Understanding the Impact of Project Risk Management on Project Performance: an Empirical Study

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Abstract

The goal of this study is to comprehend the impact of risk management on project performance. Further it aims to investigate the degree of diffusion of risk management practice in Brazilian companies. The methodological approach involves a survey of 415 projects at different levels of complexity in different industrial sectors in several states of Brazil. The results demonstrate that adopting risk management practices has a significant positive impact on project success. They also show a positive impact from the presence of a risk manager on project success. The study's principal limitations are the methodological choice of non probability sampling and a questionnaire based on respondent perception. From the practical point of view, paying attention to uncertainties during the project, making use of the risk management techniques and deeply understand the business environment are critical success factors, demanding attention of project managers and risk managers. The results demonstrate the impact of risk management practices on project success. They also show a positive impact from the presence of a risk manager on project success. Furthermore, it demonstrated the importance of soft skill in risk management.

Keywords: project risk management, project typologies, project complexity, innovation management.

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Introduction

Risk management has been one of the major concerns of executives and professionals involved with projects today, especially after the financial crisis that shook the world in 2008. The results of ex-post assessments of project or even verification of loss business opportunities for companies are clear signals that this evidence has become more intense.

Even though risk management is one of the greatest needs in project management, it is recognized that little has been done in this respect (Raz et al., 2002, Ibbs and Kwak, 2000, Zwikael and Globerson, 2006, Zwikael and Sadeh, 2007). One of the first articles that pointed to the importance of risk management was developed by Ibbs and Kwak (2000) among project managers from four sectors: telecommunications, manufacturing high technology products, information technology and construction engineering.

In an effort to understand how risk management practices in project occur in different types of projects, this article presents the results of a study carried out in four Brazilian states. By applying a questionnaire to a sample of 415 projects, it was possible to discover differences in adopting risk management practices at distinct levels of complexity.

A research question was created to guide researchers in this study: which conditioning factors for risk management influenced the project success?

In structural terms, this study attempted to identify the variables (independent, that refer to the risk management process and practices), which best explain the project success (dependent variable) according to the perception of project manager.

The answer to this formulated question could help academic and professional communities in the project area to understand some determining factors in the administration of uncertainties in the enterprises.

There are at least two important justifications for developing this article. First, to show the evidence of the relationship of the variables (i) adoption of risk management practices in projects in enterprises with (ii) success in projects. Secondly, to present data that show an panorama of the adoption of risk management practices in Brazilian companies. Further, this article makes a contribution in terms of understanding the contingent effect of different degrees of project complexity in the risk management and project success.

The development of this work will be presented in five sections, beginning with this introduction. Important aspects of the literature on risk management in projects will be presented in section 2. Section 3 includes methodology, emphasizing the kind of study done. Then section 4 presents the results of the study beginning with the characterization of the sample, according to descriptive analysis and finally, statistical analysis. Section 5 explains the conclusions, followed by bibliographical references.

Theoretical background

Concern with risk management became more evident after Ibbs and Kwak (2000) published their research, which recognized this knowledge area as one of the neediest in terms of management, as examined in three of the four economic sectors studied. However, Akintoye and MacLeod (1997) had already pointed to the effectiveness of risk management as one of the major concerns of project professionals. Nevertheless, for Raz et al. (2002) the discipline of risk management is still in its infancy.

To understand the risk management discipline at least two routes of interest were taken into account, on the nature of the risks and on the other those of practical nature.

Within the line of studies of the nature of risks and their conceptual aspects, the following works stand out: Wideman (1992), Bernstein (1997), De Meyer et al. (2002) and Perminova et al. (2008). Basically they deal with aspects of risks and their relationship with uncertainty, their effects and implications for project results, considering the ambiguities and variability, among other issues that constitute the bases of understanding this concept. While Bernstein (1997) presents a rich historical picture of risk and its importance to project managers, De Meyer et al. (2002) discuss the aspects of variability and ambiguities. In this line of studies, the work of Ward and Chapman (2003) also stands out due to its singular proposition, which emphasizes the management of uncertainties as a substitute for risk management, since it presents the broadest approach to the field.

