaches that may be utilized to capture project information.

A few of the experts noted the need to consider the tradeoff between the time spent to input information and its respective value. Each noted the value of structuring the risk identification approach and was willing to test the approach on future projects regardless of the anticipated additional time requirements. One expert was quick to note that the time required inputting information into the prototype was inconsequential relative to the opportunity to improve the risk identification approach currently practiced.

Chapter 9: **Conclusion**

The complexities of public sector large infrastructure project delivery in the planning and procurement phases are often not well understood by both public and private sector practitioners alike and construction research in this area of the field is limited. Performing the risk management tasks and meeting governance and accountability requirements in these large projects is a particular challenge given their unique features, long process time lines and the evolving nature of project information and stakeholders involved.

Practitioners and researchers performing project risk management tend to focus on the identification and elicitation of expert opinion of the more technical risks in the design, construction and to a limited extent operations and maintenance project delivery phases. Although only lightly addressed in the construction research literature to date, the thesis findings illustrate that risks driven by project stakeholders, their objectives and associated tasks warrant greater attention and explicit consideration particularly in the planning and procurement phases of large public infrastructure project delivery. In fact, failure to address these 'softer' risks can have significant adverse impacts in meeting project success objectives. Overall, a more fulsome identification of project risks, including both technical and non-technical, and improving the quality of inputs in the assessment of risk properties facilitates improved project decision making and investment analysis and thereby improved opportunities for achieving project and organizational objectives. *The goal of this research was to improve risk management as it is applied in the delivery of large civil infrastructure with particular emphasis on the planning and procurement phases and risks mainly internal to the client, in this case, the public sector organizations (e.g. end user and delivery organizations) involved.* The research focused on developing a risk management framework, support tools and an improved research prototype that introduces the concept of characterizing different aspects of a project to improve the identification of risks and their related drivers, and elicitation of expert opinion of risk properties.

Understanding the unique characteristics of public sector large infrastructure project delivery was central in achieving this research goal and aspects were described in each of the Chapters through case studies, observations and both formal and informal interviews with senior executives. The objectives of the thesis identified in Section 1.5 of Chapter 1 were summarized under three broad research themes: (1) Risk management practices and challenges in large infrastructure public projects; (2) Approaches to support elicitation of risk information to improve risk management processes; and, (3) Developing and gauging the effectiveness of a prototype integrated risk management tool. The research responded to objectives under each research theme with the purpose of providing insight on: (a) processes and risks encountered in the delivery of a public sector large infrastructure project in the planning and procurement phases; (b) strengths and weaknesses of the practitioner processes and tools available to carry out risk management in large infrastructure projects; (c) the multi-dimensionality of stakeholders involved in public sector project delivery; and (d) concepts and constructs developed to improve risk identification and the elicitation of expert opinion tasks applied in a prototype computer system. Research questions pursued in this thesis included:

1. How can modeling project context improve the processes of risk identification, and elicitation of risk properties for large public sector infrastructure projects in the early phases of a project?

2. What are the user objectives that must be considered in order to develop a practical workable approach to risk management in the planning and procurement phases of a large infrastructure public sector project?
3. How can one best model project context and specifically characterize stakeholders given the objectives identified in Question 2. in such a way that it is of value, succinct and addresses the time and resource constraints experienced on large infrastructure projects?

A fourth related question, not fundamental to but of importance to this thesis relates to the role of Information Technology in the risk management process is:

4. What are the potential roles for Information Technology in the design of a support tool for real time risk identification and elicitation of expert opinion sessions?

The research has provided ways to improve the risk identification and elicitation of risks and associated properties in the planning and procurement phase of large infrastructure projects by introducing a framework, support tools and concepts to elicit and gather better quality project stakeholder, process and risk data for input into an enhanced research prototype. The following describes under each of the research themes the objectives pursued, findings, methodology employed and research contributions in pursuit of these research questions.

9.1 Research Theme 1 – Risk Management Practices and Challenges in Large Infrastructure Public Sector Projects

Activities and stakeholders involved in the delivery of large infrastructure projects by the public sector differ from that of a project delivered by a private sector entity due to a number of factors including the political environment, legislative and compliance frameworks, and organizational complexity and multi-faceted mandates. The objectives associated with this research theme included:

O1. To characterize unique aspects of large infrastructure PPP delivery by a Canadian public sector entity;

O2. To define the stakeholders involved in the planning and procurement phases of public sector large infrastructure project delivery process; and

O3. To gain a better understanding of risk management approaches employed by industry practitioners in major public sector projects including the constraints faced, process carried out, tools/techniques employed and synergy with other project management activities.

The complex decision and stakeholder environment of large public infrastructure projects including the myriad and hierarchy of stakeholders, public entities motivation for increased utilization of private sector resources and efficiencies in new project delivery approaches, and the unique characteristics and differences relative to private sector project delivery were defined in Chapter 2 drawing upon a diverse body of both practitioner and academic literature. Contributions were seen to lie in a summary of characteristics to describe a large public infrastructure project in Canada, a description of the PPP project delivery mechanism employed in the Canadian federal context and an overview of the factors that differentiate the public and private sector to further understand the context and complexity of the public sector client environment to which the thesis framework is developed. These contributions address a lack of in depth treatment in the literature of the nuances of project delivery by public sector entities and the associated decision making and project context.

Two industry case studies were examined to better understand the challenges, industry processes and the key risks managed in the planning and procurement phases of public sector large infrastructure project delivery in Chapters 3 and 4. In both case studies, I had direct interaction and involvement with senior executives responsible for risk management tasks and overall project governance. Both case study projects allocated significant time, resource and senior executive oversight to the risk management tasks making them ideal candidates for examination of current best risk management practices applied by industry. The case studies provided a unique opportunity to garner interesting insight on processes applied, key risks managed and clarification of challenges experienced by practitioners performing risk identification and elicitation of expert opinion in actual large infrastructure projects.

Two key contributions arise from Chapter 3. First, a summary of the state of the art in risk management processes, including commercially available software tools, based on a review of academic and industry literature was presented addressing a lack of in-depth treatment in the literature. Second, a comprehensive description of the risk management process undertaken by practitioners including a description of how a risk register was developed, its content, practitioners' perspective on the strengths and weaknesses of the process and its application managing various reporting and accountability requirements at the project and organization level. Both academic and industry literature were found to be void of reference to how risk registers are developed in practice and use in associated project management tasks and reporting requirements at the organization level.

The second case study described in Chapter 4 provided a description of key risk issues managed in the planning phase by a Canadian public sector entity implementing the first federal real property PPP in Canada for the delivery of a large infrastructure project. A contribution arising from this chapter included a description of risk issues not explicitly identified in the project risk register but where mitigation steps were taken to reduce potential adverse impacts. The description of these undocumented risk issues provided context of 'soft', hard to describe risk issues which exist but tend to either not be acknowledged or identified in industry and academic literature due to the qualitative nature and early occurrence in the project delivery process in which they occur. This chapter also provided a contribution in describing the multitude of stakeholders involved in the early planning phase of public sector project delivery, how these stakeholders responsible for the review, implementation or approval drove risks and the consideration of both risks managed at the project and organizational level on these large infrastructure projects. My position in both academia and industry presented the unique situation where I had access to project information and the time of senior executives to reflect on actual projects in depth, and test and validate research concepts in realistic settings which is notably lacking in academic literature due to the challenge in gaining the trust of project officials and opportunity to do so.

In support of this research theme, a portion of Chapter 5 provided a detailed listing of stakeholders involved in the planning and procurement phases of public sector large infrastructure project delivery process. A master list compiled of all stakeholders involved in a federal public sector large infrastructure project was created through a review of industry and practitioner literature, experience and feedback from senior project management executives. A contribution included the master list of stakeholders created which is of direct benefit to construction management practitioners and researchers because following a thorough review of both industry or academic literature, discussions with senior executives highlighted that a similar comprehensive listing does not exist. To note, senior public sector executives identified the stakeholder listing of direct value to organizational project management practices and standards for ensuring sound stakeholder and communication management.

Effective risk management process and support requires consideration of the unique process steps, multi-dimensional stakeholder involvement, and the accountability and governance requirements of decision makers and oversight bodies of a large public sector infrastructure project. Described are the context including challenges, stakeholder involvement, key risk issues identified and lessons learned of risk management in public sector large infrastructure project delivery which facilitated an integrated view of the project environment for developing support tools and approaches (informing Chapter 5 (partial aspects), 6 and 7 that follow) to improved risk identification and elicitation of expert opinion.

9.2 Research Theme 2 – Approaches to Support Elicitation of Risk Information to Improve Risk Management Processes

Support tools and a risk management framework were developed to provide a structured and explicit approach to facilitate the compilation of quality information to input into the research prototype discussed in Chapter 7 and inform the risk identification and elicitation of expert opinion tasks. The objectives associated with this research theme included:

- O4. To characterize stakeholders involved in a Canadian federal large public sector infrastructure project, using a PPP project as a specific case;

- O5. To gain a better understanding of how stakeholders contribute to the risk profile of a project and develop attributes for classes of project participants and associated values that may be used in the approach formulated based on literature and direct observation; and
- O6. To develop and apply an approach to elicit project objectives that may be utilized in multiple stages of project delivery.

Two risk management support approaches were presented in Chapter 5 and 6 including: (a) a framework to identify and manage project stakeholders and (b) a decision support approach for the identification of project objectives and improved decision making. These approaches introduced and illustrated how practitioners can identify stakeholders, their objectives and performance metrics of public infrastructure projects in a new way adapted for the unique project context of public sector project delivery. They were successfully vetted in the public sector case study projects presented.

Chapter 5 introduced a stakeholder management framework which provided a structured and explicit approach to identify stakeholders, understand and clarify their interests, needs and capabilities, inform how stakeholders affect project riskiness and viability, and determine the extent to which certain groups or individuals should participate in the various project delivery phases. A review of construction management literature highlighted that there is a lack of thorough conceptualization of the stakeholder notion yet a number of authors have noted and experts interviewed as part of this thesis highlight that stakeholders are significant drivers of project risk. This research serves to help bridge this gap with a stakeholder management framework developed for the public sector large infrastructure project delivery context. A senior executive, responsible for a multi-billion dollar portfolio, reviewed the framework developed and noted it was “informative, practical and useful” and highly suitable as a reference document for a national departmental stakeholder management approach. The framework was developed based on a thorough review of industry and academic literature (including public sector policies and directives), feedback and guidance from practitioners involved in performing stakeholder management on a range of project types and a review of relevant stakeholder and communication management project reports of a large infrastructure public sector project. The contribution includes a standalone stakeholder management framework to assist project managers to operationalize their stakeholder management responsibilities serving both their governance and accountability requirements in addition to their explicit understanding of stakeholder characteristics and associated contribution to the project risk profile.

