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The Interplay of Risk Management and Uncertainty: A Project Management Practice Perspective.

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ABSTRACT : The paper empirically measures the interplay between risk management and uncertainty and the contextual variability of risk management practice. The research first clarifies the concepts of uncertainty, risk and risk management. The research defines risk management from an empirical perspective i.e., from an empirically identified set of tools that is actually used to perform risk management. This toolset is derived from the results of an ongoing major worldwide survey on what experienced practitioners actually do to manage their projects. This paper uses a sample of 1,296 responses for which the interplay between risk management and uncertainty could be measured.

The results are very coherent. They verify and empirically validate many of the propositions drawn from a review of the literature. But results challenge some of the propositions found in the conventional project management literature and some commonly held views. The research shows that the use of risk management practices and tools is negatively related to the degree of project uncertainty. This somewhat counter-intuitive result is consistent with a general tendency for all project management tools and techniques to be used more intensively in better defined contexts. The dominant project management paradigm is oriented towards reducing or controlling uncertainty, but is less well adapted to unforeseeable events and high levels of uncertainty. A better understanding of the reality of the actual practice leads to a discussion about supplementing the current paradigm with new approaches to manage the uncertainty that cannot be removed or reduced by the conventional project management approach.

Key words: project management, uncertainty, risk, practices, tools, empirical, survey research,

INTRODUCTION

A large part of the project management literature uses the concepts of risk and uncertainty interchangeably. However, many authors insist on the importance of distinguishing these concepts. Despite effort to clarify these concepts, much confusion persists today.

Risk vs uncertainty

The eminent economist Frank Knight (1921), founder of the Chicago school, distinguishes risk from uncertainty by relating risk to a "quantity susceptible of measurement" ... "a measurable uncertainty" opposing it to real uncertainty "an unmeasurable one" (P. I.I.26). This reference to measurable and quantifiable events is also found within the project management literature. Sicotte and Bourgault (2008, p.468) relate risk to an "identifiable event... that will have negative consequences....whereas uncertainty relates to the source" (of risk). Perminova and al. (2007) also define uncertainty as a situation being the source of risk: "a context for risks as events having a negative impact... or opportunities... that have beneficial impact..." (underline added; p.76). Extending the consequence of the identified event to opportunities has the commendable intention of encouraging the management of opportunities, but adds to the confusion when trying to distinguish risk from uncertainty. Chapman and Ward (2003) have encouraged and largely influenced the use of the uncertainty concept over risk partly because the later is trapped in the perspective of negative perceptions of threatening events, which has the side effect of keeping practitioners from managing opportunities.

All Project management standards refer to the positive and negative impact of risk. The APMBoK of the Association for Project Management (APM, 2006) makes the distinction between risks and opportunities. The Guide to Project Management Body of Knowledge (PMBoK Guide) (PMI, 2008) does not define opportunities but defines risk as "An uncertain event or condition, that if it occurs, has a positive or negative effect on a project's objective" (p.438). The PMBoK also refers to "known risks" vs "unknown risks... (that) ...cannot be managed..."(p.275); thus considering that only known risk events can be manage.

Risk vs risk managment

The present study does not investigate the concept of risk per se; it is focused more on "risk management" as a practice. Project risk management is related to the set of practices and tools generally used to manage project risk. The research identifies and compares the risk management set of tools with other project management toolsets and further establishes the relative importance accorded to risk management by the practitioners in different contexts.

The list of practices and tools useful to manage risk can vary greatly from one author to the other; the list may include a very large number of project management practices, tools and techniques. For example, the first project management tools developed in the fifties like the well-know PERT model or lesser known GERT model, were specifically designed to respond to the foreseeable consequences of uncertain project contexts. Even if they are generally consider to be planning tools rather than risk management tools, almost all planning tools could be related to risk management. Planning attempts to anticipate future action; from a risk management perspective, planning and control are tools to manage project risks. Studies of risk management by Zwikael and Sadeh (2007) and Raz and Michael (2001) included large numbers of planning and control tools among what they considered to be risk management tools. Still, all project management standards recognise risk management as a separate "knowledge areas" or "process" possessing its own dedicated set of practices and tools.

The research defines risk management from an empirical perspective i.e., from an empirically identified set of tools that is actually used to perform risk management. This toolset is derived from the results of a major worldwide survey about what practitioners actually do to manage their projects. The research is funded in part by the PMI Research Department. This paper uses a sample of 1,296 experienced practitioners for which the interplay between risk management and uncertainty could be measured. Using principal component analysis on this sample, Besner and Hobbs (2010a) have empirically identified nineteen reliable toolsets that validate in part the traditional knowledge areas that are shared by the major project management standards, those from Australia, South Africa, APM and PMI. One of the nineteen toolsets is composed exclusively of well-know risk management tools indicating that in practice the risk management toolset is separate from the planning toolsets.

