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Risk management applied to projects, programs, and portfolios

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Abstract

Purpose – The purpose of this paper is to present a review of recent risk management literature applied to projects, programs and project portfolios performed inside an organization with the aim of finding areas of opportunity to continue research and the development of current guides and methodologies.

Design/methodology/approach – The paper uses a review of recent literature published by international organizations and journals specializing in the field of project, programs, and portfolios.

Findings – The review shows that project risk management is a well developed domain in comparison to the program risk management and portfolio risk management fields, for which specifically written methodologies are difficult to find. The review also demonstrates the need to include better tools to perform a continuous control and monitoring process. Integrating a vulnerability approach is also necessary in order to consider the project, program or portfolio characteristics which mediate between consequences and the exposure to hazards and opportunities.

Research limitations/implications – The review does not consider white papers or popular media.

Originality/value – The limitations found in current risk management methodologies show the challenges researchers must undertake to continue improving this domain for projects performed inside an organization. The paper exhibits the areas of opportunity where methodologies and guides can be further improved to evolve towards better management structures.

Keywords Project management, Risk management, Chaos theory, Corporate strategy

Paper type Literature review

1. Introduction

In recent years, there has been a growing need to include a strategic perspective in project risk management methodologies in order to consider the holistic views of an organization. A project is not isolated and it must be considered inside an organization which links the project with programs, project portfolios, and the strategic goals of the organization. Project management offices are an example of this integration, managing project portfolios, programs, and projects and co-ordinating their interdependencies. They also perform some functions related to strategic management, constituting one of the most important roles of the project management office (Dai and Wells, 2004; Hobbs and Aubry, 2006). A project is an element inside the triad portfolio-program-project, which follows the strategic vision of the organization. In consequence, it is not enough to define a project only in terms of schedule, costs, and product specifications; it is necessary to take into account a holistic perspective. This also applies to project risk management. For instance, integrated risk management is defined as:

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> [...] a continuous, proactive, and systematic process to understand, manage, and communicate risk from an organization-wide perspective. It is about making strategic decisions that contribute to the achievement of an organization's overall corporate objectives (Treasury Board of Canada Secretariat, 2007).

However, in practice, project risk management has been seen for a long time as a process to manage events which have an effect only on a project's objectives, such as cost, time, scope, or quality objectives (Cooper *et al.*, 2005; Olson, 2007; Perminova *et al.*, 2008; Project Management Institute (PMI), 2004; Williams, 1995). Since the introduction of the PERT methodology in the late 1950s, the conventional risk analysis considers a project as an independent element inside an organization. That is, risk analysis focuses mainly on project objectives, leaving aside the strategic goals that an organization would want to achieve through the project's development. This focus upraises from the traditional interpretation of "project success" which is usually related only to cost, time and project performance (Williams, 1995).

This paper reviews risk management applied to projects, programs, and portfolios in recent literature. We believe that these interrelated areas are essential to implementing the strategic vision of the organization, since portfolios and programs transfer the strategic needs to the project's definition and link business strategy to the organization's project collection. Our review and recommendations focus on projects performed inside an organization which could be classified as internal or external projects (Shenhar cited by Elonen and Artto, 2003). External projects develop products to satisfying market needs and internal projects aim at preserving or improving the performance of the organization such as problem solving, maintenance or research projects. We do not consider other projects which may have other needs; for instance, major capital projects or mega-projects involving the use of different tools and techniques.

The review does not include the historical development of this domain because our intention is to focus on recent literature in order to find areas of opportunity for further research and development. Readers may consult Edwards and Bowen's review (1998) or Williams' article (1995) as better references about the historical progress of project risk management.

The scope of research was limited to journals, books, government documents and publications by specialized organizations such as the PMI in the USA, the Association for Project Management (APM), and the Office of Government Commerce (OGC) in England. This research did not consider popular media or white papers. Although business practices may have different meanings for program and portfolio concepts and organizations may manage them in different ways, we keep the approaches and definitions proposed by the specialized institutions PMI, APM, and OGC. They supply a generic structure which can be tailored considering the needs of each organization and the characteristics of projects, such as Payne and Turner (1999) suggest. However, we are conscious that even using a tailored methodology there will always be deviations in the practice which must be solved without following standard risk management procedures (Hällgren, 2007).

The objective of the paper is to find the limitations that risk management methodologies currently have in order to show the challenges researchers must undertake in continuing the improvement of this domain. Its contribution consists in defining the areas of opportunity where methodologies and guides can be further improved to evolve towards better management structures adapted to current needs.

2. Risk management applied to projects

Risk management applied to project management involves the analysis of the objective functions of the project in their interaction with the project variables. These variables – for instance, cost resources or other factors – have a dynamic behaviour and they present different degrees of uncertainty through time. In consequence, the achievement of the objective, which has a strong relationship with these variables, is also uncertain (Jaafari, 2001). We may define "uncertainty" as *the difference between the data required and the data already possessed* (Thiry, 2002). Some other factors adding uncertainty and influencing variability on projects are lateness in taking a decision, the complexity of the decision, and lack of control during the experimentation phases (Chapman, 1973). Ward and Chapman (Chapman and Ward, 2003; Ward and Chapman, 2003) explain that uncertainty is generated not only because of context variability but also because of ambiguity. They present some examples such as the ambiguity of the priorities and objectives of the project, or the ambiguity of bases to estimate the project's parameters. Kwak and Stoddard (2004) and Flyvbjerg (2006) expose optimism as another factor, which increases ambiguity. Optimism generates unrealistic estimations or status reports, which are the basis in taking a decision, increasing the probability of a project failure.

It is understood that the uncertainty of a project in a steady environment is higher at the beginning and diminishes as the project progresses due to proactive planning and pertinent decision-taking. However, uncertainties do not decrease in all cases. Complex projects in changing environments are an example in which uncertainty remains higher throughout the project's evolution. In consequence, the processes of risk management must continually verify the project's variables, re-value the status of the project's objectives and adjust the established plans. In other words, it must be capable of quickly re-evaluating the project's options facing the changing circumstances of the environment (Jaafari, 2001).

The management of risks must take into consideration the dynamic nature of projects. In addition, it must take into account not only the negative consequences of an event but also the positive consequences. Cooper *et al.* (2005) express this need, saying that managing only the negative perception of risks is effectively to ignore one half of a project manager's responsibility. Jaafari (2001) and Ward and Chapman (2003) support this statement exposing the importance of considering risks and opportunities during the risk analysis process. In addition, the PMI and the APM take into account the positive consequence of an event in the following definitions:

- Risk: "An uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives" (PMI, 2004).
- Risk: "An uncertain event or set of cir cumstances that, should it occur, will have an effect on the achievement of the project's objectives" (APM, 1997).