Chapter 6 introduces a decision support approach designed for application on large public sector infrastructure projects and provides context of the public sector project delivery decision environment. The chapter made use of a large infrastructure case study to highlight the multiple objectives elicited from senior public sector executives in a front end project decision problem. These objectives were more broad and varied than traditional “on-time” and “on-budget” project management objectives identified in the literature. For a holistic risk management process and framework proposed, a user must first identify the multiple objectives of stakeholders involved and then consider how risk events impact these preferential objectives such as service delivery, corporate image, etc. Contributions that arise from this chapter include a stand alone decision support approach that improves how practitioners manage risks at key decision points over the course of project delivery. The approach is a tool to facilitate the collection of project information such as the identification of stakeholder objectives, differences across stakeholder objectives and the development of relevant consequences/outcomes to assess risks against. This information can be used to populate the research prototype (Chapter 7) and perform the preparatory work associated with conducting a comprehensive risk identification and elicitation of expert opinion tasks outlined in the three step risk management framework (Chapter 7). Informal discussions with practitioners highlighted agreement with the importance of stakeholder objective identification but the lack of tools available developed for the public sector context such as the approach presented herein.

Both support approaches are stand-alone tools that assist users improve decision making, facilitate the characterization of stakeholder attributes and values (as introduced in Chapter 7), meet accountability and governance requirements in considering multiple stakeholder objectives, and collect relevant information to prepare and conduct a comprehensive risk management process. The applicability of these two support tools developed was illustrated in the successful application on case study projects and interest of senior executives to incorporate the tools into a federal department national project management system compendium.

9.3 **Research Theme 3 – Developing and Gauging the Effectiveness of a Prototype Integrated Risk Management Tool**

Large infrastructure public sector project delivery is complex, involving a diverse network of stakeholders and technical design, construction and operation requirements. The management of risk is considered integral to ensuring successful delivery of these projects yet practitioners must perform the associated tasks under time and resource (financial and human) constraints, constant evolving organizational and project information, arduous governance requirements and involve multiple stakeholders with varying capacities and abilities. Few, if any, practitioners have a complete understanding of the project context and risks due to the scope and complexity of these large infrastructure projects. Tools and frameworks to improve risk management processes, in particular the two most challenging of tasks being risk identification and elicitation of expert opinion is of great value to practitioners and academic researchers alike. The objectives associated with this research theme included:

- O7. To enhance features of a project management research prototype to demonstrate the value of the ideas and concepts developed to improve the risk identification and elicitation of expert opinion approach addressing identified weaknesses and to further improve current practices;
- O8. To implement characterizing in a practical way to assist with the risk identification and elicitation of expert opinion in the early planning phases of the project lifecycle; and
- O9. To demonstrate the application of the approach and its response to tests that reflect industry needs as set out at the forefront of the thesis and current practice shortcomings.

Described in Chapter 7 are a systematic risk management framework and aspects of this framework incorporated in a project management research prototype to improve the tasks of risk identification and elicitation of expert opinion in large infrastructure project delivery. The three step process framework provides guidance on how one may perform risk identification and elicitation of expert opinion tasks and refers to the support tools, introduced in Chapters 5 and 6, to aid practitioners prepare, define and model the project context. The concept of project component characterization was introduced and attributes for seven key stakeholder categories involved in the delivery of public sector large infrastructure projects were developed based on a distillation of findings from the literature, experience, and concurrence with industry practitioners. The ability to model and characterize project components and their attributes in the four project views enables the user to link risk entities to the associated component, determine inter-dependencies and relationships across risks, therefore, improving the identification of risks and associated properties. Lastly, the Chapter detailed two examples of key risks of a public sector large infrastructure case study to highlight features of the research prototype, the research concepts discussed and the significant stakeholder contribution to a project's risk profile. The risk examples highlighted a number of benefits of the prototype and research concepts to improved risk identification and elicitation of associated properties including: (a) the development of a shared image, documentation (memory trace) of the project context and associated attributes amongst project participants; (b) a direct linkage between project context and risk profile; and (c) the ability to document the linkage in the form of risk drivers. Other benefits identified include access to and easy use of project information for knowledge management and record keeping of project decisions to meet corporate governance and accountability requirements.

The framework and research prototype contribute in filling the gap identified by practitioners regarding the lack of tools and support aids for the risk identification and elicitation of expert opinion tasks. The integrated framework provides a more comprehensive guide and 'way of thinking' for practitioners to carry out risk identification and elicitation of expert opinion combining findings across disciplines to create tools suitable and vetted for application on large infrastructure public sector projects which is a direct contribution to practitioners and the research community. The development of each of the project views and the risk view cannot be claimed as a contribution; however, aided by the use of case study public sector projects more detailed versions of these views (with a particular focus on the participant view) are. Improving the quality of data input in these views in the IT research prototype enabled a more fulsome assessment of project risk and associated properties and facilitated other learning opportunities for stakeholders and organizations as a whole. Finally, the knowledge management capacity, improved quality of standard templates of the prototype is of direct use in assisting stakeholders meet accountability and governance requirements while also assisting in the documentation of project information for project personnel or transitions of project teams across project delivery phases.

In Chapter 8 the perspective of sixteen senior executive practitioners on both the research concepts and the application of the research prototype were surveyed through semi-structured interviews. These executives represented both public and private sector Canadian organizations, occupied senior positions in their organization (CEO, Partner, Director General, etc.) and had significant depth and years of experience in infrastructure delivery. The majority of public sector representatives had over twenty years and their private sector counterparts over fifteen years of experience and all are considered ‘subject matter experts’ in the infrastructure field. Interviews were conducted over the period of one to two hours in both group and one-on-one sessions. Interviewee’s expertise covered the range of roles and responsibilities encountered in large infrastructure project delivery such as policy development and approval, performance reporting to Ministers or shareholders, and delivery of infrastructure projects or programs in the hundreds of millions of dollars.

Contributions that arise from this Chapter revealed the senior executives insight on the research concepts and test questions including the features they liked, disliked and the applicability of the research prototype and concepts in practice. Senior executive feedback reinforced that stakeholders are a significant source of risk and that on a number of project tasks stakeholders can either individually or in combination drive project and organizational risks. Each of the experts highlighted that an integrated model of the project context and the characterization of stakeholders with the risk identification tasks are new and an improvement over traditional practices. They indicated that the structured approach introduced and the knowledge management capacity of the research prototype was an improvement over current practice facilitating a more comprehensive identification of project risks, the multiple risk sources (drivers) across the different project dimensions and the opportunity to develop a more appropriate list of risk response strategies. Experts also found the integrated approach applicable in managing the diverse and complex project information as it facilitated a logical or common sense approach for users to 'bucket' project information and their knowledge using a platform that also assisted in characterizing and defining project components. Explicit identification of the project context and characterization of project components was noted as a key benefit of the approach in teasing out key risk issues that as one expert indicated are 'the elephant in the room' but which users may be reluctant to identify amongst their peers for various reasons (be it associated with political issues, trust amongst partners, etc.) where the project context is not modeled and components characterized. A number of experts identified the use of the prototype and project context model as a training tool for junior project professionals to aid in the consideration of the multiple project dimensions implicitly considered by seasoned professionals through experience over time.

Success of the framework and prototype depends on whether or not public and private sector personnel are willing to spend the necessary time and resources to develop a working model of the project context and integrate the approach with other project management processes. Although a few of the experts anticipated additional time required to perform these exercises relative to traditional practices, feedback from the majority of experts indicated that the value to improved risk management would exceed the time and resources required to input information into the research prototype and carry out the associated risk management framework process steps.

9.4 Recommendations for Future Work

A number of areas for future research are suggested for examination as follow up to this research, many of which have been identified in Chapter 7.

It would be useful for future researchers to apply the risk management framework, support tools and the research prototype together and successively to an actual project in real time to provide further insight in how these tools improve practitioner risk identification and associated tasks under the time, resource and evolving project information and stakeholder environment. The research presented in this thesis applied the tools and research prototype on actual projects for which I had an intimate working knowledge and experience. However, the opportunity to apply the risk management framework, support tools and research prototype together as an integral part of managing a project could flush out interesting nuances of user interactions, treatment of risk inter-relationships and associated properties in an IT tool, management of project information for future reuse, enhancements to ensure practicality of the approach to large infrastructure projects, and how best to extract insights from risk data. User feedback could also reinforce the benefits identified by the senior executives interviewed as part of the validation exercise in Chapter 8.

As discussed, the risk management framework developed is intended to be iterative and was applied in case study projects in the planning and procurement phases of project delivery although it is applicable in its current form for implementation in other project phases. Adaptations to suit the nuances of the project delivery phase and organizational requirements in an actual project could be assessed in future research.

A focus of this thesis was on characterizing the participant view. A useful extension to the work would be to *further* characterize components in other project views (physical, environmental and process) in greater detail. In addition, in the participant view assessing the relevancy of attributes and the associated values identified from the perspective of different stakeholders involved in a project would provide insight on multi-stakeholder interests and concerns (the viewpoint reflected in the thesis is that of the public sector client and government agency tasked with overseeing project delivery). The series of tests applied to judge the relevance and usefulness of an attribute and its accompanying value (Section 7.5.2) can be asked of practitioner's in an actual project to provide further feedback and confirmation of applicability. Of particular interest would be to verify practitioner feedback (described in following Validation Chapter 8) that the prototype facilitates consistent and speedy responses while maintaining user flexibility in modeling the risk profile of the project. A related area of interest is to examine how key project stakeholders change over time, whether the attributes developed are most effective in their characterization, and impact of their motivations and influence on the risk profile as their role and responsibility evolves over the course of project delivery. An evaluation of stakeholder influence on project objectives and the relationship with risk identification and metrics assigned could also provide insight in how objectives criteria were met and assessed.

From a system design perspective of the research prototype, a goal to enhance usability is to provide as much assistance to users as possible. For the current implementation, users are required to identify project view components that are related to a risk issue class. Given values for the component attributes selected, a feature could be added to have the system automatically screen for relevance of a component by examining the attribute values assigned. If a component has no negative ('False') ratings for any of its attributes, then it could be eliminated from the list, thus helping the user to focus on the most likely source of risk events for the issue class under consideration. As described in Section 7.5.3, another goal to enhance usability of the prototype is to develop a feature to facilitate the comparison of attribute values across members within a stakeholder category as well as across categories to assist in identifying risk drivers shared across participants and interdependencies of risk drivers. A visual representation of shared attributes with 'False' value ratings would enable users to quickly and explicitly assess multiple contributors to a specific risk event and thereby improve the qualitative and/or quantitative performance assessment assigned.