Risk management vs context

Project management is practiced in many different contexts, each with its own relation to project uncertainty and particular management problems. The project and organisational context influence the need and use of project management practices and tools including risk management. Project management practitioners use project management practices to better address these contexts and problems. Walewski et al. (2004) report that projects occurring within one or more of the following context are significantly more likely to need a comprehensive, detailed risk management process: large projects, long planning horizons, substantial resources, significant novelty, complexity, etc.. Kwak (2003) describe the influence of context in this way "As the size and complexity of the project increases, the effort for risk management increase exponentially" (p. 6).

The project stage is also a dimension of the context that influences the use of risk management tools, according to the conventional project management conceptual framework, more uncertainty is generally found during the early phases of the project (Winch, 2001). Xie et al. (2006) argue that risk management is need in all stages and report greater use in the early bidding stage for software projects. Uher and Toakley (1999) agree that the conceptual phase of a project development cycle is the one with the highest level of uncertainty, but report a relatively low frequency of use of risk management during the concept phase of construction projects. Kwak and Dixon (2008) doing research in the pharmaceutical industry suggest that sometimes risk management during the front-end is only being done because it is a formal requirement for approval of the project plan.

Besides project context, the organisational context also influence the use of the risk management toolset. The research investigates the effect of these and other context variables empirically.

Context vs uncertainty

The degree of project uncertainty is an important dimension of the context. Many sources of uncertainty can be identified generating different uncertainty levels and needing different management responses. According to Kumar (2002) a major source of uncertainty in IT projects is uncertainty regarding the scope or specifications of the project. Youker (1999) defined nine types of projects which he differentiated in terms of their degree of uncertainty. Meyer et al. (2002) propose a project uncertainty profile to help determine the degree of uncertainty, from foreseeable uncertainty that can be controlled by traditional risk management techniques to unforeseeable uncertainty and chaos that may be found in some highly innovative projects. Olson (2008) differentiates uncertainty using the internal vs. external (contextual) perspective. Turner and Cochran (1993) made the same distinction by proposing two dimensions to classify projects: how well-defined are the project goals, and how well-defined are the methods used to accomplish the project. This produced four types of projects, with well- or ill-defined goals and methods. The authors further associate different management practices and tools and a typical project type to each quadrant. The well-defined goals and methods quadrant typical of well-defined engineering and construction projects and the ill-defined goals and methods are typical of complex internal organisational development projects.

It seems natural to suppose that an increase in uncertainty will induce an increase in risk of project failure, and that risk management can circumvent such a fate. A delphi study lead by Krahn and Hartment (2006) involving 60 project management professionals concluded that risk management is the most important skill/competence required for projects with high uncertainty. Risk management is thus generally perceived as a way to reduce uncertainty and its consequences, which in turn will improve the chance of success. One of the objectives of the present paper is to empirically verify this assumption.

Uncertainty and risk management vs success

Numerous authors have researched project critical success factors (CSFs). The lists of CSFs they produced include some recurrent items that are related to the degree of project uncertainty. Better definition of the project has been identified as a CSF through better identification of the project goals, mission, requirements or specifications (Martin, 1976; Morris and Hough, 1987; Pinto and Slevin (1988); Gartner group, 1995, 2000, 2009).

The link between uncertainty and failure (or between certainty and success) seems to be well established, but the link between risk management and success is not as clear. Bakker et al. (2009) present clear indications of the influence of individual project risk management activities on the success of IT projects. The same is true for that surveyed a group of 187 risk experts from the PMI Risk Management Specific Interest Group (SIG) primarily, but not exclusively, from IT and telecom. Zou et al. (2007) also find a clear link analysing construction projects. But Raz et al. (2002) and Bannerman (2008) did not find a clear relation between risk management and success.

Risk professionals from the PMI Risk Management SIG (Voetsch et al. (2004), also reported that despite the high visibility and favourable perception of risk management in their organizations, an important gap exists between interest for risk management and resource allocation and staff training; a lot of people talk about risk, but not so many do something about it. If this is the case for members of the risk management SIG, it must be true for other practitioners.

THE RESEARCH QUESTIONS, METHODOLOGY AND DATA

The research questions are:

What is risk management practice and how does it compare to other practices?

How is risk management practice related to project and organisational contexts?

How is project uncertainty related to project and organisational contexts?