Another aspect of the risk concept is its dual characteristic from the negative perspective (as a threat), but also from the point of view of positivity (as an opportunity) (Hillson, 2001, Ward and Chapman, 2003). For him, risks are related to uncertain events that can affect project objectives negatively or positively. For each risk perspective different administrative strategies are demanded.

Another stream of work on project risk management carried out by PMI (2008) and other bodies of knowledge focus on the practical aspects, in which the risk management processes and tools become important from the point of view of its applications to organizations. Further highlights in this line of study go to the work of Hillson (2002), DOD (2002), Raz et al. (2002), as well as Wideman (1992) who have de-

veloped work in a broad way along the two lines mentioned here. Anchored in practices frequently adopted by companies interested in managing uncertain events in projects, the articles mentioned here reflect the vision of risk from various perspectives.

These two routes show the evolution of thinking about risk management in projects today. But the interest in managing project risk is in a certain way derived from the interest in project management in the broad sense and is concentrated in the 1990s, a period of notable growth.

Wideman (1992) made one of the most valuable contributions to understanding the concepts of risk by setting out the limits of the field of uncertainties, including opposing the elements of the unknown and uncertainty. Uncertainty, in this view can be considered a conceptual field delimited between these two elements, which become the center of concern for risk studies.

In this respect, the risks in a project have their origin in the field of uncertainties which, in turn, is present in a more or less intense form in all projects (Perminova et al., 2008).

The relationship risk versus uncertainty adopted by the PMI (2008) for example, considered this relationship, and established a broad definition of risk as "an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one the project objective."

For Perminova et al. (2008) the main difference between risk and uncertainty is the opportunity to establish the probability of an event. Thus, uncertainty is characterized by a situation wherein decisions are made under conditions of unknown probabilities. It is impossible to associate numerical probability values to them, as well as there being a lack of knowledge about the consequences of an event.

One very interesting feature of uncertainties, inherent in and at the same time complementary to Wideman's (1992) studies was done by De Meyer et al. (2002) who proposed four types of uncertainty:

1. Variability: random variations, however predictable and controllable around the known objectives of cost and timeframe;
2. Foreseeable uncertainty: a few known factors will affect the project in a predictable way allowing therefore that contingency plans be established to deal with the consequences of an eventual occurrence;
3. Unforeseen uncertainty: one or more significant factors that influence the project that cannot be predicted, thus demanding solutions when and if they occur;

4. Chaos: completely unpredictable factors entirely invalidate the objectives, planning and approach to the project, requiring its repeated and complete redefinition.

Conceptually, uncertainties can be seen as the center of project management concerns. In this respect, Ward and Chapman (2003) argue that the entire project risk management should focus on administering uncertainties, since risk is always associated with threats (or opportunities) of uncertain events to the projects.

This view is shared by Shenhar and Dvir (2010) who refer to uncertainty as something unknown and risk as something that can occur. According to these authors much of the risk in projects comes from uncertainty, but there are other factors that contribute to project risk, for example, the time-frames and deadlines, costs, scarcity of resources, inadequate abilities and competencies, among others.

Ward and Chapman (2003) showed that the traditional forms of dealing with risk tend to concentrate on variability events and little considers the view of existing ambiguities in projects. For them variability refers to the elements of a project that can assume distinct, though uncertain, values, such as deadlines, costs and quality. Ambiguity is already associated to the lack of clarity of the data, the details, and structures among other factors since there is bias in the behavior of those involved, restricted knowledge and unclear situations.

For the U.S. Department of Defense (DOD, 2006) risk is understood as a measure of future uncertainties about what can affect the objectives of the program within the restrictions established by cost, timeframe and performance. According to several authors (Modarres, 2006; PMI, 2008; Keelling, 2006), the term risk means not just the occurrence of an undesirable event, but also how probable it is and what its consequences would be.

Several articles (PMI, 2008, Keelling, 2006) have presented risk management as a series of interconnected processes involving specific techniques and tools. The PMI (2008) proposed six risk management processes: risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk responses planning and risk monitoring and control.