It may be useful to examine the application of the approach to a program of projects versus an individual project. Requirements could be assessed to identify how the approach, support tools and prototype are adjusted to ensure practicality, ease of use and robustness. Of particular interest would to examine how multiple users across a program of projects could be calibrated to organizational objectives, risk tolerances and associated values to foster a consistent approach to reporting. Potential benefits at an organization level would be consistent reporting and performance management assessment.

In a related area, a number of senior executives identified that both the risk management framework and the research prototype could be useful organization training tools for junior project professionals involved in large infrastructure projects. Other project and organization benefits to examine by applying this structured approach to model project context and consider the multiple financial, technical, environmental, social and organizational dimensions that offer interesting research opportunities include improved user project decision making, positioning in contract negotiations with partnering firms through modeling of risk from different project participant perspectives (e.g. client versus private sector project delivery firm), and user/organizational learning of applicable risk issues over project phases.

Currently, the research prototype facilitates data reporting and knowledge management. A useful enhancement would be to allow users to sort risks by drivers, identify associated inter-relationships and consequences. In addition, a reporting function aligned with an organizations performance and accountability reporting requirements could be evaluated to determine opportunities of cross functions of project management tasks.

The research provides a useful foundation for highlighting risk management practices and the project context in large Canadian public sector infrastructure projects delivered in the planning and procurement phases. Extensions to this work include the adaptation of the risk management framework, tools and research prototype to private sector projects. Although similarities may exist across public sector jurisdictions (levels of government and/or country) in terms of project delivery practices, stakeholder involvement and governance requirements, future researchers may also consider examining the project context and processes carried out in other jurisdictions to verify similarities and assess whether differences exist, as the literature pertaining to public sector project delivery, and specifically that of large infrastructure, is limited.

References

Aaltonen, K., Jaakko, K. & Tuomas, O. (2008). Stakeholder salience in global projects. *International Journal of Project Management*, 26(5), 509-516.

Abdel Aziz, A.M. (2007). Successful delivery of public-private partnerships for infrastructure delivery. *Journal of Construction Engineering and Management,* 133(12), 918-931.

Achterkamp, M.C. & Vos, J,F.S. (2008). Investigating the use of the stakeholder notion in project management literature, a meta-analysis. *International Journal of Project Management*, 26(7), 749‑757.

Adams, F.K. (2006). Expert elicitation and Bayesian analysis of construction contract risks: an investigation. *Construction Management and Economics*, 24(1), 81-96.

Ahadzi, M. & Bowles, G. (2004). Public-private partnerships and contract negotiations: an empirical study. *Construction Management and Economics*, 22(9), 967-978.

Ahmed, S. & Bakhsheshi, A.H.F. (2009). Improving risk management in projects: stakeholder management in perspective of risk management a case study in StatoilHydro. Masters Thesis. NTNU University.

Akintoye, A., Beck, M., Hardcastle, C., Chinyio, E., & Asenova, D. (2001) Framework for Risk Assessment and Management of Private Finance Initiative Projects. Glasgow Caledonian University Publishers, Glasgow.

Akintoye, A., Beck, M., Hardcastle, C., Chinyio, E., & Asenova, D. (2003). Achieving Best Value in Private Finance Initiative Project Procurement. *Construction Management and Economics*, 21(5) , 461-470.

Akintoye, A. & Chinyio, E. (2005). PFI in the healthcare sector: trends and risk assessment. Engineering, *Construction and Architectural Management,* 112(6), 601-616.

Andersen, T. (2001). Knowledge-based approaches to project risk management. Proceedings of the Civil and Structural Engineering Computing, Vienna, Austria, 83-105.

Aritua, B., Smith, N. J., & Bower, D. (2011). What risks are common to or amplified in programmes: Evidence from UK public sector infrastructure schemes. *International Journal of Project Management*, 29(3), 303-312.

Arvai, J.L., Gregory, R., & McDaniels, T.L. (2001). Testing a structured decision approach: Value focused thinking for deliberative risk communication. *Risk Analysis*, 21(6), 1065-1076.

AS/NZS 4360 (2004). *Risk Management.* Standards Australia. Homebush, NSW.

Audit Committee. (2001). Beyond Compliance: Building a Governance Culture, Final Report, Joint Committee on Corporate Governance, November 2001.

Australian Capital Territory (ACT). (2003). Private Provision of Public Infrastructure in the ACT – The Public Sector Comparator. June 2003.

Australian Government Department of Finance and Deregulation (AUF). 2012. Australia Gateway review process. Accessed March 10, 2012 from http://www.finance.gov.au/

Ayyub, B.M. (2001). *Elicitation of Experts Opinions for Uncertainty and Risks.* CRC Press.

Bajaj, D., Oluwoye, J., & Lenard, D. (1997). An analysis of contractors approaches to risk identification in New South Wales Australia. *Construction Management and Economics*, 15(4), 363-369.

Baldry, D. (1998). The evaluation of risk management in public sector capital projects. *International Journal of Project Management*, 16 (1), 35-41.

Baloi, D., & Price, A. D. (2003). Modelling global risk factors affecting construction cost performance. *International Journal of Project Management*, 21(4), 261-269.

Bannerman, P. L. (2008). Risk and risk management in software projects: A reassessment. *The Journal of Systems and Software*, 81(12), 2118-2133.

Barki, H., Rivard, S., & Talbot, J. (2001). An Integrative Contingency Model of Software Project Risk Management. *Journal of Management Information Systems*, 17 (4), 37-69.

Bianchi, R.R. and Kossoudji, S.A. (2001). Interest Groups and Organizations as Stakeholders. Paper Number 35, June 2001. Social Development Papers. World Bank.

Bibby, C.J and Alder, C. (2011, March 10). *The conservation project manual, 2003*. Cambridge, UK: BP Conservation Program. Retrieved from http://www.conservationleadershipprogramme.org/UserDataWEB/ProjectManuals/ConservationProjectManual.pdf

Biehler, A. D., Dot, P., Brown, L. L., Dot, M., Conti, E. A., Transportation, S., Dot, N. C., et al. (2010). REPORT 658 Guidebook on Risk Analysis Tools and Management Practices COOPERATIVE HIGHWAY PROGRAM. Risk Management. Transportation Research Board. Retrieved from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_658.pdf

Biggs, B.G. and Kiker, M.K. (2005). Environmental Security in Harbors and Coastal Areas: Management using Comparative Risk Assessment and Multi-Criteria Decision Analysis Framework. White Paper on Stakeholder Involvement. RA + MCDA: How do Stakeholders Fit In?. 20-24 April 2005, Thessaloniki, Greece.

Bourne, L. (2005). Project Relationship Management and the Stakeholder Circle™, Doctoral dissertation, Royal Melbourne Institute of Technology University, 2005.

Bourne, L., & Walker, D.H.T. (2006). Visualizing stakeholder influence – Two Australian examples. *Project Management Journal,* 37(1), 5-22.

British Columbia Ministry of Transportation (BC MoT). (2006). Federal-Provincial Business Case Template. A guidebook for multiple account evaluation and cost benefit analysis. Program Development and Monitoring Branch. Transportation and Planning Policy Branch.

Bruijin, H. & Leijten, M. (2008). Management of characteristics of mega-projects. In Priemus, H., Flyvbjerg, B., & van Wee, B. (Eds.), *Decision Making on Mega Projects, Cost-Benefit Analysis, Planning and Innovation* (pp. 23-39). Cheltenham - UK / Northhampton Massachusetts - USA: Edward Elgar publishing Limited.

Bryson, J. M. (2004). What to do when stakeholders matter, *Public Management Review*, 6(1), 21-53.

BTY Group. (2005). The Perfect Storm Has Come. Market Intelligence. December 2005.

CAN/CSA ISO 31000: Risk Management – Principles and Guidelines.

Canada Line Rapid Transit Inc (CLCO). (2011, March 21). Final Project Report, April 2006. Retrieved from www.partnershipsbc.ca/files/project-rav.html.

Canadian Council of Public Private Partnerships (CCPPP). (2011). Retrieved from http://www.pppcouncil.ca/resources/about-ppp/why-choose-ppp.html

Canadian Environmental Assessment Certificate Application (CEACA). (2004). Section 4 Consultation and Communication. P. 1.

CBC News. (2009, July 26). Burnaby to rezone land to block new prison. Retrieved from www.cbc.ca/news/canada/british-columbia /story/2009/03/23/bc-burnaby prison

Canada.THE NEX T PHASE OF CANADA'S ECONOMIC ACTION PLANA LOW-TAX PLAN FOR JOBS AND GROWTH (2011). Tabled in the House of Commons By the

Honourable James M. Flaherty, P.C., M.P.Minister of Finance. Retrieved from http://www.budget.gc.ca/2011/plan/Budget2011-eng.pdf

Canada. A STRONGER, SAFER, BETTER CANADA (2007). Tabled in the House of Commons By the Honourable James M. Flaherty, P.C., M.P.Minister of Finance. Retrieved from http://www.budget.gc.ca/2007/pdf/bp2007e.pdf.

Chan, A., Scott, D., & Lam, E. W. (2002). Framework of success criteria for design/build projects. *Journal of Management in Engineering* , 18 (3), 120-128.

Chan, D., Chan, A., Lam, P., Yeung, J., & Chan, J. (2011). Risk ranking and analysis in target cost contracts: Empirical evidence from the construction industry. *International Journal of Project Management*, 29(6), 751-763.

Chapman, R. (1998). The effectiveness of working group risk identification and assessment techniques. *International Journal of Project Management*. 16(6), 333-343.

Chapman, C.B., & Ward, S.C. (2003). Project Risk Management: Processes, Techniques, and Insights (2nd ed.). Chichester Wiley.

Chua, D.K.H., Kog, Y.C., & Loh, P.K. (1997). Critical success factors for different project objectives. *Journal of Construction Engineering and Management,* 125(3), 142-150.

Chung, J.K.H., Kumaraswamy, M.M., & Palaneeswaran, E.(2009). Improving megaproject briefing through enhanced collaboration with ICT. *Automation in Construction*. 18(7), 966–974.

City of Burnaby. (2009). Supplementary Council Report: Review of Provincial Prison Facility Site Selection Process. April, 23 2009. File: 49500 20.

Clarke, P., & O'Connor, R. V. (2012). The situational factors that affect the software development process: Towards a comprehensive reference framework. *Information and Software Technology*, 54(5), 433-447.

Clarkson Centre for Business Ethics (CCBE). 1999. Principles of Stakeholder Management. University of Toronto.