How is risk management practice related to uncertainty?

The list of more than a hundred practices, tools and techniques used in the survey was drawn from the PMBOK® Guide, the Max Wideman's Comprehensive Glossary of Project Management Terms (2006) and a general review of the project management literature mostly from the International Journal of Project Management and the Project Management Journal. The present research investigates only tools and techniques that are project-specific and well known. It does not investigate general processes. Restricting the investigation to well-known practices, tools and techniques specific to project management ensures that the questionnaire is well understood by practitioners (The list of practices and tools is in appendix A; the next section will present the grouping of individual practices and tools shown in appendix A).

Data was collected with support from the PMI Research Department, several chapters of PMI and colleagues in universities around the world. For each project management tool or practice, the questionnaire includes two questions designed to investigate the use and perceived value of project management practices tools and techniques chosen for the study.

The first question measures the extent of actual use by practitioners.

The second question measures the extent to which more extensive or better use would improve project performance.

Both were measured on a 5-point Likert type scale.

The questionnaire also gathers demographic information on the respondents (position, education, level of experience, etc.) and information on industry and project types, project and organizational contexts (geographic region, size, project management maturity, etc.), and project characteristics (size, complexity, etc.).

These variables allow for an assessment of how project management practices vary according to organisational and project contexts. In particular, concerning the measure of uncertainty, the respondents were ask to evaluate if the projects they were involved in were well-defined or ill-defined based on the degree of project definition at the point they become involved.

Demographics

The respondents of the present research are mostly between 30 and 50 years old (71.6%). Their current primary role and the average number of years of experience in this role are as follows: team member (9%; 8y); project manager (50%; 8y); programme manager/director (31%; 5y); other (12%; 6y). Considering that 85% of the respondents declare experience in at least two of these categories, they appear well qualified to provide valuable information based on their practical experience.

Descriptive statistics

Project types		Project contexts	
Engineering & Construction	17%	Project cost (median)	1 million
Business and Financial Services	18%	Project duration (median)	9 month
Software Development	11%	External project	58%
IT & Telecom	54%	Private project	76%
Organisation size by number		International project	41%
of employees (median)	2 000	Ill-defined project	51%

TABLE 1
Descriptive statistics of the contextual variables

ANALYSIS

Identification of the risk management practices or "Toolset"

There are many different tools, techniques and practices in the field of project management; the present study identified more than one hundred. Some of these tend to be used together. Besner and Hobbs (2010a) have identified tools, techniques and practices that tend to be used in groups. The groupings are referred to here as "toolsets."

The toolsets were empirically induced without any a priori concerning the identification of groups; group identification was not even considered at the time the tools were selected for inclusion in the study. Principal Components Analysis (PCA) was chosen as a basic method to support toolset identification. A varimax rotation PCA and a panel of forty-five experts, all PMP certified, were employed together with researchers' judgment in the identification of the nineteen toolsets. Toolset reliability was verified a posteriori using the Chronbach alpha statistic. The detailed method and results are presented in Besner and Hobbs (2010a).

On the left side of Table 1, the nineteen identified toolsets are presented in decreasing order of their average level of use. On the right side they are ordered by their level of potential to improve project performance by more or better use. The Chronbach alpha for each toolset based on their level of use is also presented in Table 1; The Chronbach alpha based on the level of potential (not presented) is slightly higher. The composition of each toolset can be found in appendix A.

As can be seen from table 2, the levels of use and potential vary a great deal among the toolsets and important differences also exist between the use and the potential of many toolsets. Risk management is very near the middle position for its level of use and it comes second for its potential. Practitioners responding to this survey are indicating that there is still considerable potential for increased contribution to project performance from more or better use of risk management practices, tools and techniques.

ALPHA	Toolset name	Use	Toolset name	Potential
0.82	Initial planning	3.33	Databases	3.82
0.77	Project closure	3.01	**Risk management**	**3.60**
0.88	Basic project management software	3.01	Initial planning	3.54
0.79	Business case definition	2.94	Project closure	3.54
0.76	Monitoring progress	2.78	Basic project management software	3.51
0.79	Baseline change management	2.77	Project analysis	3.51
0.80	Bidding and fixed price contract	2.76	Monitoring progress	3.48
0.76	Financial evalutation	2.76	Multiproject management	3.44
0.90	**Risk management**	**2.70**	Business benefits measures	3.42
0.64	Project analysis	2.68	Financial evalutation	3.41
0.72	Cost estimation	2.43	Business case definition	3.40
0.75	Team management	2.41	Cost estimation	3.39
0.86	Multiproject management	2.33	Team management	3.37
0.78	Network planning	2.18	Baseline change management	3.35
0.79	Business benefits measures	2.13	Advanced project management software	3.27
0.84	Databases	2.10	Quality	3.19
0.764	Quality	2.09	Bidding and fixed price contract	3.14
0.62	Variable price contract	1.96	Network planning	3.07
0.86	Advanced project management software	1.92	Variable price contract	2.71

TABLE 2
The list of toolsets ordered by their level of use and potential

The risk management toolset is the one with the highest Chronbach alpha, which means that this toolset is the most reliable and that the practices it is composed of are very strongly correlated. Table 3 shows the items composing the risk management toolset.