The specialized literature on project risk management as seen here, provides sufficient elements for understanding the concepts and principles treated. Nonetheless, only more recent studies address the relationship of using this discipline with effective project results. The use of risk management practices in projects related to successful projects can be seen in studies by Zwikael and Ahn (2011). These authors

carried out a study in three countries, (New Zealand, Israel and Japan), with 701 project managers in 7 industrial sectors. The results suggest that risk management, even when moderate, has a relationship with levels of risk and project success. The study showed the importance of the project context, both the industry and the country, to levels of project risk.

Allied with this approach, Bakker et al. (2012) emphasize the importance of risk identification as the most influential process in terms of numbers as well as in the strength of communications effects, followed by risk reporting, risk registration and risk allocation, risk analysis, and finally risk control. In this view, according to work by Besner and Hobbs (2006), sharing information about project risk with project' stakeholders, constitutes an important practice for management. According to the literature review, we can establish the following hypothesis:

(H01): Risk management does not influence the perception of the success of the projects.

Several authors highlight the importance to consider the contingent effect of the type of project (Lawrence and Lorsch, 1967, Shenhar and Dvir, 2010). The researches show evidence that contingency approaches should be considered for different type of projects. Based on pioneering studies by Lawrence and Lorsch (1967) about contingency theory, Shenhar and Dvir (2010) proposed a conceptual framework for contingent approach for project management.

Based in four conceptual dimensions – technology, novelty, complexity, and pace – so called a "diamond" was created that is useful for representing the characteristics of an enterprise. The technology dimension varies according to intensity and difficulty in development in four levels – low, medium, high and super high. The novelty dimension refers to the degree of innovation associated with the product or service of the project and can be classified as derivative, platform or new. Another proposed dimension has to do with the complexity required to develop the project product or service – the simplest of which, called the assembly, runs through the systems category and arrives at headquarters. The last dimension refers to the pace that responds to time demands, including regular, rapid, critical and urgent.

The most important features of uncertainty appear in the technology and novelty dimensions, due to their natures, and there is a direct relationship among these variables. Thus it is believed that the greater the degree of novelty and technology, the greater the uncertainties involved.

For Sauser et al. (2009) the theory of contingency project management can provide new insights to understand the failure in projects more deeply. For Shenhar and Dvir (2010) the idea that "one size fits all" for project management can be adjusted to "one size does not fit all projects".

Thus, the contingency approach suggests the following hypotheses:

(H02): Company revenue does not influence the perception of project success.

(H03): The type of project does not influence the perception of project success.

Studies of risk management show that the discipline has absorbed management techniques and tools from a number of other disciplines and they form an interconnected set of their own processes. Included in this set is the Delphi technique (Okoli and Pawlowski, 2004), subjective probability evaluation, decision analysis, sensibility analysis, and Monte Carlo simulations, among others. Akintoye and MacLeod (1997) mention that in addition to risk management techniques, the risk manager is an important element for administering the non-routine undertakings that can bring better results to projects.

For Akintoye and MacLeod (1997) this is one of the reasons client companies and project management companies have associated risk managers to their projects. Akintoye and MacLeod's (1997) research, developed in the construction sector, found that risk events influenced the results in terms of schedules, costs and performance. Thus, they recommend that project activities remain under the attention of risk management, and that this must become continuous over the project life cycle.

In this view the position of risk manager is a professional concerned with coordinating activities in order to identify, assess and respond to the risks of an undertaking. For Clark et al. (1990) the risk manager also masters control techniques carrying these out in a continuous form throughout the project life cycle.

The position of the risk manager and the results of project are the elements that help define the fourth hypothesis of this study.

(H04): The presence of a risk manager does not influence project success.

The elements that help compose the theoretical picture of risk management for projects of the complex type, contingency management and performance in projects treated in this review are structured in Table 1, in order to make the information from the research that will be treated next more traceable.

Method

Aiming to understand the phenomena of the importance of risk management in projects, quantitative analysis was adopted as an alternative method. By means of a survey involving 415 project management professionals, it was possible to establish a chart to analyze the theme of risk management in projects. The study involved project managers and members of teams in over 9 sectors of the economy classified into 4 types of projects, according to their complexity.