Ward and Chapman go further by proposing an approach called *uncertainty management* which considers the positive and negative consequences of uncertainty (Chapman and Ward, 2003; Ward and Chapman, 2003). They argue that the word "risk" already has a negative connotation, complicating the exploration of opportunity during the risk identification and analysis process. *Uncertainty management* focuses on identifying and managing all sources of uncertainty, forming threats or opportunities.

The introduction of a vulnerability assessment in risk management is an important contribution made by Zhang (2007). He presents an interesting

redefinition of the project risk analysis. He explains that previous project risk studies pay much attention to the statistical links between risk events and risk consequences, leaving aside the influence that a project may have on those links. These studies take for granted that events produce consequences without considering that a project's characteristics influence them. Zhang describes this influence as the vulnerability of the project and he suggests including its assessment during the risk analysis. As a matter of fact, other domains such as disaster mitigation or environmental change already include a vulnerability assessment to complement risk management (Vatsa, 2004; Weichselgartner, 2001). Zhang categorizes project vulnerabilities by exposure and capacity; defining exposure as the degree to which a project is exposed to risk events and capacity as the capability of a project to deal with the impacts from risk events. His contribution brings a more complete interpretation of risk providing a base to continue researching in this direction.

There are many books describing the processes and characteristics of project risk management. We mention specifically the following books that we consider well explained and complete providing an important contribution to this domain:

- *Project Risk Management Guidelines: Managing Risks in Large Projects and Complex Procurements* (Cooper *et al.*, 2005).
- *Risk Management in Projects* (Loosemore *et al.*, 2006).
- *Project Risk Management: Processes, Techniques and Insights* (Chapman and Ward, 2003).
- *Risk Management in Project Organizations* (Edwards and Bowen, 2004).

However, the most recognized risk management guides for projects are the *Project Risk Analysis and Management Guide* (The *PRAM Guide*) and Chapter 11 of the *Project Management Body of Knowledge* (The *PMBOK Guide*). In the following paragraphs, we present a brief description of them:

- *PRAM Guide: Project Risk Analysis and Management Guide* – 2nd ed., 2004, APM, UK.

The *PRAM Guide* is specifically developed to be used in the project management domain. It is oriented to avoid or decrease threats and to exploit or make the most of opportunities. The process is iterative and it consists of five phases and eight sub-phases repeated through the project life cycle. During the focus sub-phase, the objectives of the project risk management process are defined by referencing the project's objectives as well as higher-level objectives such as strategic or corporate governance goals. It includes a complete list and descriptions of tools and techniques used during the risk management process. It focuses on project-specific issues, however it also considers how the risk management process at project level connects to corporate or program level risk management (APM, 2004; Chapman and Ward, 2003):

- *PMBOK Guide*, Chapter 11: *Project Management Body of Knowledge* – 3rd ed., 2004, PMI, USA.

Chapter 11 of the *PMBOK Guide* is also written specifically to be applied in the project risk management field. It has a linear framework composed by inputs, processes and outputs. It aims at increasing the probability and impact of positive events and

decreasing the probability and impact of events that may affect the achievement of the project's objectives. This chapter does not explicitly consider risks and opportunities linked to the achievement of strategic objectives. However, we can say that they are indirectly taken into account because the risk management approach addresses time, cost, scope, and quality project objectives; Chapter 4 of *PMBOK* explains that the project scope must focus on the business needs, the product description and the support of the organization's strategic goals. The framework presents some tools and techniques to use in each risk management process (Cooper *et al.*, 2005; PMI, 2004).

Project risk management is a mature domain that is rapidly growing. However, there are some limitations during the implementation of these methodologies.

2.1 Limitations of project risk management during implementation

As shown before, there is a need to closely consider opportunities in project risk management. However, project risk management has a strong orientation towards the negative effects (Hillson, 2002; Jaafari, 2001; Pellegrinelli *et al.,* 2007; Ward and Chapman, 2003; Williams, 1995; Zhang, 2007). For instance, Kristensen *et al.* (2006) propose that risk control strategies may be grouped into three categories:

(1) *Risk-based approach:* This approach focuses directly on risks found in previous steps and treatments developed from the analysis of these risks and their possible solutions. Strategies are usually integrated into four groups:
   - avoidance;
   - reduction;
   - transfer; and
   - retention.

   Project termination may also be a way to treat risks (Turner, 2005) which falls in the avoidance group.

(2) *Precautionary approach:* This approach is based on continuous project monitoring, continuous search of risk and the development of substitutes. It is not based on a formal risk assessment.

(3) *Discursive approach:* This approach is oriented towards people with the intention of building confidence and trustworthiness through reduction of uncertainties, clarification of facts, involvement of affected people, deliberation, and accountability.

This classification takes into account treatments looking to control the negative consequences. Chapman and Ward consider this kind of plans to be a reactive response to the uncertainty. To complement them, it is also necessary to establish plans with proactive responses in order to treat opportunities (Chapman and Ward, 2003).

Years ago, conventional project risk management approaches did not explicitly consider strategic and holistic risks (Jaafari, 2001). They were oriented towards the identification and analysis of other risks such as technical, operational, cost, schedule, etc. Project risk management has only in recent years started to consider strategic issues; an example of this fact is the second edition of the *PRAM Guide* (APM, 2004) where the process considers a wider perspective of the organization. Another example is the third edition of *Managing Successful Projects with PRINCE2* which asks for the consideration of project interdependencies with other projects, the impact on a business

program and the impact on a business case (OGC, 2002). Risk assessment uses tools such as cause and effect analysis, subcontractor management, cost-benefit analysis, benchmarking, custom satisfaction surveys, and simulation (Raz and Michael, 2001). However, despite considering external variables in some tools such as Benchmarking and Custom satisfaction surveys, there are several deficiencies when treating risks generated by external variables; especially in treating market, political, financial and environmental risks (Jaafari, 2001).

We have already discussed the importance of having a risk management process constantly verifying the project's variables, re-valuing the status of the project's objectives and adjusting the established plans facing the continuously changing environmental circumstances. However, risk management approaches have discrete risk control and monitoring in practice. Risk analysis is made periodically during the progress of a project, especially at the beginning of each phase. Analysis is performed assuming that risks and opportunities will not change during this time. That is obviously incorrect because even projects' objectives change in time, along with the means to achieving them (Grundi, 1998). The conditions of a project continually change, and not considering this dynamic behaviour may threaten the project because of unexpected events (Robert and Bourgault, 2005).