Cleland, D.I. (1999). *Project Management – Strategic Design and Implementation* (3rd ed.). McGraw-Hill.

Clemen, R. (1996). *Making Hard Decisions: An Introduction to Decision Analysis*. Wadsworth Publishing Company. Belmont, California.

Cooke, R.M. (1991). Experts in Uncertainty: *Opinion and Subjective Probability in Science*. New York: Oxford University Press.

Construction Industry Board (CIB). (1997). Briefing the team, Thomas Telford, London

Crawford, L. (2000). Profiling the competent project manager. Project Management Research at the Turn of the Millenium: Proceedings of PMI Research Conference, 21-24 June, 2000, Paris, France, 3-15.

Crawford, L. (2005). Senior management perceptions of project management. *International Journal of Project Management*, 23(1), 7-16.

Crawford, L.H., & Helm, J. (2009). Government and governance: the value of project management in the public sector. *Project Management Journal*, 40(1), 73-87.

DBRS. 2011. Rating Canadian Public-Private Partnerships. (2011, April). Retrieved from http://www.dbrs.com/research/239403/rating-canadian-public-private-partnerships.pdf

De Zoysa, G. N. S. (2006). *Application and Re-use of Information and Knowledge in Managing Risks of Infrastructure Projects*, PhD Thesis, Department of Civil Engineering, University of British Columbia, Vancouver, Canada, January 2006.

Dikmen, L., Birgonul, M., Anac, C., Tah, J., & Aouad, G. (2008). Learning from risks: A tool for post-project risk assessment. *Automation in Construction*, 18(1), 42-50.

Doloi, H. K. (2011). Understanding stakeholder' perspective of cost estimating in project management. *International Journal of Project Management*, 29(5), 622-636.

Donaldson, T. & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidences, and implications. *Academy of Management Review*, 20(1), 65–91.

Dyer, J. S. (1990). Remarks on the Analytic Hierarchy Process. *Management Science*, 36(3), 249-258.

EcoPlan International Ltd (EPI). 2010. United Nations Protocol for Local and Economic Development and Planning.

Edwards, P.J., Bowen, P.A., Hardcastle, C., & Stewart, P.J. (2009). Identifying and communicating project stakeholder risks. Building a sustainable future: Proceedings of the 2009 construction research congress, Seattle, Washington; April 5-7, 2009.

Edwards, W., & von Winterfeldt D. (1987). Public Values in Risk Debates. *Risk Analysis,* 7(2), 141-158.

El-Gohary, N.M., Osman, H., & El-Diraby, T.E. (2006). Stakeholder management for public private partnerships. *International Journal of Project Management*, 24(7), 595-604.

Euske. K. J. (2003). Public, private, not-for-profit: everybody is unique? *Measuring Business Excellence*, 7(4), 5-11.

Fernie, S., Green, S.D. and Weller, S.F. (2003). Dilettantes, discipline and discourse: requirements management for construction, Engineering. *Construction and Architectural Management*, 10(5), 354- 367.

Fidan, G., Dikmen, I., Murat, T. A., & Birgonul, M. T. (2011). Ontology for Relating Risk and Vulnerability to Cost Overrun in International Projects. *Journal of Computing in Civil Engineering*, 25 (4), 302-315.

Fiori, C., & Kovaka, M. (2005). Defining Megaprojects: Learning From Construction at the Edge of Experience. Proceedings of Construction Research Congress, ASCE, Reston, VA.

Firesmith, D. (February 2010). Profiling Systems Using the Defining Characteristics of Systems of Systems (SoS). Software Engineering Institute. Pittsburgh: Carnegie Mellon.

Fischer, K., Jungbecker, A., & Alfen, H.W. (2006). The emergence of PPP task forces and their influence on project delivery in Germany. *International Journal of Project Management,* 24 (7), 539–547.

Fischer,K., Leidel, K., Riemann, A., & Alfen Hans Wilhelm. (2010). An integrated risk management system (IRMS) for PPP projects. *Journal of Financial Management of Property and Construction*, Vol. 15 (3), 260 – 282.

Flahaut, B., Laurent, M., and Thomas, I. (2002). Locating a Community Recycling Center Within a Residential Area: A Belgian Case Study. *The Professional Geographer*, 54(1), 67-82.

Flaherty, J.M. (2006). Economic and Fiscal Update Speech, p.-18. Retrieved from http://www.fin.gc.ca/ec2006/pdf/speeche.pdf

Flyvbjerg, B., Skamris Holm, M., & Buhl, S. (2002). Underestimating costs in public works projects: Error or lie? *Journal of the American Planning Association*, 68 (3), 279-295.

Flyvbjerg, B., Garbuio, M., & Lovallo, D. (2009). Delusion and Deception in Large Infrastructure Projects: Two Models for Explaining and Preventing Executive Disaster. *California Management Review*, 51(2). Winter 2009.

Foo, L.M., Asenova, D., Bailey, S., & Hood, J. (2011). Stakeholder Engagement and Compliance Culture. *Public Management Review*, 13(5), 707-729.

Freeman, E. (1984) Strategic Management: A Stakeholder Approach, Boston, MA: Pitman.

Frick, K.T. (2008). The cost of the technological sublime: daring ingenuity and the new San Francisco – Oakland Bay Bridge. In Priemus, H., Flyvbjerg, B., & van Wee, B. (Eds.), *Decision Making on Mega Projects, Cost-Benefit Analysis, Planning and Innovation* (pp. 239-262). Cheltenham - UK / Northhampton Massachusetts - USA: Edward Elgar publishing Limited.

Garthwaite, P.H., Kadane, J.B & O'Hagan, A. (2005). Statistical methods for eliciting probability distributions. *Journal of the American Statistical Association*, 100 (470), 680-700.

Gibson, G.E., Wang, Y., Cho, C. & Pappas, M.P. (2006). What is preproject planning, anyway? *Journal of Management in Engineering*, 22 (1), 35-42.

Gil, N., & Tether, B. S. (2011). Project risk management and design flexibility: Analysing a case and conditions of complimentarily. *Research Policy*, 40(3), 415-428.

Global Reporting Initiative (GRI).(2011, April 13). Guidelines. Retrieved from https://www.globalreporting.org/Pages/default.aspx

Gomes, R. C. & Gomes, L. O. M. (2008). Who is supposed to be regarded as a stakeholder for public organizations in developing countries? *Public Management Review*, 10(2), 261-273.

Gomes, R.C., Liddle, J., & Gomes, L.O.M. (2010a). A Five-Sided Model Of Stakeholder Influence. *Public Management Review*, 12(5), 701-724.

Gomes, R.C., Liddle, J., and Gomes, L.O.M. (2010b). Cross-Cultural Analysis of Stakeholder Identification in Municipal Districts. *Public Management Review*, 12(1), 53 -75.

Government of British Columbia Risk Management Branch and Government Security Office. (RMB). (2007). Enterprise Risk Management (ERM) Guideline. Retrieved from http://www.fin.gov.bc.ca/pt/rmb/ref/RMB_ERM_Guideline.pdf

Government of India (GoI). (2011, March 10). Projections of Investment in Infrastructure during the Eleventh Plan. Planning Commission, Government of India, New Delhi, 2007. Retrieved from http://infrastructure.gov.in/pdf/Inv_Projection.pdf.

Government of Newfoundland and Labrador (GNL). (2011, March 1). Stakeholder Analysis. Office of the Chief Information Officer. Retrieved from www.ocio.gov.nl.ca/OCIO/pmo/StakeholderAnalysisTemplate.doc

Gregory, R., & Slovic, P. (1997). A constructive approach to environmental valuation. *Ecological Economics*, 21,175-181.

Guo. H.L., Heng, L. & Skitmore, M. (2010). Life-cycle management of construction projects based on virtual prototyping technologies. *Journal of Management in Engineering*, 26(1), 41-47.

Hall, J. W., Cruickshank, C., and Godfrey, P. S. (2001). Software-supported risk management for the construction industry. *Civil Engineering*, 144(1), 42-48.

Han, S. H., Kim, D. Y., Kim, H., & Jang, W.S. (2008). A web-based integrated system for international project management. *Automation in Construction*, 17(3), 342-356.

Harker, P.T., & Vargas, L.G. (1990). Reply to "Remarks on the Analytic Hierarchy Process" by J. S. Dyer. *Management Science*, 36(3), 269-273.

Hatush, Z., & Skitmore, M. (1997). Criteria for contractor selection. *Construction Management and Economics*, 15(1), 19-38.

Hertogh, M., Baker, S.K., Staal, P.L., & Westerveld, E. (2008). Management of Large Infrastructure Projects, NETLIPSE Retrieved March 5, 2012 from http://www.netlipse.eu/network/knowledge-center

Hertogh, M. and Westerveld, E. (2010). Joint PhD Thesis. Erasmus University Rotterdam Playing with complexity, Management and organization of large infrastructure projects. NETLIPSE. Retrieved from http://www.netlipse.eu/network/knowledge-center

Hillson, D. (2000). Project risks – identifying causes, risks and effects. PM Network, Project Management Institute. 14(9), 48-51.

Hillson, D. (2003). Using a risk breakdown structure in project management. *Journal of Facilities Management*, 2(1), 85-97.

HM Treasury. (2004). Orange Book: Management of Risk – Principles and Concepts. Retrieved from http://www.hm-treasury.gov.uk/orange_book.htm.

HM Treasury (2011, July), The Green Book, Appraisal and Evaluation in Central Government, Treasury Guidance, London: TSO. Retrieved from http://www.hm-treasury.gov.uk/d/green_book_complete.pdf)

HM Treasury. (2006). Value for Money Assessment Guidance.

Hobbs, B., and Horn, G. (1997). Building public confidence in energy planning: A multi-method MCDM approach to demand-side planning at BC Gas. *Energy Policy,* 25(3), 357-375.

Holder, R.D. (1991). Response to Holder's Comments on the Analytic Hierarchy Process: Response to the Response. *Journal of the Operational Research Society*, 42(10), 914-918.

Horii, T., Jin, Y., & Levitt, R.E. (2005). Modeling and analyzing cultural influences on project team performance. *Computational and Mathematical Organization Theory*, 10 (4), 305-321.

Iacobacci, M. (2010). Conference Board of Canada. Dispelling the Myths: A Pan-Canadian Assessment of Public-Private Partnerships for Infrastructure Investments.

Information Bulletin, Ministry of Transportation and Infrastructure, (2009, January 14), Accessed March 21, 2011 from www.partnershipsbc.ca/files/project-rav.html.

InfraDeals. (2011). Project asset database. Retrieved from http://www.infra-deals.com/public/.

Infrastructure Journal. (2010). Infrastructure 100, A showcase of the most interesting projects from around the world, published 2010. Greater London House, Hampstead Road, London NW1 7EJ.