	Mean	Std. Deviation
Risk management Cronback Alpha: 0.901	2.68	1.07
Risk management documents	2.91	1.29
Contingency plans	2.77	1.20
Ranking of risks	2.84	1.30
Assignment of risk ownership	2.70	1.29
Graphic presentation of risk information	2.17	1.27

TABLE 3
Risk Management Toolset

The five items form a very coherent group; all are directly related to risk management. These practices and tools are used as a set; they do not have the same level of use, but the more one of the set is used the more the others are also used. The items composing the toolset are well know and generally recognized as a subset of project management practice. This identification of the risk management toolset can be seen as a validation of the corresponding knowledge area of project management standards.

The difference in the level of use of each item may in part be explained by the sequence of actions normally related to risk management. Risk identification and documentation is a prerequisite to ranking risks and planning contingency. The more complex tasks, such as assigning responsibility for a high-ranked risk to a risk owner and representing risk information graphically for analysis, usually come later and show less intensive use than the other practices.

Database of risk is another tool that is directly linked to risk management. This tool is generally included by the literature and standards in the risk management process, but here it is not. Database of risk is part of the database toolset. The use of databases necessitates much support from the organization. Once the database system is in place, it is certainly easier to use the infrastructure for different needs,

which explains why the levels of use of database tools vary concomitantly and why they are part of the same toolset.
Besner and Hobbs (2006) found that quantitative risk analysis tools, such as Monte Carlo analysis, Simulation, Scenario analysis, PERT analysis and Decision trees are very seldom used and have practically no unused potential. Because they are only used very rarely, some of these well-know tools like the Monte Carlo analysis were dropped from data collection in the later phases of the research reported here and therefore are not part of the risk toolset identified in Table 3. Voetsch et al. (2004) also found that the use of quantitative risk management tools is very low. As discussed in the introduction, other tools including many planning and control tools and team management practices can be considered as part of risk management, but the empirical identification of toolsets revealed that tools for planning and for risk management are distinct sets of practices.

What is the influence of the project and organisational contexts on the use of risk management practices

Table 4 shows the differences in the level of use of the risk management toolset and the level of the risk management potential. All variable scores were dichotomized to measure the difference in used between the two subgroups using a robust non parametric Mann Whitney test to compare means (the same test was used for table 6).
The project type and phase variables have four possible values, but they were also dichotomised: each of these variables is compared to the rest of the sample. An equal sign means that no significant difference was found. A plus or minus sign indicate a significant difference.

Project type

The research differentiated the industry from the type of project e.g., IT projects take also place in firms in the construction industry. Among the four project types only one uses risk management more than the others. IT and telecom projects represent the largest groups of practitioners in the sample. As discussed in the introduction the greater use of risk management is probably related to the changing nature of scope in IT projects compare to the detailed specification usually found in engineering and construction projects (E&C) for example.

Differences in the level of use and perceived potential of the risk management toolset

Project type	Use	Potential
Engineering & Construction	=	=
Business and financial services	=	=
Software Development	=	- *
IT & Telecom Project	+**	+*
Project phase	**Use**	**Potential**
Front-end initiation phase	+***	=
Planning development phase	+***	=
Execution implemenation	=	=
Closing Handover phase	=	=
Level of project definition		
Ill defined project		+**
Well-defined project	+***	
Organisational context	**Use**	**Potential**
Small organisation		=
Large organisation	+**	
Immature PM processes		+***
Mature PM processes	+***	
Less competent personnel		+***
More competent personnel	+***	

Project context	Use	Potential
Public project / Private project	=	=
Internal project / External project	=	=
Small project < 3M$		
Large project >3M$	+***	+***
Local or National project		
International project	+***	+**
Not Multidisciplinary		=
Multidisciplinary project	+**	
Less complex project		
More complex project	+***	+**
Similar project		
Quite different project	+***	+*
Low innovation project		
High innovation project	+***	+**
Organisational context	**Use**	**Potential**
Functionnal & weak matrix		+*
Strong matrix & Project based	+***	
Independant project		=
Multiproject Program	+***	
Unsuccessful organisation		+***
Successful organisation	+***	

* 0.100 > p > 0.049 ; ** 0.05 > p > 0.01; *** p < 0.01

TABLE 4
The use and potential of the risk management toolset

On the other hand software development projects are also renowned from their high scope instability. Considering that the comparative level of potential is negative for software development, it could be argued that the practitioners of this sector are more aware of the limits of the traditional risk management approach in their sector. In addition, this sector is well in advance compare to the other project types concerning the use of new alternative methodologies promoted by the Agile or lean approaches (discussed further below).