To conclude this section, it is pertinent to remark that the most serious project risk management limitation is its low implementation in the industry (Kwak and Stoddard, 2004; Uher and Toakley, 1999). Kwak and Stoddard (2004) refer to Kwak and Ibbs showing that risk management is the least practiced discipline among the knowledge areas in project management. In addition, Hobbs and Aubry's (2006) results show that only 29 percent of the project offices studied consider managing a risk database to be an important function. It is an overwhelming fact showing that it is still necessary to build a stronger risk culture if we want to increase the efficacy of risk management processes in project-based organizations.

2.2 Alternative approaches

Kristensen *et al.* (2006) propose nine different uncertainty components to analyze risks. These components are:

(1) extent of damage;
(2) probability of occurrence;
(3) incertitude;
(4) ubiquity;
(5) persistency;
(6) reversibility;
(7) delay effects;
(8) violation of equity; and
(9) potential of mobilization.

This is an interesting approach which shows that a risk description and characterization can be adapted to the needs of specific situations and is not restricted to the usual probability-impact description.

Another interesting approach is the one proposed by Petit *et al.* (2004). They propose an approach giving priority to an event's consequences rather than the event's probability of occurrence. The approach is based on the fact that it is very difficult, or maybe impossible, to find all causes which may induce negative consequences; moreover, it is even more difficult to estimate the probabilities of their occurrences in a clear and accurate way (El-Sayegh, 2008; Pender, 2001; Petit *et al.*, 2004). This risk management approach, called "Approche par conséquences" (approach by consequences), was born in the civil engineering domain in order to evaluate the vulnerability of critical infrastructures (Petit *et al.*, 2004; Robert, 2005). Robert and Bourgault (2005) applied this perspective to project risk management resulting in an approach with the following characteristics:

- A strong environment of co-operation to facilitate communication.
- Continuous monitoring of resource status in order to anticipate potential consequences.
- An interdependence analysis assessing their importance in the transference of failure.
- A risk analysis and evaluation starting from consequences and going to causes.

This approach is still conceptual and it needs to be developed. However, its contribution is important in emphasizing the need to continually perform risk management as well as considering interdependencies searching for risk transferences. Perminova *et al.* (2008) concur with this vision by stating that risk analysis and planning processes interpret uncertainty as known or clearly defined circumstances or events. But uncertainty includes also those circumstances and events which are unknown and may happen unexpectedly. For those cases, it is very difficult or impossible to do a risk identification, analysis or planning if they do not exist in the minds of people performing those processes. As they say, an over exaggerated importance of planning may be questioned and it is necessary to maintain a continuous monitoring of risk during the project life cycle, keeping reflective learning and common sense as key elements for managing uncertainty.

3. Risk management applied to programs

A program of projects is a structure composed of projects which are managed in a co-ordinated way in order to reach an ensemble of major benefits (Pellegrinelli, 1997). Another definition considers a program as a temporary organization constituted by an ensemble of projects which are managed together to achieve higher order strategic goals not delivered by the individual project management (Turner and Müller, 2003). Looking at these definitions, it is clear that there is a strong link between the strategic goal achievement, the benefits delivered by projects and the program of projects. Program management plays an important role to implement the strategy of an organization because all projects constituting the program follow the same strategic direction. It is strongly related to strategic change management and organizational development domains (Pellegrinelli, 2002) since Program management does not focus in the product delivery, but overall on obtaining benefits delivered by the management of the collection of projects (Aubry *et al.*, 2006; Dietrich, 2006; Garon, 2003; Milosevic and Srivannaboon, 2006; Szymczak and Walker, 2003; Thiry, 2004).

There is an important distinction between a project and a program. A project is a temporary organization designed to achieve a set of specific change objectives (Turner and Müller, 2003) and a program is a structure that provides a strategic direction to a project collection in order to obtain a strategic change and an organizational development (Dietrich, 2006). In spite of that difference, there is a tendency for programs to have a rigid hierarchy and to consider a linear life cycle, such as with a project (Lycett *et al.*, 2004; Thiry, 2002). It is also assumed that tools and techniques used in project management may be used also in program management. Risk management is an example; the first edition of *Managing Successful Programmes* suggested the use of a risk log based on a project-level risk log (Lycett *et al.*, 2004). The problem of considering projects and programs in the same perspective is that all potential benefits are lost. This narrow perspective enhances the program manager domination of projects and the lack of a strategic view to measure the value added during the program progress (Pellegrinelli, 1997).

3.1 Risk management methodologies for programs

There are three main issues to consider during the management of risks in programs:

(1) the program's effectiveness in improving the organization's competitive position;

(2) the achievement of the program's expected benefits; and

(3) the changes in the assumptions of the program business case (Lycett *et al.*, 2004; Pellegrinelli, 1997).

These issues are oriented to complement strategic management in order to supervise and evaluate the environmental threats and opportunities in relation to the organization's weaknesses and strengths (Van der Merwe, 2002). Supporting this, Pellegrinelli (1997) proposes the use of strategic management techniques during risk analysis, such as competitor analysis, and the identification of key competitive dimensions and benchmarking. In addition, it is necessary to include organizational issues to perform a holistic approach. For example, Szymczak and Walker (2003) propose three suggestions:

(1) compare the feasibility of projects;

(2) analyze the way in which each project is linked to the organization; and

(3) most importantly, analyze how each project is linked to other projects.

The PMI also proposes six activities for managing risks in programs (PMI (2006b)):

(1) To identify and analyze inter-project risks.

(2) To verify project risk response plans whose actions could affect other projects.

(3) To determine root causes.

(4) To propose specific solutions to risk escalated by project managers.

(5) To implement response mechanisms which benefit more than one project.

(6) To manage program contingency reserves (in terms of cost and time).

Despite these propositions, it is difficult to find a risk management guide specifically developed for programs. There are some approaches which try to satisfy this need; for instance, an approach exists to improve the efficacy of the risk planning system for

NASA's space programs (Ray, 2000). This approach is based on knowledge using an expert system, which provides a structured guideline for planning risks in a cost-effective way. There are also some books such as the *Gower Handbook of Programme Management* (Reiss *et al.*, 2006) and *Managing Successful Programmes* (OGC, 2003) that dedicates a chapter to explaining how risk management is applied to programs. However, they treat it in a general approach without explaining in detail how benefits may be drawn, how project interdependencies and opportunity achievements are considered during risk analysis and evaluation, and how risk control and monitoring is performed, taking into account the main objectives of program management. On the other hand, the PMI is working on the next edition of *The Standard for Program Management*. The draft of this standard was shown on the PMI web site introducing important improvements. For example, Chapter 11 presents risk management specifically adapted to program management, considering the complete context of the triad portfolio-program-projects. It contains tools to analyze threats, opportunities and dependencies from a program perspective. PMI develops this chapter following the risk management structure exhibit on its *PMBOK Guide*. In spite of still having some limitations and not being a detailed guide to perform program risk management, they are improving their standard in a good direction.