Infrastructure Ontario (IO). (2012, January 20). Current Projects. Retrieved from http://www.infrastructureontario.ca/What-We-Do/Projects/Current-Projects/

Integrated Computer Engineering Inc (ICE). (2006). Risk Radar®: Essential Software for Managing Project Risk. Retrieved from http://www.iceincusa.com/Products.aspx?p=Products_RiskRadar

International Organization for Standardization (ISO). (2003). ISO 10006 Quality Management Systems– Guidelines for Quality Management in Projects. Retrieved from http://marcelrzmut.comxa.com/2APII/ISO100062003.pdf

Jeffries, M., & McGeorge, W.D. (2009). Using public-private partnerships (PPPs) to procure social infrastructure in Australia. *Engineering, Construction and Architectural Management*, 16(5), 415-437.

Jin, X.-H., & Doloi, H. (2008). Interpreting risk allocation mechanism in public-private partnership projects: an empirical study in a transaction cost economics perspective. *Construction Management and Economics*, 26 (7), 707-721.

Joyner, K. (2007). Dynamic evolution in public-private partnerships: The role of key actors in managing multiple stakeholders. *Managerial Law*, 49(5/6), 206-217.

Jun, L., Quizhen, W., & Qingguo, M. (2011). The effects of project uncertainty and risk management on IS development project performance: A vendor perspective. *International Journal of Project Management ,* 29(7), 923-933.

Kadane, J. B. & Wolfson, L. J. (1998). Experiences in elicitation. *Journal of the Royal Statistical Society. Series D. The Statistician*, 47, 3-19.

Keeney, R.L. (1992). *Value Focused Thinking: A Path to Creative Decision making*. Harvard University Press, Boston, Massachussetts, USA.

Keeney, R. L., & Gregory, R. S. (2005). Selecting attributes to measures the achievement of objectives. Operations Research, 53 (1), 1-11.

Keeney, R., & vonWintefeldt, D. (1991). Eliciting Probabilities from Experts in Complex Technical Problems. *IEEE Transactions on Engineering Management*, 3(3), 191-201.

Keeney, R.L. and McDaniels, T.L. (1992). Value-focused thinking about strategic decisions at BC Hydro. *Interfaces,* 22(6), 94-109.

Keeney, R.L. and McDaniels, T.L. (2001). A Framework to Guide Thinking and Analysis Regarding Climate Change Policies. *Risk Analysis,* 21(6), 989-1000.

Klose, A., and Drexl, A. (2005). Facility Location Models for Distribution System Design. *European Journal of Operational Research*, 162(1), 4-29.

Koppenjan, J. (2008). Public-private partnership and mega-projects. In Priemus, H., Flyvbjerg, B., & van Wee, B. (Eds.), *Decision Making on Mega Projects, Cost-Benefit Analysis, Planning and Innovation* (pp. 189-212). Cheltenham - UK / Northhampton Massachusetts - USA: Edward Elgar publishing Limited.

Koutsikouri, D., Austin, S., & Dainty, A. (2008). Critical success factors in collaborative multi-disciplinary design projects. *Journal of Engineering, Design and Technology*, 6 (3), 198-226.

Kraus, N., Malforms, T., and Slovic, P. (1992). Intuitive Toxicology: Expert and Lay Judgements of Chemical Risks. *Risk Analysis,* 12, 215-232.

Kutsch, E., & Hall, M. (2010). Deliberate ignorance in project risk management. *International Journal of Project Management,* 28, 245-255.

Lau, A. and Leong, T. (2005, December 5). *PROBES: A framework for probability elicitation from experts.* Retrieved from http://www.amia.org/pubs/symposia/D005714.PDF

Lehtiranta, L. (2011). Relational risk management in construction projects: modeling the complexity. *Leadership and Management in Engineering,* 11(2), 141-154.

Lemley, J.K. (1996). Image versus reality – Channel Tunnel image management. Proceedings of the Institution of Civil Engineers, Civil Engineering, 114,12-17

Leung, M. & Olomolaiye, P.(2010). Risk and Construction Stakeholder Management. In Chinyio, E. and Olomolaiye, P. (Eds.), *Risk and Construction Stakeholder Management* (pp 75-98), Wiley-Blackwell. Oxford, UK.

Levitt, R.E., Henisz, W., Scott, W.R., & Settel, D. (2010). Governance Challenges of Infrastructure Delivery: The Case for Socio-Economic Governance Approaches. Construction Research Congress, 757-767.

Li, Y. Y., Chen, P.-H., Chew, D. A., Teo, C. C., & Ding, R. G. (2011). Critical Project Management Factors of AEC Firms for Delivering Green Building Projects in Singapore. *Journal of Construction Engineering and Management*, 137 (12), 1153-1163.

Ling, Y. Y. (2003). A conceptual model for selection of architects by project managers in Singapore. *International Journal of Project Management* , 21(2), 134-144.

Ling, F. Y., & Poh, B. H. (2008). Problems encountered by owners of design-build projects in Singapore. *International Journal of Project Management*, 26(2), 164-173.

Linsey, P.M. and Shrives, P.J. (2005). Examining risk reporting in UK public companies. *The Journal of Risk Finance*, 6(4), 292-305.

Liu, S., Zhang, J., Keil, M., & Chen, T. (2010). Comparing senior executive and project manager perceptions of IT project risk: a Chinese Delphi study. *Information Systems Journal*, 20(4), 319-355.

Loewenstein, G., Weber, E.U., Hsee, C.K., & Welch, N. (2001). Risk as Feelings. *Psychological Bulletin*, 127(2), 267-286.

Loosemore, M. A. (2007). Risk allocation in the private provision of public infrastructure. *International Journal of Project Management,* 25(1), 66-76.

Marie, F., Vidal, L.-A., & Bocquet, J. C. (2011). Interactions-based risk clustering methodologies and algorithms for complex project management. *International Journal Production Economics*.

Maytorena, E., Winch, G.M., Freeman, J., Kiely, T. (2007). The influence of experience and information search styles on project risk identification performance. Engineering Management, IEEE Transactions on 54, 315–326.

McIntyre, C., and Parfitt, M.K. (1998). Decision Support System for Residential Land Development Site Selection Process. *Journal of Architectural Engineering*, 4(4), 125-131.

McLeod, L., & MacDonell, S. G. (2011, October). Factors that Affect Software Systems Development Project Outcomes: A Survey of Research. ACM Computing Surveys , 43(4), 56.

Merrow, E.W. (1988). Understanding the Outcomes of Megaprojects: A Quantitative Analysis of Very Large Civilian Projects.

Metro Vancouver. (2009). Board of Directors Agenda. Supplemental Agenda Items to the April 24, 2009 Board Regular Meetings. File No. 004920944.

Miller, R. & Hobbs, B.H. (2005). Governance Regimes for Large Complex Projects. *Project Management Journal,* 36(3), 42-50.

Mitchell, R.K., Agle, B.R., & Wood, D.J. (1997). Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Academic Management Review,* 22(4), 853-86.

Morgan, M.G. & Henrion, M. (1990). *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. New York: Cambridge University Press.

Multiple Account Evaluation Guidelines (MAE). 1993. Crown Corporations Secretariat. Province of British Columbia.

Murphy, T. (2008). The Case for Public–Private Partnerships in Infrastructure. *Canadian Public Administration,* 51, 99–126.

National Academy Press (NAP). (2000). Characteristics of Successful Megaprojects. Board on Infrastructure and the Constructed Environment. National Research Council.

National Project Management System (NPMS). (2011, May 12). Retrieved from http://www.tpsgc-pwgsc.gc.ca/biens-property/sngp-npms/index-eng.html

Nelms, C., De Zoysa, S., & Russell, A.D. (2006a) Application of an information and knowledge management methodology in analysing the risks in construction projects. The Eleventh International Conference on Computing and Decision Making in Civil and Building Engineering. (ICCCBE-XI), Montreal, Quebec, Canada, 14-16 June 2006.

Nelms, C., DeZoysa, S. & Russell, A. (2006b). Features of a Risk Management Tool Applied to a Major Building Project, CD Rom Proc. of 1st Int. Construction Specialty Conference, CSCE, Calgary, Alberta, Canada, 23-26 May 2006.

Nelms, C., Russell, A.D. (2007). *Improving the risk management process using IT.* ASCE Construction Research Congress, Bahamas, 2007. May 6-8,2007, Grand Bahama Island, Bahamas.

Nelms, C.E. & Russell, A. D. (2008). *Identifying and responding to risks: the role of project profiling*, Proc., Int. Construction Innovation Forum, CSCE 2008 Annual Conference, Quebec City June 10-13, 2008.

Newcombe, R. (2003). From client to project stakeholders: a stakeholder mapping approach. *Construction Management and Economics*, 21(8), 841-848.

Ng, T.S., Cheng, P. K., and Skitmore, M.R. (2005). A framework for evaluating the safety performance of construction contractors. *Building and Environment*, 40(10), 1347-1355.

Ng, A., & Loosemore, M. (2007). Risk allocation in the private provision of public infrastructure. *International Journal of Project Management*, 25(1), 66-76.

Northwest Controlling Corporation Ltd (NOWECO). (2006, December 10). RiskEasy® Risk Register risk management software. Retrieved from http://www.noweco.com/riskrege.htm

Nutt, P.C. (2005). Comparing public and private decision-making practices. *Journal of Public Administration Research and Theory*, 16(2), 289-318.

Obeng, E. (1994). The Project Leaders Secret Handbook. Financial Times Prentice Hall.

Olander, S. (2007). Stakeholder impact analysis in construction project management. *Construction Management and Economics*, 25(3), 277–287.

Olander, S. & Landin, A. (2005). Evaluation of stakeholder influence in the implementation of construction projects. *International Journal of Project Management*, 23(4), 321-328.

Olander, S. & Landin, A. (2008). A comparative study of factors affecting the external stakeholder management process. *Construction Management and Economics,* 26(6), 553-561.

Owen, S.H., and Daskin, M.S. (1998). Strategic Facility Location: A review. *European Journal of Operational Research*, 111, 423-447.

Partnerships British Columbia (PBC). (2012, January 20). Projects. Retrieved from http://www.partnershipsbc.ca/files-4/projects.php

Partnerships Victoria. (2011a, August 29). Risk allocation and contractual issues. Retrieved from www.partnerships.vic.gov.au.

Partnerships Victoria. (2011b, August 29). PSC Supplementary Technical Note, 2003. Retrieved from www.partnerships.vic.gov.au.

Patterson, F.D. and Neailey, K. (2002). A Risk Register Database System to aid the management of project risk. *International Journal of Project Management*, 20, 365-374.