To carry out this study a review of the specialized literature on project risk management was carried out in an attempt to understand the issue conceptually and to identify existing gaps in this area of knowledge. Constructs were suggested to guide the research and provide the conditions for researchers to carry out, evaluate and conclude the study. The chart of the independent variables was constituted taking into account the processes of risk management in projects adopted by the current specialized literature (see Figure 1). The project typology (characterized by complexity), the budget and duration data, as well as company revenue, constitute the moderating variables of the construct. Finally, represented in the area furthest to the right in Figure 1 the dependent variables can be found, represented by the success factors in the respective projects.

Data collection

Data collection tools and a structured questionnaire were used to survey information. Eisenhardt (1989) says that researchers generally combine multiple data collection techniques to construct a theory.

The questionnaire was structured in three blocks (i) data from the interviewee and local company where it is planned to collect information on experience, sex and position of the interviewee as well as revenue from the activity sector of the company (ii) data on the project. In this block it is expected to gather information on project typology (low technology – uses existing and known technology; medium technology – uses simple technology, but incorporates new technologies; high technology – new generation of computers, new versions of systems, integration of existing technologies into a unique product and super-high technology – new products whose technologies need to be created) data

Theme	Specific subject-factor studied	Main authors
Risk management	Conceptual factors - uncertainty	Wideman (1992)
		Ward and Chapman (2003)
		Perminova *et al.* (2008)
		Meyer *et al.* (2002)
	Processes, techniques and tools	PMI (2008)
		Keelling (2006)
		Carvalho and Rabechini Jr. (2011)
		Hillson (2002)
		DOD (2002)
		Raz *et al.* (2002)
		Wideman (1992)
	Risk manager	Akintoye and MacLeod (1997)
Contingency Management	Conceptual factors	Shenhar and Dvir (2010)
		Raz *et al.* (2002)
	Project typologies	Shenhar and Dvir (2010)
	Indicators	Sauser *et al.* (2009)
Success in Project Management	Indicators	Shenhar and Dvir (2010)
		Raz *et al.* (2002)

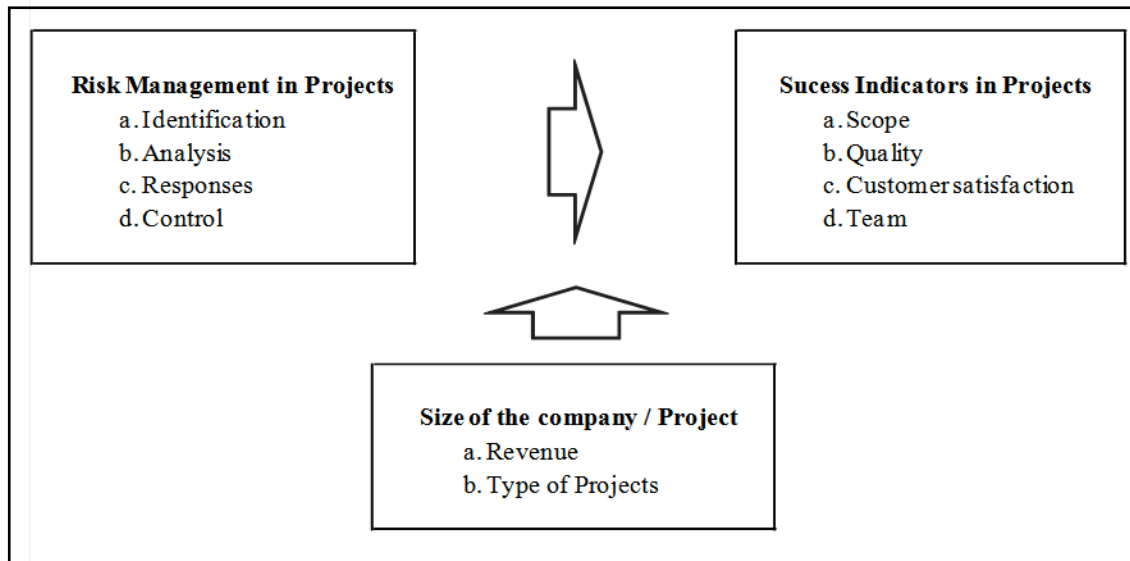Table 1. Summary of authors discussed.