Some generic risk management guides can be adapted to perform program risk management. Some examples are the AZ/NZS4360 Standard or the *M_o_R Guide*:

- *M_o_R Guideline*: *Management of Risk: Guidance for practitioners* – 2nd ed., 2007, OGC, UK.

This guideline is developed for public and private sector organizations and deals with risks affecting the organization's success in a positive or negative manner. The departure point to analyze risks is the strategic level going through programs, projects and operations. It considers a project as an element inside a program and interconnected with other projects or programs. It highlights the importance of identifying the interdependencies linking the project to its context. In addition, the guideline presents a complete description of tools and techniques. An interesting issue of this guideline is the presentation of an organization maturity model depending on the level of risk management implementation. Its risk management process structure is iterative in nature (Cooper *et al.*, 2005; OGC, 2007a):

- *AS NZS 4360 Standard*: *AS NZS 4360:2004* – 3rd ed., 2004, Council of Standards, Australia – New Zealand.

This standard presents a generic process to implementing risk management. It does not say anything about project-specific issues; however due to its generic characteristic, it can be adapted to portfolios, programs and projects. It addresses threats and opportunities having an iterative structure to perform the management of risks. Tools and techniques are listed but not explained. It takes into account links between risk management processes, the strategic direction and the daily action and treatment activities (Cooper *et al.*, 2005; Standards Australia International Ltd, 2004).

4. Risk management methodologies for a portfolio of projects

A project portfolio is defined by the PMI as "... a collection of projects or programs and other work grouped together to facilitate effective management of that work to meet

strategic business objectives" (PMI, 2006a). Another definition considers a portfolio of projects as a permanent or temporary organization in which their components are managed together to coordinate interdependencies and prioritize resources between them, reducing uncertainty (Turner and Müller, 2003). The principal points of these definitions are the importance of the project portfolio in achieving strategic goals and performing specific management processes in order to reduce the uncertainty of the portfolio. The main difference between a portfolio of projects and a program is that a portfolio does not necessarily have a life-cycle. It consists of an ensemble of processes performed to reach three objectives:

(1) to balance the portfolio;

(2) to maximize the portfolio value; and

(3) to align projects or programs towards the organization's strategic goals (Callahan and Brooks, 2004; Cooper *et al.*, 2001, 1997; Kendall and Rollins, 2003).

There is usually confusion between program and project portfolio concepts in regards to their role in linking strategy to individual projects (Aubry *et al.*, 2006). However, this situation has started to change. There was a difference in the way in which European and American organizations treated these concepts. American organizations put the portfolio of projects in the organizational relationship model below the organizational strategy and objectives having programs and projects as components of the portfolio (PMI, 2006a, b). European organizations put the program right below the organizational strategy and objectives having only projects as components. Within the last vision, a project portfolio was a kind of program configuration or was a concept referring only to the project ensemble (OGC, 2007a, 2003; Pellegrinelli, 1997). However, at the end of 2007 the OGC in the UK published the book *Managing Portfolios of Change: Integrating MSP and PRINCE2* (OGC, 2007b) that also puts the portfolio right below the organizational strategy and objectives having programs and projects as components. It is an important improvement towards a unification aiming at diminishing confusion.

In project portfolio management, risk management processes focus on analyzing the probability of the success or failure of projects and on analyzing risks generated by the selection of a project ensemble during the balancing of a portfolio (Archer and Ghasemzadeh, 1999; Caron *et al.*, 2007; PMI, 2006a). However, in the literature it is difficult to find a risk management guide to managing threat and opportunities coming directly from portfolio processes such as project selection, project alignment or project prioritization. The PMI prepares the new edition of *The Standard for Portfolio Management*, which will help to solve part of this limitation. *PMI* presented the draft of the new edition and Chapter 5 explains how portfolio risk management would be performed. They consider not only portfolio processes and objectives but also present an iterative risk management framework complemented with tools and techniques that can be applied at this level. In spite of not being a guide and continuing to have some limitations, it is a good improvement in the portfolio management domain explaining in a general manner how risk management can be integrated specifically to this area.

Generic approaches can also be adapted to apply at this level. Some of these generic approaches are:

- A risk management standard (AIRMIC, ALARM, IRM – UK, 2002).
- The orange book: management of risk – principles and concepts (HM Treasury – UK, 2004).
- Integrated risk management framework (Treasury Board of Canada Secretariat – Canada, 2001).

These frameworks consider risks in a corporate context for managing strategic and organizational risks. In spite of not being developed for a project management context, they implement their risk management processes at all levels of the organization, adapting them to portfolios, programs, and projects. Their structures are iterative in nature and they are implemented using different perspectives, such as strategic, financial, business line, corporate management, and compliance or government agenda perspectives. They highlight the role of different organizational actors during the management of risks; for instance, the responsibilities belonging to the board of directors, the business units and individuals. Their risk definition addresses to the positive and negative consequences on the organization's overall objectives. Some of them propose tools and techniques to use during risk management without providing a description of them (AIRMIC, ALARM, IRM, 2002; HM Treasury, 2004; Treasury Board of Canada Secretariat, 2007).

In summary, Table I exhibits the structures of the risk management approaches presented in the preceding sections. The structure steps are collected in five groups to facilitate their comparison. The groups are:

(1) context establishment;
(2) risk analysis;
(3) risk evaluation;
(4) risk control and monitoring; and
(5) communication.

The manner Table I exhibits the steps of the structures is just a way to represent them; it does not mean that these steps are consecutive and linear in nature.

5. Soft systems, complexity science, and risk management

Edwards and Bowen's review (1998) highlighted the importance of considering soft issues in project risk management such as risk profiles of people participating on the project or the interpersonal communication of risk. Loosemore (1999) exhibited how people communication and behaviour during a crisis influence substantially the efficiency responding to it. Communication and the exchange of information are crucial for helping people to recognize the interdependencies with others, their environment and to investigate and decrease assumptions (Danilovic and Sandkull, 2005). All these issues belong to the qualitative approach of risk management which considers uncertainties generated by the interaction between individuals. However, although all methodologies include this approach in their process, they continue to be reductionist in essence tending to consider individuals in isolation without a dynamic nature. A social network standpoint would help to regard projects, programs or portfolios as a system of interdependent elements, activities, or resources with a variety of relationships changing constantly over time. A social network perspective focuses on