Project phase

As per the literature reviewed in the introduction, greater use of risk management in the front-end/initiation and planning/development phases was expected. When interpreting the equal signs for potential in each phase, it is important to bear in mind that risk management is the toolset with the second highest score for potential. Performance is perceived to be equally enhanced in each phase by a more or better use of risk management.

Project context

Eight dimensions of context are presented on the right-hand side of table 4. The result for each of these dimensions appears consistent with the literature reviewed. Large international complex innovative multidisciplinary projects dissimilar from one another are most probably riskier. Theoretically, intuitively and rationally, practitioners should use more risk management in situation generating more risks. Using risk management means investing time and resources to identify, analyze and respond to risk. More rational decisions mean more benefits must be expected for large complex innovative etc. projects. Risk management practices take time and require special expertise and therefore project managers tend to use these practices less in low-risk environments, because it is less worth the effort. Table 4 also clearly shows that more or better use should improve project performance, especially in the case of large projects, but also in other contexts. For each dimension of the context the actual greater use is not enough, it does not represent the full potential of risk management. What practitioners already do, they believe they should do more and better in a similar situation.

Organisational context

Large organizations have generally more resources and can be more supportive of the use of practices in general and of risk management in particular by providing procedures, models, templates, training, etc. Practitioners in these larger organizations do not perceive that a greater use of risk management is especially needed in large organizations. Practitioners from both large and small organization perceive the same high potential of more or better risk management.

Project management maturity is a concept widely used in the project management community both among practitioners, professional associations and researchers (PMI, 2008). The measure of maturity is modeled on Software Engineering Institute's Capability Maturity Model (CMM) scale in five levels. The concept of maturity is based on the systematic use of project management processes that are materialized through the use of tools, techniques and practices. It is, therefore, almost by definition that more mature organizations use risk management more often. The most mature organizations already use project management tools close to their full potential. It therefore comes as no surprise that practitioners in less mature environments declare more unused potential.

The same reasoning applies with the other organizational contexts. The availability of more competence personnel and project and program based structures enable a greater capability to use tools, which brings the level of use closer to its full potential and conversely induce greater un used potential in less project management supportive functional structures.

Finally, it is easy to extent the reasoning to the measure of organisational success. If risk management leads to success as this research suggests and if successful organisations use risk management closer to its full potential, it can be expected that less successful organisation will perceived a greater potential as shown in table 4. Organisational success is a measured of the respondents' perceived rate of project success of their organisations compared with competitors' organisations in the same sector of activity. This measure of success was shown to be very robust by Cooper, Edgett and Kleinschmidt (2004). This paper does not pretend that this measure is sufficient to truly and precisely measure success. The large scope of the investigation deliberately chosen during research design prevented a complete and exact measure of all dimensions. It is nevertheless hoped that the results are indicative of important basic relations and that they will stimulate further research.

Risk management versus uncertainty

This research directly relates uncertainty to the degree of project definition. This measure of uncertainty is central to many discussions and research on uncertainty. The more the project is well defined, the more risk management is used; the more uncertainty there is, the less risk management is used. This result seems a priori to be counter-intuitive. If something is less defined, more vague, more uncertain, then it is more risky and more risk management should be needed and perform. This result challenges an intuitive assumption. It also challenges the conventional project management literature and standards.

In fact, all toolsets are used more in well-defined less uncertain contexts (results not shown in tables).

Nevertheless, it is for the risk management toolset that this result is the most surprising and challenges the intuitive assumption. It is indeed easier to recognize that project analysis, planning, control, estimation or evaluation are easier to do and consequently done more, for well defined projects. This does not contradict the facts already discussed that large complex innovative etc. projects use risk management more, but why is it that "well-defined" large complex innovative etc. projects are the overall greatest users of risk management.

Well-defined scope and goals facilitate the practitioner's task related to planning and control e.g., the cost or duration of a well-defined project can be estimated using a detailed analysis of the project content. One must then realize that risk management is an integral part of the project management paradigm. The practices and tools used to manage risk are easier to use and were designed to manage risks in well-defined projects where they can be identified, measured and analyzed.