Figure 1. Risk management model for complex projects.

on time and cost and data that reflect the opinion of project success, considering them as indicators of scope, customer satisfaction, satisfaction of the team and conformance to quality (see Appendix A) (iii) data on project risk management. This last block is meant to identify opinions of those interviewed about adopting specific management processes for risks in projects. Questions were programmed that sought, among other things, the opinion of the respondents on the concern over use of techniques such as the impact vs. probability grid, identification of uncertainties, evaluation of uncertainties, simulation of timeframes and costs for projects, elaboration and implementation of response to risk plans, construction of decision trees and changes to projects in function of the risks (see Appendix B).

The Cronbach coefficient was used to validate the questionnaire and reached a value of 0.861, which is considered relevant and has good adherence from questions to the constructs.

The questionnaires were applied personally with questionnaires identified and the sample was gathered in the period 2008 to 2009. Before sending and collecting the information a pre-test was conducted with specialists in the area of project management and with professionals. The Likert scale was used to gather respondents' perceptions about the project results and risk management practices. Once tabulated, the results were analyzed and the reports were written.

The information analysis was done using statistical evaluation techniques. The expected information was analyzed using statistical evaluation techniques. With help from the theoretical picture constructed in the revision presented in

the earlier section, it was possible to elaborate 4 hypotheses for verification and to aide in data analysis. They are:

(H01): Project risk management does not influence the perception of project success.

This hypothesis is intended to verify the relationship between adopting project risk management practices and evaluation the results.

(H02): Company revenue does not influence the perception of project success.

This hypothesis says that company revenue can be considered a success factor in its projects. The attempt is to verify the relationship between these variables.

(H03): The type of project does not influence the perception of project success.

The literature on project management does mention the importance of establishing a project typology and adapting management according to type.

(H04): The presence of a risk manager does not influence the perception of success in projects.

This is an attempt to verify the importance of the figure of the risk manager. The strategy of formulating the null hypothesis is linked to understanding that this always contains equality and that evidence to reject it will be identified. In this way, and based on analyzing the hypotheses information to be able to conclude the study was obtained.

Sample

The sample was defined by convenience, therefore, the sample units (projects) and the participants were chosen by ease of access and their availability to respond to the study. Despite using a non-probability sample, we tried to meet the necessary requirements for a multivariate analysis, using for calculation the minimum size of the sample software G*Power 3.0 (Faul et al., 2007), available from the site http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/. As recommended by Hair Jr. et al. (2005), the sample size at the level of statistical significant (α=5%) and the level of power required of 95%, size of effect at 15%, following indications by Cohen (1977), resulting in a required sample of 411 respondents.

The study respondents were defined as project managers or project members with involvement in the area of risk management.

Data analysis

The analysis of the results of the study will be based on the model of logistical regression, a multivariate statistical technique used to predict or explain the relationships that influence a categorical dependent variable.

The dependent variable made operational to be analyzed by the binary logistical model in this study refers to the results of the project, according to the perception of success given by the respondents. In this sense, the intent is to identify which characteristic attitudes of the professionals (respondents related to the project) and of the companies is associated to the perception of project success.

A model was established taking into account the response variable associating 1 to the perception of success and 0 to the non-perception of success. In this way the modeling will permit us to measure the dimension of the effect of each explanatory factor in the presence of others.

The independent variables made operational to be analyzed by the model were: the project type; project manager; company revenue and factors referring to the attitudes inherent to project management. It is worth mentioning that the revenue variable did not enter into the model, since it is a variable associated to the type of project. The method used to select the best model was forward stepwise, by the criteria of maximum likelihood.

Results

Descriptive analysis – characterization of the sample

The data were obtained from a study undertaken in four Brazilian states with 415 project management professionals in the period 2008 to 2009, including 70.8% men and 29.2% women.

There was a predominance of professionals under 35 years of age (63.4%). Professionals older than 45 years old were 45% of the sample, and the rest were between 35 and 45. Along with this information approximately 84% have less than 10 years of experience. The rest have more than ten. The sectors of information technology (19%), construction engineering (14%) high technology manufacturing products (10.6%) made the greatest contribution, representing approximately 45% of the sample. The figure of the dedicated risk manager, according to the opinion of respondents, was verified in less than 5% of the questionnaires from the sample. This is, the majority of projects (95%) do not have risk managers playing this role in projects.