Table I. Comparison of risk management guides

	PRAM Guide (APM, 2004)	*PMBOK*, Chapter 11 (PMI, 2004)	*M_o_R Guideline* (OGC, 2007a)	*AS/NZS4360* (Standards Australia International Ltd, 2004)	*A Risk Management Standard* (AIRMIC, ALARM, IRM, 2002)	*The Orange Book* (HM Treasury, 2004)	*Integrated Risk Management Framework* (Treasury Board of Canada Secretariat, 2007)
Context establishment	(1) Initiate • Define • Focus (2) Identify	(1) Risk management planning (2) Risk identification	(1) Identify • Context • Identify the risks	(1) Establish the context (2) Risk assessment • Identify the risks	(1) The organization's strategic objectives	(1) Establishing context • Risk environment • Context • The extended enterprise (2) Identifying risks	(1) Risk identification • Identifying issues • Setting Context
Risk analysis	(3) Assess • Structure • Ownership • Estimate	(3) Qualitative risk analysis	(2) Assess • Estimate	• Analyze the risks	(2) Risk assessment • Risk analysis • Risk identification • Risk description • Risk estimation	(3) Accessing risks	(2) Risk assessment • Assessing key risk areas • Measuring likelihood and impact • Ranking risks
Risk evaluation	• Evaluate	(4) Quantitative risk analysis	• Evaluate	• Evaluate the risks	• Risk evaluation		(3) Risk response • Setting desired results
Control and monitoring	(4) Plan responses • Risk event responses	(5) Risk response planning	(3) Plan	(3) Treat the risks	(3) Risk reporting (4) Decision	(4) Addressing risks	• Developing options • Selecting a strategy

(*continued*)

Table I.

	PRAM Guide (APM, 2004)	*PMBOK*, Chapter 11 (PMI, 2004)	*M_o_R Guideline* (OGC, 2007a)	*AS/NZS4360* (Standards Australia International Ltd, 2004)	*A Risk Management Standard* (AIRMIC, ALARM, IRM, 2002)	*The Orange Book* (HM Treasury, 2004)	*Integrated Risk Management Framework* (Treasury Board of Canada Secretariat, 2007)
	• Project risk responses	(6) Risk monitoring and control >	(4) Implement		(5) Risk treatment	(5) Reviewing and reporting risks	• Implementing the strategy
				(4) Monitor and review	(6) Residual risk reporting		
	(5) Implement responses				(7) Monitoring		(4) Monitoring and evaluation • Monitoring, evaluating and adjusting
Communication	(6) Manage process		(5) Communicate	(5) Communicate and consult	(8) Modification	(6) Communication and learning	(5) Continuous learning and communication
					(9) Formal audit		

the structure of those relationships trying to identify their causes and consequences (Tichy *et al.*, 1979). Soft systems theory may be incorporated to risk management methodologies in order to shifting the reductionist perspective to a more holistic point of view. Jaafari (2001) exposes the necessity of an integrative and holistic approach in project risk management, receiving also attention to social, political, and strategic aspects during decision making. Nevertheless, if we want to take into account interdependences and their dynamic nature we must also include complexity science theories. Complexity science principles are based on indeterminism and non linear behaviour. It describes the way complex adaptive systems function facilitating the understanding of project behaviour (McKinnie, 2007). Aritua *et al.* (2009) explain the close connection multi-project management has with the achievement of major benefits if managers use the principles of complexity science.

The level of complexity depends on the number of interdependencies and their variation over time (Danilovic and Sandkull, 2005). Interdependencies may be classified in different ways, for instance:

(1) Following Verma and Sinha (2002):
   - *By resources:* resources are shared by different projects.
   - *By technology:* a single technology is developed by different projects.
   - *By market sharing:* market conditions have an effect on objectives and specifications of different projects.

(2) Following Lycett *et al.* (2004):
   - *By resources*.
   - *By technology*.
   - *By knowledge:* knowledge is shared or generated by different projects.

(3) Following Fernez-Walch and Triomphe (2005):
   - *By resources*.
   - *By knowledge*.
   - *By components:* in modular design, projects share components for different products.

Summarizing, there are four major sources of complexity:

(1) the resources;
(2) the technology or knowledge used or generated;
(3) the functionality of the product developed; and
(4) the market which represents the strategic relation between the organization and its environment.

These sources interact and originate uncertainty (Danilovic and Sandkull, 2005) which must be handled in order to achieve the objectives of the project, program, or portfolio.

Geraldi (2008) divides complexity into three groups:

(1) *Complexity of fact:* it deals with the large amount of interdependent information.
(2) *Complexity of faith:* it deals with high uncertainty.

(3) *Complexity of interaction:* it deals with the interactions between humans in different locations. It is characterized by transparency, multiplicity of reference and empathy.

As stated before, one characteristic of complex systems is their non-linear nature (McKinnie, 2007; Aritua *et al.*, 2009). That means, we cannot predict the consequences that small changes in the environment may produce in the outcome of the system. Actual tools and techniques for complex projects or multi-projects are based on the assumption that events and consequences are linearly related. This assumption exposes the need for developing different tools and techniques taking into account non-linearity in complex projects or multi-projects environments. For example, Jaafari (2007) presents a toolset developed from a systemic standpoint which assesses the health at any point in the life cycle of a project or program. The toolset helps the project team in monitoring if they are doing the right things and in managing the project or program variables in a systemic and consistent manner.

6. Discussion

Literature in project risk management is vast; there are many books and guides that help its study and implementation. Risk management literature applied to the whole organization is also a recognized domain that is sometimes called "Enterprise Risk Management". However, there is an important gap between both levels. Both are well documented but as long as we search for specific risk management guides for programs and project portfolios, it becomes difficult to find a reference which presents processes, tools and analysis approaches to draw benefits and control and monitor the threats or opportunities to achieve strategic goals. From a strategic perspective, this is an outstanding inconvenience because programs and portfolios are the means to the transfer of strategic needs to projects and operational activities. Standards or generic approaches can be adapted to these levels; however, a risk management approach developed specifically for programs or project portfolios would bring better support. Customized analysis and monitoring tools would supply focus and better results such as project risk management does at a project level. The approaches presented in section one are a good example of this. The *PRAM Guide* and the Chapter 11 of the *PMBOK Guide* introduce the steps to following a risk management process from the context definition step to the risk control and monitoring step. They provide a list with descriptions of tools and techniques that focus directly on project issues. Program risk management guides or portfolio risk management guides would focus on program and portfolio issues enhancing the strategic benefits.

Observing the risk management frameworks exhibited in Table I, there are different manners to structure its process. All of them are consistent and in spite of using different words or steps, we can organize them within five groups:

(1) context establishment;

(2) risk analysis;

(3) risk evaluation;

(4) control and monitoring; and

(5) communication.