The greater level of potential for risk management in ill-defined projects suggests that practitioners are nevertheless aware that something is needed and must be done, especially in the case of ill-defined projects in highly uncertain contexts. This contrast with the other project contexts listed in table 4; as mentioned above: "what practitioners already do, they believe they should do more and better in a similar situation". Considering now the well-ill-defined context: what practitioners already do, they "do not" believe they should do more and better in a similar situation. A well-defined project is a project management capability enabler. It enables the use of practices and tools that have in turn the capability to enhance performance. A well-defined project enables a greater use of project management practices and brings their use closer to a full potential; in an ill-defined context levels of use are lower, but potential is higher.

A synthesis of the impact of context on the use of risk management

Table 5 presents the results of a regression of the context variables on risk management. This multivariate stepwise analysis identifies the combined dominant influences of the context on the use of the risk management toolset. Maturity is, as previously mentioned, almost by definition at the top of this list. This is followed by project size, level of innovation and organizational size, all of which were to be expected. Involvement in the first two phases of the project life cycle are also in the regression model, again no surprise. Note that the explanatory power of involvement in the fuzzy front end is lower than that for involvement in the planning and development phase. This is consistent with the finding that risk management is practiced more in better structured contexts. Only one of the project types is part of the model, E&C projects reduce the likelihood of using risk management, which is again consistent with previous results. It is, however, noteworthy that project type does not contribute very much to the explanation of the use of risk management. The availability of competent personnel is certainly an important enabling factor. Noticeably, project definition or uncertainty is not one of the main determinants of the use of risk management, while innovation a variable often related in the literature to the level of uncertainty is. That level of innovation is a predictor of the use of risk management may seem to contradict the finding that risk management is used more on well-defined projects. However, the large proportion of incremental innovations compared to radical innovations can easily reconcile this apparent contradiction; the level of innovation refers to better defined "incremental" innovations.

Variables Adj. R2 0.22 (p=0.000)	B	T	prob.
Organisational Maturity	0.26	6.797	0.000
Project size	0.17	4.459	0.000
Level of innovation	0.13	3.776	0.000
Organisation size	0.12	3.386	0.001
Planning/dev. Phase	0.10	2.815	0.005
Availability of competent personnel	0.08	2.235	0.026
Multiproject program	0.07	1.983	0.048
Front-end initiation phase	0.07	1.980	0.048
Engineering & construction	-0.08	-2.173	0.030

TABLE 5
Regression of the context variables on risk management

How project uncertainty is related to project and organisational contexts

Table 6 presents the significant differences in level of project definition for the different contexts. Project uncertainty is here shown to be probably the lowest in situations having all of the characteristics listed with a positive sign in table 6; or a significant subset of these characteristics. The opposite is also true.

Differences in the degree of project definition: + means better defined
Well-defined project = low uncertainty ; ill-defined project = high uncertainty

Project type	Use	Project context	Use
Engineering & Construction	+***	Internal project	
Business and financial services	=	External project	+***
Software Development	=	Local or National project	
IT & Telecom Project	=	International	+**
		Similar project	+***
		Quite different project	
Project context	Use		
Small project < 3M$		Low innovation	
Large project >3M$	+*	High innovation	+**
Organisational context	Use	Organisational context	Use
Small organisation		Functionnal & weak matrix	
Large organisation	+**	Strong matrix & Project based	+***
Immature PM process		Less competent personnel	
Mature PM process	+***	More competent personnel	+***
		Unsuccessful organisation	
		Successful organisation	+***

* 0.100 > p > 0.049 ; ** 0.05 > p > 0.01; *** p < 0.01

TABLE 6
Contexts in which well-defined projects are found more often

The organisational level dimensions are all highly significant. Strong organisational contexts in large successful organisation oriented toward project management involving mature project-based structures are clearly driving the level of project definition.

As previously noticed a somewhat intriguing result is the fact that more innovation is related to better defined projects. It was suggested above that incremental innovation is better define. It could also be possible that innovation needs more efforts to be managed and since innovation drives success, it also drives the investment in project management tools necessary to manage it, leading in turn to better defined projects.

As expected E&C project are generally better defined than other project types. It also seems reasonable to assume that large, international and external projects are better defined considering the resources involved, the necessary agreement/negotiation with an external client and possibly international regulations. Besner and Hobbs (2010b) found internal projects to be often related to non-performing cases of small non-innovative projects. At the time the first project management standards were developed, the large external project occupied an important place in the project realm. Today only a relatively small subset of the project management field is populated by such projects; more and more small internal endeavours are recognised as projects. The classic project management tools such as risk management tools are better adapted to the types of projects for which they were originally intended. They are, however, less well adapted to the types of projects that have come to dominate the project landscape in recent years.