PertMaster Project Analytics (PertMaster). (2006, December 10). PertMaster Project Risk. Retrieved from http://www.pertmaster.com/products/projectRisk.htm

Pinto, J.K. (2000) Understanding the role of politics in successful project management. *International Journal of Project Management*, 18(2), 85–91.

PPP Canada. (2011). PPP Canada P3 Canada Fund: Round Three Application Guide & Application Form. May-June, P.54.

PPP Canada. (2012, March 13). Retrieved from http://www.p3canada.ca/p3-canada-fund-milestones.php

Project Management Guidelines (PMG). (2011, March 10). Tasmanian Government, Version 7.0, (2001, July). Office of Government, Department of Premier and Cabinet. Retrieved from http://www.egovernment.tas.gov.au.

Project Management Institute (PMI). (2008). A guide to the project management body of knowledge, Project Management Institute, Newtown Square, PA.

Province of British Columbia, Risk Management Branch. (2004). Guide to Risk, Draft. April 2004.

Province of British Columbia. (2012, March 28). Risk Management Framework. Retrieved May 12, 2012, from Risk Management Branch & Government Security Office: http://www.fin.gov.bc.ca/PT/rmb/index.shtml

Public Works Government Services Canada (PWGSC). (2011, February 12). Communications Policy. Retrieved from http://source.tpsgc-pwgsc.gc.ca/policy/text/p020-e.html

Rahman, M., & Kumaraswamy, M. M. (2005). Relational Selection for Collaborative Working Arrangements. *Journal of Construction Engineering and Management*, 131 (10), 1087-1098.

Rayner, J. (2012). Understanding reputation risk and its importance. Retrieved from: http://www.qfinance.com/contentFiles/QF02/g26fs3i7/11/0/understanding-reputation-risk-and-its-importance.pdf

Raz, T., & Michael, E. (2001). Use and benefits of tools for project risk management. *International Journal of Project Management*, 19(1), 9-17.

ReVelle, C.S., and Eiselt, H.A. (2005). Location Analysis: A Synthesis and Survey. *European Journal of Operational Research*, 165(1), 1-19.

Ricci, K. (2006). Jail Site Evaluation and Selection. New Jail Planning. Bulletin from the Jails Division of the National Institute of Corrections. U.S. Department of Justice, National Institute of Corrections. April 2006.

Risk Management Research and Development Program Collaboration (RMRDPC). (2002). Risk Management Maturity Level Development, April. Formal Collaboration: INCOSE Risk Management Working Group; Project Management Institute Risk Management Specific Interest Group; UK Association for Project Management Risk Specific Interest Group.

Rowlinson, S. & Cheung, Y.K.F. (2008). Stakeholder management through empowerment: modelling project success, *Construction Management and Economics*, 26(6), 611-623.

Russell, A. D. and Udaipurwala, A. (2004) *Using Multiple Views to Model Construction, Proceedings CIB World Building Congress*, 02-07 May 2004, Toronto, Canada, 12 pages.

Russell, A.D., Nelms, C. (2007) The Application of Information Technology to Support the Elicitation of Expert Judgement in Project Risk Management. Construction Management and Economics 25th Anniversary Conference, CME25, Reading, United Kingdom, 16-18th July 2007.

Saaty T.L. (1990). An Exposition on the AHP in Reply to the Paper "Remarks on the Analytic Hierarchy Process". *Management Science*, 36(3), 259-268.

Samset, K. (2008). How to overcome major weaknesses in mega-projects: the Norwegian approach. In Priemus, H., Flyvbjerg, B., & van Wee, B. (Eds.), *Decision Making on Mega Projects, Cost-Benefit Analysis, Planning and Innovation* (pp. 173-188). Cheltenham - UK / Northhampton Massachusetts - USA: Edward Elgar publishing Limited.

Sari, A., & El-Sayegh, S. M. (2007). Factors Affecting the Selection of the Appropriate Construction Management at Risk Contractor. Developing Entrepreneurial Engineers for the Sustainable Growth of Latin America and the Caribbean: Education, Innovation, Technology and Practice (pp. 5C.1-8). Tampico, Mexico: Fifth LACCEI International Latin American and Caribbean Conference for Engineering and Technology (LACCEI 2007).

Satterfield, T., Mertz, C.K., Slovic, P. (2004). Discrimination, Vulnerability, and Justice in the Face of Risk. *Risk Analysis,* 24(1), 113-127.

Schmidt, R., Lyytinen, K., Keil, M., & Cule, P. (2001). Identifying software project risks: An international Delphi study. *Journal of Management Information Systems*, 17(4), 5-36.

Shared Service British Columbia (SSBC). 2009. Willingdon Lands Planning. January, 2009.

Shen, L.Y., Platten, A., & Deng, X. (2006). Role of public private partnerships to manage risk in public sector projects in Hong Kong. *International Journal of Project Management*, 24(7), 587-594.

Shenhar, A., & Dvir, D. (2004). How Projects Differ, and What to do about it. The Wiley Guide to Managing Project. PWG Morris and JK Pinto EDs, John Wiley and Sons.

Singh, D., & Tiong, L.K. (2006). Contractor Selection Criteria: Investigation of Opinions of Singapore Construction Practitioners. *Journal of Construction Engineering and Management*, 132 (9), 998-1008.

Slovic, P. (1992). Perception of risk: Reflections on the psychometric paradigm. In S.Krimsky & d. Golding (Eds.), *Social theories of risk (*pp 117-152). New York: Praeger.

Slovic, P., Fischoff, B., Lichtenstein, S. (1977). Behavioural decision theory. *Annual Review of Psychology,* 28, 1-39.

Slovic, P., Finucane, M.L., Peters, E., & McGregor, D.G. (2004). Risk as analysis and risk as feelings: some thoughts about affect, reason, risk and rationality. *Risk Analysis*, 24(2), 311-322.

Spetzler, C.S. and von Holstein, S. (1975). Probability Encoding in Decision Analysis. *Management Science,* 22(3), 340-358.

Standard & Poor's (S&P). 2007. *Infrastructure Finance Ratings, Public Private Partnerships – Global Credit Survey 2007*. May 2007.

Sunke (2009). Planning of Construction Projects: A Managerial Approach. PhD Thesis, Department of Civil Engineering, University of Siegen, Germany, 2009.

Tabish, S., & Jha, K. N. (2011). Identification and evaluation of success factors for public construction projects. *Construction Management and Economics*, 29 (8), 809-823.

Tah, J.H.M., and Carr, V. (2000). A proposal for construction project risk assessment using fuzzy logic. *Construction Management and Economics,* 18(4), 491-500.

Thomas, A., Kalidindi, S., & Ganesh, L. (2006). Modelling and assessment of critical risks in BOT road projects. *Construction Management and Economics*, 24(4), 407-424.

Thomas, J.C., Poister, T.H. (2009). Thinking about stakeholders of public agencies: The Georgia Department of Transportation. *Public Organization Review*. 9, 67-82.

Toor, S.R., & Ogunlana, S. (2009). Construction professionals' perception of critical success factors for large-scale construction projects. *Construction Innovation: Information, Process, Management* , 9 (2), 149-167.

Translink, (2011, March 19). Richmond Airport Vancouver RAV Rapid Transit Line. 2003. Retrieved from http://www.translink.ca/en/About-TransLink/Media/2003/July/Richmond-Airport-Vancouver-RAV-Rapid-Transit-Line.aspx

Treasury Board of Canada Secretariat (TBS). (2010). A guide to project gating for IT enabled projects. Retrieved from http://www.tbs-sct.gc.ca.

Treasury Board of Canada Secretariat (TBSa). (2011, February 12). Guide to Integrated Risk Management. Retrieved from http://www.tbs-sct.gc.ca/tbs-sct/rm-gr/guides/girm-ggirtb-eng.asp.

Treasury Board of Canada Secretariat (TBSb). (2011, February 12). Communications Policy of the Government of Canada. Retrieved from http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=12316&section=text#sec6.8

Treasury Board Secretariat (TBSc). (2011, June 6). Management of Major Crown Projects. Retrieved from www.tbs-sct.g.ca/pol/index-eng.aspx.

Treasury Board Secretariat (TBSd). (2011, January 6). Values and Ethics Code for the Public Service. Retrieved from www.tbs-sct.gc.ca/pubs_pol/hrpubs/TB_851/vec-cve-eng.asp

Treasury Board Secretariat (TBS). (2012). *TBS Risk Taxonomy*. Retrieved from http://www.tbs-sct.gc.ca/tbs-sct/rm-gr/guides/grt-gtrtb-eng.asp.

Trousdale, W. & Nelms, C. (2009). Siting Major Public Facilities: Facts, Values and Accountability. *Journal of Urban Planning and Development*, 135(4), 159-165.

Tversky, A. & Kahneman, D. (1974). Judgment under uncertainty: heuristics and biases. *Science*, 185, 1124-1131.

Uher, T.E. & Toakley, A.R. (1999). Risk management in the conceptual phase of a project. *International Journal of Project Management*, 17 (3), 161-169.

United Kingdom's Office of Government Commerce (OGC). (2011, January 12). Gateway to success. Retrieved from www.ogc.gov.uk/

United Nations (UN). 2008. Guidebook on promoting good governance in public private partnerships.

United Nations Economic Commission for Europe (UN). (2004). Governance in Public Private Partnerships for Infrastructure Development, United Nations, Geneva.

Xu, P. & Ramesh, B. (2007). Software process tailoring: An empirical investigation. *Journal of Management Information Systems,* 24(2), 293-328.

Voetsch, R. J. (2003). The Current State of Project Risk Management Practices Among Risk Sensitive Project Management Professionals. PhD Thesis, George Washington University, Washington, D.C.

Von Winterfeldt, D., and Edwards, W. (1986). *Decision Analysis and Behavioral Research.* Cambridge University Press, Cambridge, England

Walewski, J. and Gibson, G. E. (2003). International Project Risk Assessment: Methods, Procedures, and Critical Factors. Center for Construction Industry Studies, Report # 31, The University of Texas at Austin.

Wang, Y. (2005) *Environmental Risk Modeling of Infrastructure Projects*, MASc Thesis, Department of Civil Engineering, University of British Columbia, Vancouver, Canada, May 2005.

Wang, J., & Yuan, H. (2011). Factors affecting contractors' risk attitudes in construction projects: Case study from China. *International Journal of Project Management*, 29(2), 209-219.

Ward, S. & Chapman, C. (2003). Transforming project risk management into project uncertainty management. *International Journal of Project Management*, 21(1), 97-105.

Ward, S. & Chapman, C. (2008). Stakeholders and uncertainty management in projects. *Construction Management and Economics*, 26(6), 563-577.