It is relevant because a risk management approach specifically designed for programs or portfolios may use these groups as a departure point to further develop its process steps, tools and techniques. In addition, tools and techniques may include those suggested by Pellegrinelli or Szymczac and Walker presented in Section 3.1 and the process may include the six activities suggested by the PMI.

There are important differences between the *PMBOK Guide*'s risk management approach and the other approaches. The *PMBOK Guide* exhibits a linear framework and does not explicitly consider the risk analysis of strategic issues. In addition, project risk management is not viewed within a program context nor does it take into account project interdependencies. Chapter 17 of *Managing Successful Projects with PRINCE2* considers those interdependencies plus the impact on business programs and the impact on business cases using an iterative risk management framework. We cannot find these characteristics in Chapter 11 of *PMBOK*. Chapter 17 is not so detailed to explain the risk management framework; however, the OGC which published *Managing Successful Projects with PRINCE*, has the *M_o_R Guide* to explain in detail what risk management is. It also happens with the APM. It has its own *Body of Knowledge* as a project management guide and the *PRAM Guide* to explain in detail how to undertake the project risk management processes. The PMI has only *PMBOK*'s Chapter 11 to explain this knowledge area. We consider that this institute may reinforce their risk management approach by developing a guide to complement this knowledge area.

Current risk management approaches already document the need expressed by authors to consider the positive consequence of events. Each of them includes opportunities in their risk definitions. They also explicitly or implicitly present the need to view a project within an organization, meaning to analyze risks related to the program and to the organization's strategic goals. However, it is still necessary to highlight the continuous risk identification and monitoring. Indeed, it is necessary to develop tools and techniques aiding in the constant identification of new threats or opportunities and to constantly monitor the progress of risks. Until now, the performance of these steps has a discrete nature. They are performed at the beginning of a new phase or verified in weekly revisions. A tool helping to identify threats or opportunities at the moment they appear would reduce the response time or even anticipate the consequences. The approach by consequences presented in Section 2.2 supports this point. It focuses on the continuous monitoring of resources in order to identify risks and implement action plans to minimize potential consequences. Further development taking into account this idea is necessary in order to have a non-discrete risk management approach facing the continuously changing environment.

An important remark is that risk management approaches do not include vulnerability during the risk identification and evaluation processes. The system vulnerability (whether the project, program, portfolio or the organization's vulnerability) influences the perception during the risk identification or evaluation process. For instance, a threat will no longer produce negative consequences if the project can resist its effects. On the other hand, the vulnerability of a system may change the severity of the consequence depending on its exposure. As Zhang says, it is necessary to include a system vulnerability assessment which supports the risk analysis and evaluation processes as other domains already do. Further research towards the integration of this concept into the project risk management theory would be an interesting improvement to explore.

Soft systems and complexity science approaches need to be integrated to current risk management methodologies. Soft systems theory is not new in the project management domain. Some articles in the mid 1980s can be found introducing this approach to project risk management. However, it has not been fully developed and at the present time it is difficult to find soft systems techniques adapted to risk management characteristics or supporting the decision making with a systemic approach. Complexity science is a domain which starts to appear more often in the literature of project and multi-project management. It is necessarily to continue developing research on this direction because of the significance of interdependencies in the project, program and portfolio success. Resource interdependence is generally considered in management but other interdependences such as knowledge, technology or strategic interdependences are forgotten or underestimated. As exposed by Danilovic and Sandkull, the level of complexity depends on the number of interdependencies and their variation over time. Project risk management methodologies need to consider all of them because their interaction is a major source of uncertainty.

Figure 1 summarizes the points expressed in this section. White balloons represent the risk management areas where there is a need to continue development. They are research challenges which must be undertaken in order to improve the current guides and methodologies. It is important to remember that generic risk management guides are adapted to fit to the characteristics of portfolios and programs. Figure 1 considers these adaptations to exhibit the columns and rows. However, there still exists the need to develop guides specially conceived for portfolios and programs.

7. Conclusion

Projects, programs, and project portfolios are interdependent and consequences of events do not affect them separately, but collectively. However, a generic approach is not a solution to managing risks. Each domain has different characteristics and needs,

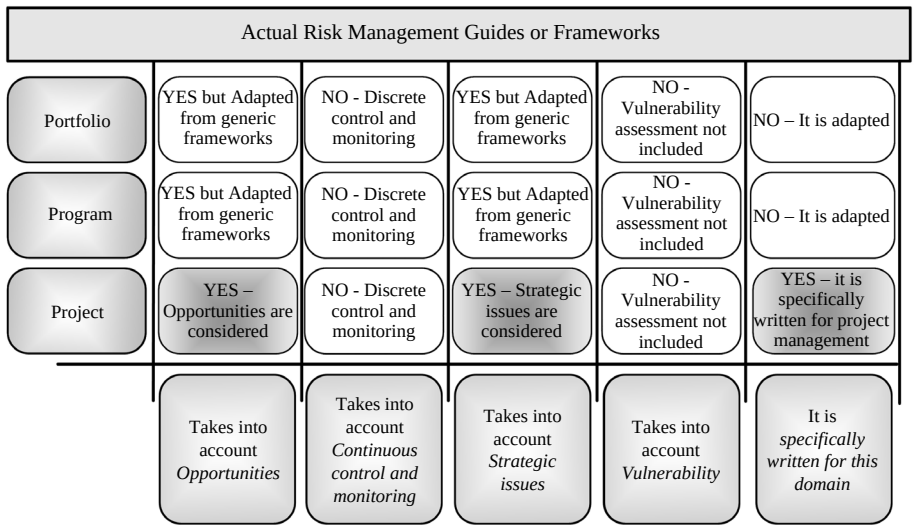

Figure 1.
Research opportunities to continue developing risk management

and specific risk management guides must be developed if managers want to collect as many benefits as possible. Despite vast literature, there is an evident gap between risk management approaches applied at the project level and at the organization level. It is difficult to find risk management guides specifically conceived for programs or project portfolios. Further development in this direction is needed in order to fulfil this gap.

We have included a figure summarizing the research opportunities in continuing to develop risk management guides. This figure is based on needs exposed by authors; for example, including tools and techniques to identify, control, and monitor risks in a continuous manner or the integration of a vulnerability assessment for the risk management process. Incorporating a vulnerability analysis would complement the risk analysis and evaluation processes, strengthening the methodology and providing a more complete risk perception. Other needs are already included in risk management literature; for instance, taking into account opportunities or including strategic perspectives.

This paper exposes some areas of risk management methodologies that present a challenge to progress. It is a departure point aiming to encourage further research and to provide a platform for improving the current risk management methodologies applied to projects, programs, and portfolios.