The regression of the context variables on the level of project definition (table 7), makes clear which variables are driving uncertainty levels. Again, as a group, the organisational context variables clearly dominate the influence on the level of project definition. Only one variable of the project context is a determinant of project definition; a very coherent relation between the level of project definition and the level of project similarity; uncertainty is linked to the fact that project are different from one another.

Variables Pseudo R2 0.23 (p=0.000)	B	Wald	prob.
Organisational success	0.66	24.898	0.000
Organisational maturity	0.34	18.295	0.000
Project similarity	0.56	10.979	0.001
Competent personnel available	0.41	8.395	0.004
Engineering & construction	0.47	4.345	0.037
Strong matrix project based	0.12	4.030	0.045

TABLE 7
Regression of the context variables on precision of project definition

DISCUSSION

The analysis has shown that risk management is not an easy straightforward applicable solution in unforeseeable highly uncertain contexts. The conventional way to interpret uncertainty as a generator of uncertain events that can be controlled with standard risk management practices and tools does not apply in all cases. High uncertainty may thus create situations in which practitioners will or believe they should manage risk the old fashion way; investing time and resources in management practices and tools that are not the best suited to such contexts, may result in unproductive investment.

The results suggest that a high level of project definition can be viewed as a context that facilitates the implementation of project management practices, tools and techniques; a context that enables and explains the greater use of all project management practices including risk management. The level of project definition does not yet explain all about risk management. For example, E&C projects are better defined but use less risk management and the level of definition was not identified by the regression as the main determinant of risk management use. The level of project definition has nonetheless an important and counter-intuitive impact that begs for analysis; an analysis that lead this paper to put forward the limits of the actual project management paradigm.

Alternatively the causal relationship between the level of project definition and level of use of project management practices could be the opposite: well-defined projects are better defined through more and better use of project management practices. But this alternative explanation does not hold when considering “highly uncertain ill-defined project contexts”; in particular for the risk management toolset. A risk is by definition a foreseeable quantifiable event, risk management is thus not well suited to the task of managing unforeseeable uncertainty; other tools or approaches are needed.

Moreover, both alternatives point in the same direction, the need to reduce uncertainty to better perform. A complementary view is the option to “manage” uncertainty. A paradigmatic shift is needed to supplement the traditional project management strategy of reducing uncertainty with the strategy of managing uncertainty through flexible approaches.

Mintzberg (1994) among many other authors in the strategic management literature is an advocate of flexibility to manage organisational strategic affairs. Flexibility is viewed as a way to manage uncertainty. Meyer and al. (2002) argue that to manage extreme uncertainty practitioners “need to go beyond traditional risk management, adopting roles and techniques oriented less toward planning and more toward flexibility and learning.” Floricel and Miller (2001) propose to manage uncertainty through governability, which encompasses the flexibility to restructure the project through cohesiveness and creativity when faced with unforeseen difficulties. Such new flexible approaches are required to supplement the current paradigm.

Even closer to the practice perspective adopted by the present research, Agile and lean methods inspired by the quality movements can help manage the residual uncertainty that cannot be controlled by the traditional well-known project management practices. These new approaches are currently being implemented in different project types from Scrum methodology (Schawber, 2004) in software development and IT projects to the Last Planner (Ballard, 2000) in lean construction projects.

Limits

This research has deliberately adopted a wide perspective that has allowed identification at a global level of the interplay of risk management and uncertainty. But this approach has also its limits. The precision with which it measures central concepts such as uncertainty, complexity, innovation, etc. has been limited. The results must therefore be considered as exploratory and needing to be substantiated by further research, possibly limited to one or a few contexts and / or project types.

CONCLUSION

The empirical investigation of actual practice and its contextual variability has helped better understand risk management practice. The results confirm some well-known assumptions about practices, but at the same time produced unexpected results that can stimulate the development of new practices adapted to highly uncertain contexts.

It seems logical to assume that more risk management is necessary for example in large, international, complex, innovative, etc. environments. The empirical results confirm that project management practice of risk management conforms to these assumptions; practitioners use more risk management in such contexts. The same had been assumed concerning uncertain environments, but empirical results shows that this assumption is not verified. To the contrary risk management tools are clearly used more in a well-defined environment. The research also reports that practitioners believe that risk management has considerable potential to enhance project performance through more and better use.