Wells, A.S., Hirshberg, D., Lipton, M.,& Oakes, J. (1995). Bounding the Case Within Its Context: A Constructivist Approach to Studying Detracking Reform. Educational Researcher, 24(5), 18-24.

Williams, W. & Lewis, D. (2008). Strategic management tools and public sector management, *Public Management Review*, 10(5), 653-671.

Yang, J., Shen, Q.G., Bourne, L., Man-Fong Ho, C. & Xue, X. (2011) A typology of operational approaches for stakeholder analysis and engagement. *Construction Management and Economics*, 29(2), 145-162.

Yeo, K.T., Tiong, R.L.K. (2000). Positive management of differences for risk reduction in BOT projects. *International Journal of Project Management*. 18(4), 257–65.

Yin, R.K. (1999). Case Study Research: Design and Methods, Sage, Thousand Oaks, CA.

Yu, A. T. W., Shen, Q. P., Kelly, J., & Hunter, K. (2006). Investigation of critical success factors in construction project briefing by way of content analysis. *Journal of Construction Engineering and Management*. 132(11), 1178-1186.

Yuan, J., Skibniewski, M.J., Li, Q. and Zheng, L. (2010). Performance objectives selection model in public private partnership projects based on the perspective of stakeholders. *Journal of Management in Engineering*, 26 (2), 89-103.

Zhang, X. (2004). Concessionaire Selection: Methods and Criteria. *Journal of Construction Engineering and Management*, 130 (2), 235-244.

Zhang, X. (2005). Critical success factors for public-private partnerships in infrastructure development. *Journal of Construction Engineering and Management*, 131 (1), 3-14.

Zou, P., Zhang, G., & Wang, J. (2007). Understanding key risks in construction projects in China. *International Journal of Project Management*, 25(6), 601-614.

Appendices

Appendix A

Table 29: Public Sector Project stakeholder analysis results

Stakeholder	Impact of Project on Stakeholder	Impact of Stakeholder on Project	Stakeholder Participation in Project Stage		
			Initiation	Planning	Procurement
Local Jurisdiction Authority	• Claims against proposed site can set adverse precedence against other similar sites in the area	• Consultation requirements can result in project delays	•	•	•
Client Department	• Project fulfills Program requirements (+); • Project funding competes with other department priorities (-); • Project meets long client term strategy; • Project allows for client operations to be optimized;	• Client is the driver for Project demand; • Client commitment to project and prescribed requirements form Project scope, budget and schedule; • Client funding and commitment to project required for Project to proceed; • Client approval can delay necessary approvals (site, funding etc); • Client requirements may reduce flexibility for future design changes • Synergy of client working teams are not strong.	•	•	•
Local Municipality	• Project provides annual and upfront revenue; • Project design meets municipal long term strategy; • Project potentially conflicts with other local interest group plans; • Project supports municipal environmental, economic and development policies;	• Poor engagement with municipality results in project failures; • Municipality may impose restrictions; • Municipality support upholds desired image and reputation objectives; • Processes may be influenced by local politics; • Additional incentives potentially available if Project proceeds; • Strong partnership potential could shorten process time lines; • Municipality offers flexibility to meet select project activities efficiently;	•	•	•
Developers	• Tender process required to be fair and transparent; • Project provides a new, local opportunity;	• Developer not familiar or interested to participate in government process; • Maintaining interest required to ensure sufficient competition	•	•	•
Business Community	• Project shifts business opportunities to a new location and jurisdiction; • Current location provides recapitalization opportunity (new business opportunity);	• Business community may engage politicians to support status quo; • Business community engages media • Consultation requirements result in delays.	•	•	•
Funding Authority	• Project must illustrate decision of 'best value' • Project funding during period of financial restraint	• Funding approval denied results in project cancelation;	•	•	•

Stakeholder	Impact of Project on Stakeholder	Impact of Stakeholder on Project	Stakeholder Participation in Project Stage		
			Initiation	Planning	Procurement
Local Interest Group	• Project opens up opportunities for local interest group to participate in sharing arrangement including funding; • Project could result in local interest group losing exclusive control of site	• Local interest group has strong relationship with local municipality; • Local interest group has access to resources; • Local interest group has strong media connections;	•	•	•
Project Sponsor Minister	• Project requires commitment of Departmental resources • Project may raise political concerns related to funding or local interest group conflicts; • Project approval time line aligned with potential re-election; • Project offers opportunity to highlight governing party priorities;	• Lack of political support may result in Project not proceeding;	•	•	•
Project Sponsor Senior Executive	• Project requires resources to deliver of their mandate and departmental mandate • Project requires time of senior executive to manage communications				
Media	• Project may generate response to various stakeholder opinions associated with the Project;	• Media could create draw additional political attention to Project; • Media response could influence Project Sponsor stakeholders	•	•	•
Chamber of Commerce	• Project objective is aligned with Chamber of Commerce economic development priorities; • Chamber of Commerce may support Business Community concerns;				
Provincial/Other Local Government Jurisdictions	• Project requires funding at a time of fiscal restraint				
Developers	• Project creates new opportunity	• Developer may propose alternative approaches to address current funding pressures; • Developer provides local expertise • Developer takes on select Project risks	•	•	•
Local Transit and Development Authorities	• Project supports transportation and development strategies;				

Stakeholder	Impact of Project on Stakeholder	Impact of Stakeholder on Project	Stakeholder Participation in Project Stage		
			Initiation	Planning	Procurement
	• Project reduces traffic congestion and environmental impact;				
Project Sponsor Department	• Project requires resources to perform the work • Project provides a source of work for several years and develops expertise				
Private Sector Consultants and Trades	• Project creates new jobs and economic activity in the region				

Table 30: Generic stakeholder list

	Stakeholder Name
1	**Custodian Senior Management (6)** - Minister - Deputy Minister - Associate Deputy Minister - Assistant Deputy Minister - Regional Director General - Chief Financial Officer
2	**Custodian Senior Management Advisors (3)** - Minister Advisors - Deputy Minister Advisors - Assistant Deputy Minister Advisors
3	**Other Major Internal Groups (National)** - Investment Major Project Directorate - Corporate Services, Policy & Communications - Director General, Accommodation and Portfolio Management - Director General, Strategic - Director General Architectural and Engineering Services - Centre of Expertise for PPP - Legal Team (National) - Translation Services (National)
4	**Custodian Steering Team (Regional)** - Regional Director Accommodation and Portfolio Management - Regional Manager Accommodation and Portfolio Management - Regional Director A&E Services - Regional Manager A & E Services - Regional Director Corporate Services, Policy & Communications (National, Regional) - Regional Director Real Property Contracting - Regional Manager Real Property Contracting - Cabinet Treasury Board Submission (National)
5	**Custodian Project Implementation Team** - Project Director - Project Manager - Design Team Leader
6	**Other Major Internal Groups** - Management and oversight services - Communications - Legal Services - HR Management - Financial Management - Information Management - Travel and other administrative services - Real Property

	Stakeholder Name
	- Material Acquisitions - Procurement
7	**Potential Participating Departments – Federal** ***Contracting Authorities and Service Agents:*** - Public Works and Government Services Canada - Defence Construction Canada ***Industrial and regional benefit departments and agencies:*** - Industry and Science Canada - Western Economic Diversification Canada - Atlantic Canada Opportunities Agency - Federal Office of Regional Development (Quebec) ***Others:*** - Privy Council Office - Treasury Board Secretariat - Department of Finance Canada - Environment Canada - Department of Justice Canada - Human Resources Development Canada - Canadian Heritage - Foreign Affairs and International Trade Canada
8	**Tenant Project Implementation Team** - Project Director - Project Manager - Design Team Leader
9	**Tenant Senior Management Team** - Client Services - Major Capital Projects - Corporate, Public Safety Office - Chief Financial Administrative Officer
10	**External Private Sector Project Team (Support Project Team)** Private Sector Advisors - Legal Team - Financial Advisors - Business Management Consultants - Process/Procurement Advisors - Quantity Surveyor - Owner Architectural & Engineering Advisors (Ex. Electrical, Specification Writer etc.) - Security Consultant - Functional Program Co-ordinator - Specialist A&E Consultant (Move, Fit-up, Operations & Maintenance, Commissioning, Equipment) - Insurance Advisor - Communication consultant - Risk Management consultant

	Stakeholder Name
12	**External Public Sector Project Team Consultants (Support Project Team)** - Department of Justice Legal Team - PPP Canada Inc. - Provincial PPP Agencies (Partnerships BC, Infrastructure Ontario etc.)
13	**End Users** - End Users Internal - End Users External - Operations Personnel
15	**Client Staff** - Group A (Ex. Internal Operations) - Group B (Ex. Senior Management) - Group C (HR, IT, Admin, Food Services)
16	**Authorities Having Jurisdiction** - First Nations Groups - Local Municipality - Provincial Government - Provincial Agencies (Ex. Transport Authority, Housing Authority) - Federal Jurisdictions
22	**Approval Agency** - Treasury Board
24	**External Private Sector Reviewers** - Fairness Monitor - Third Party Process Reviewer
27	**Third Party Stakeholders** - Local Residents - Special interest groups (Ex. Art Community, Environmental Community) - Advocacy groups - Political constituents (Federal, Provincial, Municipal)
29	**Unions / Representatives/Associations** - Public Sector Unions - Private Sector Unions - Construction Association - Chamber of Commerce
30	**Utilities** - Water Supplier - Sewer Supplier - Hydro Supplier - Gas Supplier - Informatics
31	**Trades/Subcontractors** - Excavation - Formwork - Rebar Installation

	Stakeholder Name
	- Structural steel erection - Mechanical - Electrical - Elevators/Escalators
32	**Consultants** - Architect - Electrical Engineers - Mechanical Engineers - Structural Engineers - Sustainable Design Consultant - Landscape Architect - Environmental Engineer - Civil Engineer - Geotechnical Engineer - Vertical Transportation Consultant - Specifications Developer - Architectural Design Consultant - Hardware Consultant - Radiation Shielding Consultant - Commissioning Consultant - Informatics Consultant - Security Consultant (IT) - Audio Visual Consultant - Irrigation Consultant - Equipment Consultant - Security Consultant (Physical) - Lenders Advisor
33	**Project Proponents** - Local Developers - National Developers - International Developers - Pension Funds
34	**Media** - International Media - National Media - Local Media
35	**Interested Parties** - Existing Accommodation Providers
36	**Political Representatives** - Municipal (In/Opposition) - Provincial (In/Opposition) - Federal (In/Opposition)