References

AIRMIC, ALARM, IRM (2002), "A risk management standard", available at: www.theirm.org/publications/documents/Risk_Management_Standard_030820.pdf

Archer, N. and Ghasemzadeh, F. (1999), "An integrated framework for project portfolio selection", *International Journal of Project Management*, Vol. 17 No. 4, pp. 207-16.

Aritua, B., Smith, N.J. and Bower, D. (2009), "Construction client multi-projects – a complex adaptive systems perspective", *International Journal of Project Management*, Vol. 27 No. 1, pp. 72-9.

Association for Project Management (1997), *PRAM Project Risk Analysis and Management Guide*, Association for Project Management, High Wycombe.

Association for Project Management (2004), *PRAM Project Risk Analysis and Management Guide*, Association for Project Management, High Wycombe.

Aubry, M., Hobbs, B. and Tuillier, D. (2006), "Project management office: a framework to understand organizational project management", *Proceedings of PMI Research Conference 2006: New Directions in Project Management*, Project Management Institute, Montréal.

Callahan, K. and Brooks, L. (2004), *Essentials of Strategic Project Management*, Wiley, Hoboken, NJ.

Caron, F., Fumagalli, M. and Rigamonti, A. (2007), "Engineering and contracting projects: a value at risk based approach to portfolio balancing", *International Journal of Project Management*, Vol. 25 No. 6, pp. 569-78.

Chapman, R.L. (1973), *Project Management in NASA: The System and the Men*, Scientific and Technical Information Office – National Aeronautics and Space Administration, Washington, DC.

Chapman, C. and Ward, S. (2003), *Project Risk Management – Processes, Techniques and Insights*, Wiley, Chichester.

Cooper, R., Edgett, S. and Kleinschmidt, E. (1997), "Portfolio management in new product development: lessons from the leaders I", *Research-Technology Management*, Vol. 40 No. 5, pp. 16-28.

Cooper, R., Edgett, S. and Kleinschmidt, E. (2001), *Portfolio Management for New Products*, Basic Books, New York, NY.

Cooper, D., Grey, S., Raymond, G. and Walker, P. (2005), *Project Risk Management Guidelines: Managing Risk in Large Projects and Complex Procurement*, Wiley, Chichester.

Dai, C.X. and Wells, W.G. (2004), "An exploration of project management office features and their relationship to project performance", *International Journal of Project Management*, Vol. 22 No. 7, pp. 523-32.

Danilovic, M. and Sandkull, B. (2005), "The use of dependence structure matrix and domain mapping matrix in managing uncertainty in multiple project situations", *International Journal of Project Management*, Vol. 23 No. 3, pp. 193-203.

Dietrich, P. (2006), "Mechanisms for inter-project integration – empirical analysis in program context", *Proceedings of PMI Research Conference 2006: New Directions in Project Management*, Project Management Institute, Montréal.

Edwards, P.J. and Bowen, P.A. (1998), "Risk and risk management in construction: a review and future directions for research", *Engineering, Construction and Architectural Management*, Vol. 5 No. 4, pp. 339-49.

Edwards, P.J. and Bowen, P.A. (2004), *Risk Management in Project Organizations*, UNSW Press, Sydney.

El-Sayegh, S.M. (2008), "Risk assessment and allocation in the UAE construction industry", *International Journal of Project Management*, Vol. 26 No. 4, pp. 431-8.

Elonen, S. and Artto, K.A. (2003), "Problems in managing internal development projects in multi-project environments", *International Journal of Project Management*, Vol. 21 No. 6, pp. 395-402.

Fernez-Walch, S. and Triomphe, C. (2005), "Diversité produits et management multi-projets", *Proceedings of 6e Congrès international de génie industriel, Besançon, France*.

Flyvbjerg, B. (2006), "From nobel prize to project management: getting risks right", *Proceedings of PMI Research Conference 2006: New Directions in Project Management*, Project Management Institute, Montréal.

Garon, S. (2003), "Integrated project risk management system (IPRiMS) for the Canadian Space Agency", *Proceedings of 54th International Astronautical Congress of the International Astronautical Federation (IAF)*, International Astronautical Federation (IAF), Paris.

Geraldi, J.G. (2008), "The balance between order and chaos in multi-project firms: a conceptual model", *International Journal of Project Management*, Vol. 26 No. 4, pp. 348-56.

Grundy, T. (1998), "Strategy implementation and project management", *International Journal of Project Management*, Vol. 16 No. 1, pp. 46-50.

HM Treasury (2004), "The orange book", available at: www.hm-treasury.gov.uk/media/3/5/FE66035B-BCDC-D4B3-11057A7707D2521F.pdf

Hällgren, M. (2007), "Beyond the point of no return: on the management of deviations", *International Journal of Project Management*, Vol. 25 No. 8, pp. 773-80.

Hillson, D. (2002), "Extending the risk process to manage opportunities", *International Journal of Project Management*, Vol. 20 No. 3, pp. 235-40.

Hobbs, B. and Aubry, M. (2006), "Identifying the structure that underlies the extreme variety found among PMO", *Proceedings of PMI Research Conference 2006: New Directions in Project Management*, Project Management Institute, Montréal.

Jaafari, A. (2001), "Management of risks, uncertainties and opportunities on projects: time for a fundamental shift", *International Journal of Project Management*, Vol. 19 No. 2, pp. 89-101.

Jaafari, A. (2007), "Project and program diagnostics: a systemic approach", *International Journal of Project Management*, Vol. 25 No. 8, pp. 781-90.

Kendall, G. and Rollins, S. (2003), *Advanced Project Portfolio Management and the PMO: Multiplying ROI at Warp Speed*, Ross Publishing Inc., Boca Raton, FL.

Kristensen, V., Aven, T. and Ford, D. (2006), "A new perspective on Renn and Klinke's approach to risk evaluation and management", *Reliability Engineering & System Safety*, Vol. 91 No. 4, pp. 421-32.

Kwak, Y.H. and Stoddard, J. (2004), "Project risk management: lessons learned from software development environment", *Technovation*, Vol. 24 No. 11, pp. 915-20.

Loosemore, M. (1999), "A grounded theory of construction crisis management", *Construction Management and Economics*, Vol. 17, pp. 9-19.

Loosemore, M., Raftery, J., Reilly, C. and Higgon, D. (2006), *Risk Management in Projects*, Taylor & Francis, London.

Lycett, M., Rassau, A. and Danson, J. (2004), "Programme management: a critical review", *International Journal of Project Management*, Vol. 4, pp. 289-99.

McKinnie, R.M. (2007), "The application of complexity theory to the field of project management", unpublished PhD dissertation, Walden University, Minneapolis, MN.