Risk management relies on the identification of events having an impact on project objectives and on the measure of the probability and impact of these events. A highly uncertain context, a situation in which it is difficult to predict future events, may render traditional risk management inoperable.

Results show that risk management, as it is generally defined in the literature and as it is actually performed by experienced project practitioners is confined to relatively "certain environments". In fact, all traditional project management tools and techniques are used more extensively on better defined projects. Specifically looking at the risk management toolset has brought into light the systematic bias of the project management paradigm towards well-defined projects.

The current project management paradigm is oriented towards reducing uncertainty. Project management in highly uncertain contexts needs new flexible approaches to supplement the current paradigm. Concepts such as Agile and lean methods can help manage the residual uncertainty that cannot be controlled by traditional project management practices. Hence, the research findings generate a challenge for the development of the field. The project management field needs to develop new responses for specific contexts for which it was not primarily developed. The results of this research point in the direction of such a need for ill-defined projects and highly uncertain contexts.

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APPENDIX A. The composition of the 17 toolsets

	Average use
Toolset: Initial planning	**3.33**
Kick-off meeting	3.81
Milestone planning	3.53
Scope statement	3.48
Work breakdown structure	3.37
Project charter	3.06
Responsibility assignment matrix	3.05
Communication plan	2.98
Toolset: Project Closure	**3.01**
Client acceptance form	3.12
Lesson learned/post-mortem	3.09
Project closure documents	3.07
Customer satisfaction surveys	2.98
Quality plan	2.80
Toolset: Basic project management software	**3.01**
Gantt chart	3.68
PM software for task scheduling	3.67
PM software for monitoring of schedule	3.21
PM software for resource scheduling	3.07
PM software for monitoring of cost	2.55
PM software for resource leveling	2.53
PM software for multi-project scheduling	2.32
Toolset: Business case definition	**2.94**
Assigned project sponsor	3.29
Needs analysis	3.13
Business opportunity/problem definition	3.12
Business case	3.06
Project mission statement	2.69
Updated business case at gates	2.36
Toolset: Bidding and fixed-price contract	**2.76**
Contract documents	3.29
Fixed-price contract	3.05
Bid documents	2.79
Bid/seller evaluation	2.51
Contractual commitment data	2.16
Toolset: Monitoring progress	**2.78**
Progress report	3.94
Stage gate reviews	2.77
Project scorecard/dashboard	2.68
Monitoring critical success factors	2.64
Trend report	2.40
Earned value	2.25
Toolset: Baseline change management	**2.77**
Change request	3.54
Baseline plan	3.23
Change control board	2.89
Re-baselining	2.80
Configuration review	2.50
Management reserve	2.40
Recovery schedule	2.06
Toolset: Financial evaluation	**2.76**
Cost/benefit analysis	2.86
ROI, VAN, IRR or payback	2.65
Toolset: Project analysis	**2.78**
Requirements analysis	3.48
Feasibility study	2.67
Stakeholder analysis	2.59
Value analysis	1.97
Toolset: Risk management	**2.70**
Risk management documents	2.97
Contingency plans	2.86
Ranking of risks	2.86
Assignment of risk ownership	2.70
Graphic presentation of risk information	2.12
Toolset: Team management	**2.41**
Self-directed work teams	2.74
Team building event	2.71
Project Website	2.36
Project war room	2.29
PM community of practice	2.19
Team development plan	2.17
Toolset: Multiproject management	**2.33**
Program master plan	2.61
Project priority ranking	2.55
Project portfolio analysis	2.29
Multi-criteria project selection	2.26
Organizational capacity analysis	2.26
Graphic presentation of portfolio	1.99
Toolset: Network planning	**2.18**
Critical path method & analysis	2.75
Network diagram	2.35
Probabilistic duration estimate (PERT Analysis)	1.86
Critical chain method & analysis	1.77
Toolset: Business benefits measures	**2.94**
Financial business benefits metrics	2.23
Medium-term post evaluation of success	2.19
Non-financial business benefits metrics	1.97
Toolset: Databases	**2.10**
Database of historical data	2.24
Database for cost estimating	2.16
Database of lessons learned	2.09
Database of risks	1.89
Toolset: Variable price contract	**1.96**
Contract penalties	2.24
Cost-plus contract	2.17
Gain-share contract	1.50
Toolset: Advanced project management software	**1.92**
PM software for multi-project resource management	2.22
PM software Internet access	2.19
PM software for issue management	2.01
PM software for project portfolio analysis	1.85
PM software linked with ERP	1.64
PM software for scenario analysis	1.58