Appendix B

Figure 39: Expansion of PCBS Component Hierarchy

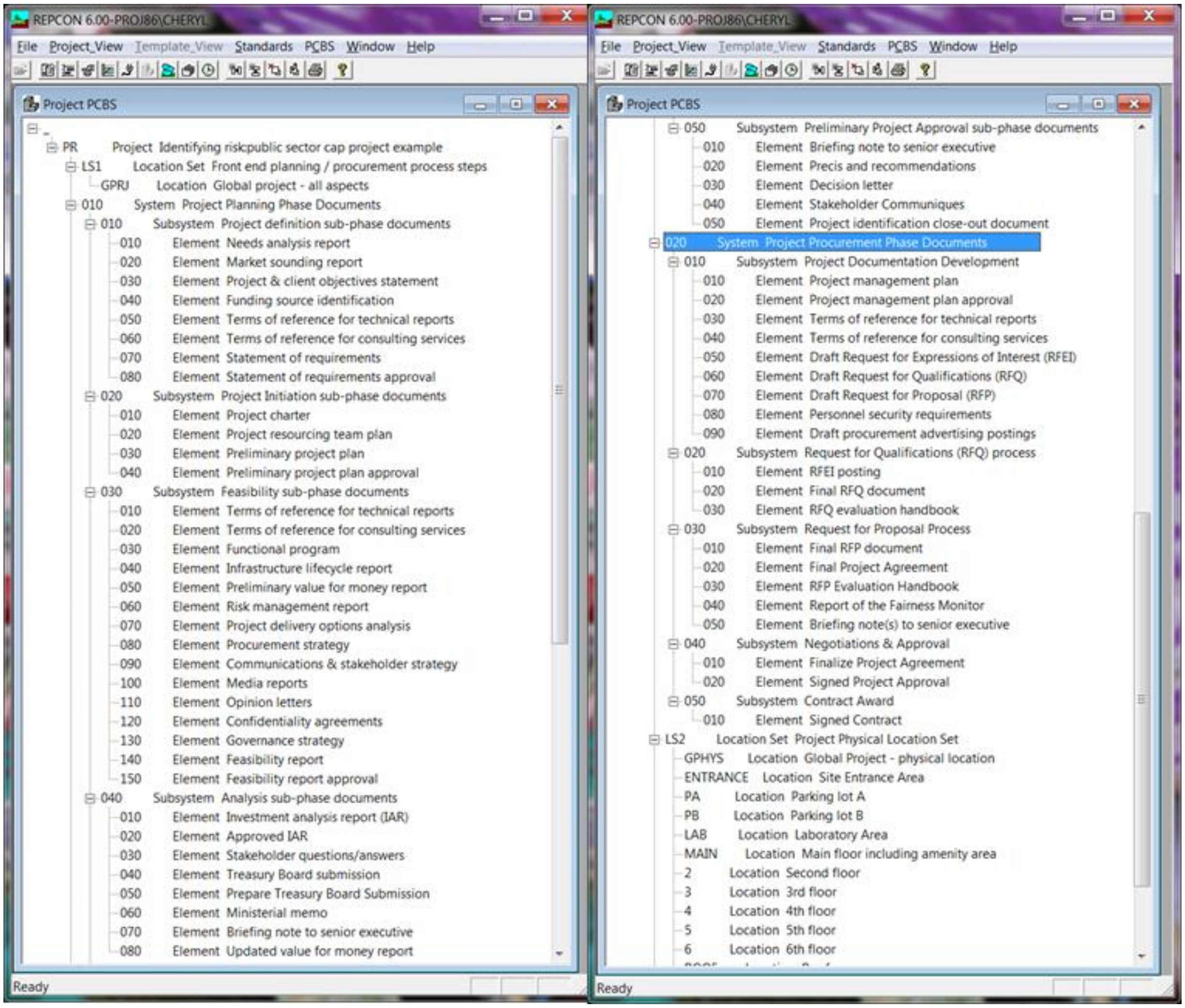


Figure 40: Expansion of process view of case study project for 2011-2012 activities

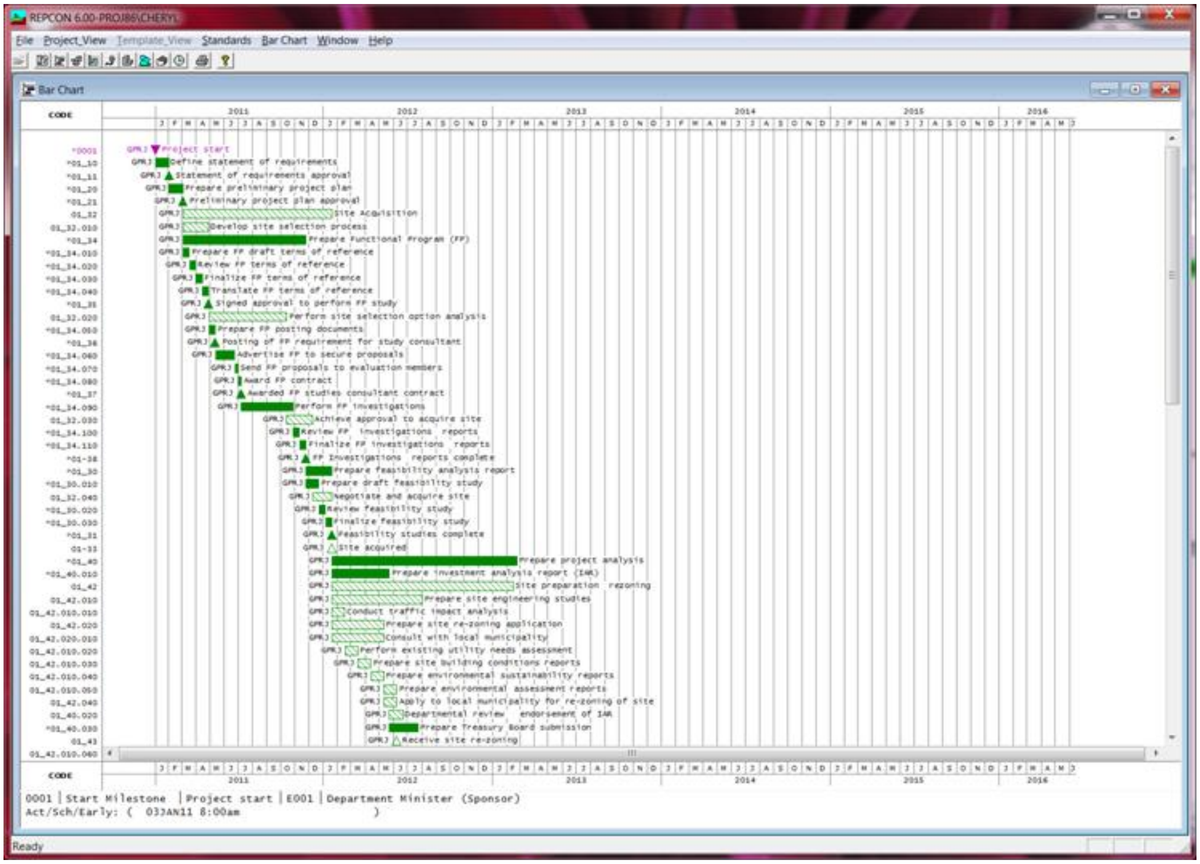


Figure 41: Expansion of process view of case study project for 2012-2014 activities (cont.)

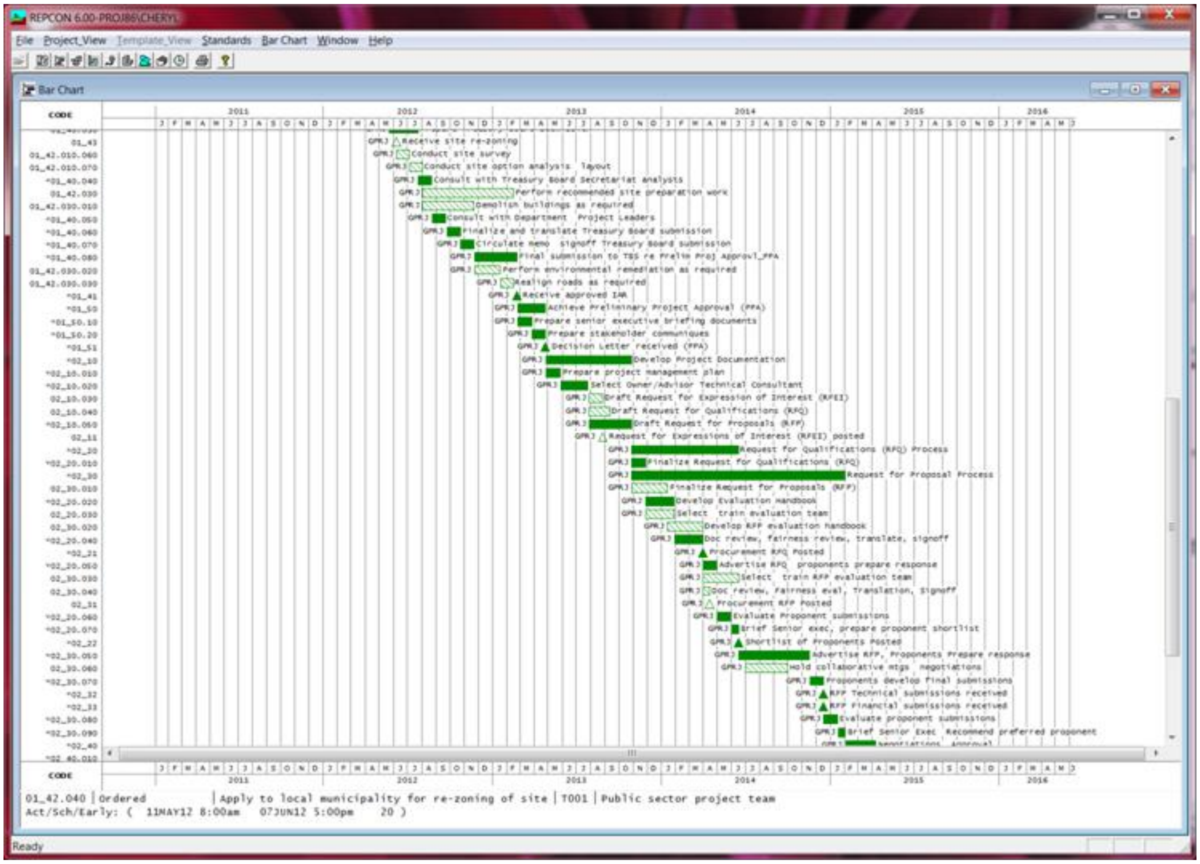


Figure 42: Expansion of process view of case study project for 2015-2016 activities (cont.)