Milosevic, D.Z. and Srivannaboon, S. (2006), "A theoretical framework for aligning project management with business strategy", *Proceedings of PMI Research Conference 2006: New Directions in Project Management*, Project Management Institute, Montréal.

Office of Government Commerce (2002), *Managing Successful Projects with PRINCE2*, TSO, London.

Office of Government Commerce (2003), *Managing Successful Programmes*, TSO, London.

Office of Government Commerce (2007a), *Management of Risk: Guidance for Practitioners*, TSO, London.

Office of Government Commerce (2007b), *Management Portfolios of Change: With MSP for Programmes and PRINCE2 for Projects*, TSO, London.

Olsson, R. (2007), "In search of opportunity management: is the risk management process enough?", *International Journal of Project Management*, Vol. 25 No. 8, pp. 745-52.

Payne, J.H. and Turner, J.R. (1999), "Company-wide project management: the planning and control of programmes of projects of different types", *International Journal of Project Management*, Vol. 17 No. 1, pp. 55-9.

Pellegrinelli, S. (1997), "Programme management: organising project-based change", *International Journal of Project Management*, Vol. 15 No. 3, pp. 141-9.

Pellegrinelli, S. (2002), "Shaping context: the role and challenge for programmes", *International Journal of Project Management*, Vol. 20 No. 3, pp. 229-33.

Pellegrinelli, S., Partington, D., Hemingway, C., Mohdzain, Z. and Shah, M. (2007), "The importance of context in programme management: an empirical review of programme practices", *International Journal of Project Management*, Vol. 25 No. 1, pp. 41-55.

Pender, S. (2001), "Managing incomplete knowledge: why risk management is not sufficient", *International Journal of Project Management*, Vol. 19 No. 2, pp. 79-87.

Perminova, O., Gustafsson, M. and Wikström, K. (2008), "Defining uncertainty in projects a new perspective", *International Journal of Project Management*, Vol. 26 No. 1, pp. 73-9.

Petit, F., Benoît, R. and Rousselle, J. (2004), "Une nouvelle approche pour la caractérisation des aléas et l'évaluation des vulnérabilités des réseaux de support à la vie", *Canadian Journal of Civil Engineering*, Vol. 31 No. 2, pp. 333-44.

Project Management Institute (2004), *A Guide to the Project Management Body Of Knowledge*, PMI, Newtown Square, PA.

Project Management Institute (2006a), *The Standard for Portfolio Management*, PMI, Newtown Square, PA.

Project Management Institute (2006b), *The Standard for Program Management*, PMI, Newtown Square, PA.

Ray, P. (2000), "An innovative approach of risk planning for space programs", *International Journal of Industrial Ergonomics*, Vol. 26 No. 1, pp. 67-74.

Raz, T. and Michael, E. (2001), "Use and benefits of tools for project risk management", *International Journal of Project Management*, Vol. 19 No. 1, pp. 9-17.

Reiss, G., Anthony, M., Chapman, J., Leigh, G., Rayner, P. and Pyne, A. (2006), *The Gower Handbook of Programme Management*, Gower, Aldershot.

Robert, B. (2005), "La démarche de prévention: une gestion des risques reliés à l'interdépendance des infrastructures", *Proceedings of Congrès international Urbanistique Montréal 2005 développement urbain intégré*, Vol. 2005, Les nouvelles tendances du développement urbain intégré, Montreal.

Robert, B. and Bourgault, M. (2005), "Une gestion proactive des risques appliquée à la gestion des projets", *Proceedings of 6e Congrés international de génie industriel, Besançon, France*.

Standards Australia International Ltd (2004), *Risk Management: AS/NZS 4360:2004*, Standards Australia International, Sydney.

Szymczak, C.C. and Walker, D.H.T. (2003), "Boeing – a case study example of enterprise project management from a learning organization perspective", *The learning Organization*, Vol. 10 No. 3, pp. 125-37.

Thiry, M. (2002), "Combining value and project management into an effective programme management model", *International Journal of Project Management*, Vol. 20 No. 3, pp. 221-7.

Thiry, M. (2004), "For DAD: a programme management life-cycle process", *International Journal of Project Management*, Vol. 22 No. 3, pp. 245-52.

Tichy, N.M., Tushman, M.L. and Fombrun, C. (1979), "Social network analysis for organizations", *Academy of Management Review*, Vol. 4 No. 4, pp. 507-19.

Treasury Board of Canada Secretariat (2007), "Integrated Risk Management Implementation Guide", available at: www.tbssct.gc.ca/pubs_pol/dcgpubs/RiskManagement/guide01_e.asp#overviewIRMF

Turner, J.R. (2005), "The role of pilot studies in reducing risk on projects and programmes", *International Journal of Project Management*, Vol. 23 No. 1, pp. 1-6.

Turner, J.R. and Müller, R. (2003), "On the nature of the project as a temporary organization", *International Journal of Project Management*, Vol. 21 No. 1, pp. 1-8.

Uher, T.E. and Toakley, R. (1999), "Risk management in the conceptual phase of a project", *International Journal of Project Management*, Vol. 17 No. 3, pp. 161-9.

Van der Merwe, A.P. (2002), "Project management and business development: integrating strategy, structure, processes and projects", *International Journal of Project Management*, Vol. 20 No. 5, pp. 401-11.

Vatsa, K.S. (2004), "Risk, vulnerability, and asset-based approach to disaster risk management", *International Journal of Sociology & Social Policy*, Vol. 24 Nos 10/11, pp. 1-48.

Verma, D. and Sinha, K.K. (2002), "Toward a theory of project interdependencies in high tech R&D environments", *Journal of Operations Management*, Vol. 20 No. 5, pp. 451-68.

Ward, S. and Chapman, C. (2003), "Transforming project risk management into project uncertainty management", *International Journal of Project Management*, Vol. 21 No. 2, pp. 97-105.

Weichselgartner, J. (2001), "Disaster mitigation: the concept of vulnerability revisited", *Disaster Prevention and Management*, Vol. 10 No. 2, pp. 85-94.

Williams, T. (1995), "A classified bibliography of recent research relating to project risk management", *European Journal of Operational Research*, Vol. 85 No. 1, pp. 18-38.

Zhang, H. (2007), "A redefinition of the project risk process: using vulnerability to open up the event-consequence link", *International Journal of Project Management*, Vol. 25 No. 7, pp. 694-701.

Further reading

Chapman, C. (1997), "Project risk analysis and management – PRAM the generic process", *International Journal of Project Management*, Vol. 15 No. 5, pp. 273-81.

Kelly, P.M. and Adger, W.N. (2000), "Theory and practice in assessing vulnerability to climate change and facilitating adaptation", *Climatic Change*, Vol. 47 No. 4, pp. 325-52.

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