In terms of revenue, 32.1% of companies involved in the study had revenue over R$1 billion and 38.4% under R$100 million. Revenue between R$100 and 500 million occupied 17.8% of the sample, and 11.7% of companies had between R$500 million and R$1 billion. 20.5% of the sample is composed of low technology projects, that is, those that use existing, known technology, such as construction, development of simple systems, etc. 47.5% are medium technology or those that use simple technology, but incorporate new technologies such as improvements and implementing new functions in already existing products. High technology projects such as new generations of computers, new versions of systems, and integration of existing technologies into a single product represent 28.7% of the sample. Finally, only 3.4% were super-high technology projects, that is, those new products and technologies need to be created.

The average budget for projects was approximately R$44 million, and the average timeframe was 11.6 months.

The study also revealed important information on the variables of company revenue and type of project (Table 2). Aiming to verify the statistical relationship among these variables it was decided to group the project typologies C and D, in order to then perform the chi-square test o (χ^2 = 34,960; p = 0,009 < 0,05).

Using the χ^2 test it was concluded that the revenue variable was associated to the high and super high technology project variables, and that in turn these are relatively more present in companies with revenue over R$ 1 billion.

| Project Typology | Revenue | | | | | Total |
	A) Under R$10 Million	B) From R$10 Million to R$100 Million	C) From R$100 Million to R$500 Million	D) From R$500 Million to R$1 Billion	E) Over R$1 Billion	
A) Low technology	18	28	15	5	18	84
	30.00%	28.60%	20.50%	10.40%	13.60%	20.40%
B) Medium technology	32	43	44	25	52	196
	53.30%	43.90%	60.30%	52.10%	39.40%	47.70%
C) High technology	9	26	14	17	51	117
	15.00%	26.50%	19.20%	35.40%	38.60%	28.50%
D) Super-high technology	1	1	0	1	11	14
	1.70%	1.00%	0.00%	2.10%	8.30%	3.40%
Total	60	98	73	48	132	411
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 2. Project Typology by Revenue.
Note: For this analysis 4 questionnaires were discarded, resulting in n = 411.

Information on Table 2 reveals that the majority of projects (47.7%) fit under the medium level of complexity and the minority (3.4%) under the super high technology level. It was also verified that few high or super-high technology companies have revenue over R$100 million.

Risk Management in studied companies

The Figure 2 exhibits the results of project risk management variables (RM 1 to 15). It can be observed that the risk management processes, tools and techniques were poorly used, because the degree of discordance is high in almost all questions. The construction of the impact/probability matrix (RM 8) showed a considerable degree of discordance (72.5%) among respondents. The same occur with the use of decision trees (RM 11) that showed the second highest degree of discordance (74%) by respondents. The elaboration of risk response plan (RM 12) was the third highest degree of discordance (67%), followed by the implementation of the risk response plan (RM 13) with 64% of degree of discordance.

The discordance occurred less intensely for the variables of risk identification (RM 4) with 58.8%, and applying techniques for risk identification (RM 5), with 58.6%. The organization roles for uncertainties management (RM 6) show almost a half (49.6%).

On the other hand, the project results variables (Appendix B) exhibit concordance (average = 4) in terms of Scope (R1); of Quality (R2); Customer satisfaction (R3); Team satisfaction (R4); and Overall success (R5).

Another important aspect observed was the relationship between the average of risk management variables and the average of performance results variables. The relationship between the two variables is shown in Figure 3.

The regression equation for Result Average Index = 0.965 + 0.777* Risk Management Average Index, was significant (p=0.000). It is possible to note a positive and significant relationship among project's results (average index of R1 to R5) and the use of project risk management (average index of RM1 to 15).

Factorial analysis: risk management drives

For better understanding and greater consistency in the presentation of these results, a factorial analysis by principal components was performed for the 15 project risk management variables that appear on the questionnaires (see Appendix B). The KMO (Kaiser-Meyer-Olkin statistic equal to 0.824) revealed the suitability of the factorial analysis to the research data and the test for sphericity concluded with the pertinence of performing a factorial analysis (TEB: χ^2 = 1520,2; p < 0,05). Fourteen variables entered into the com-
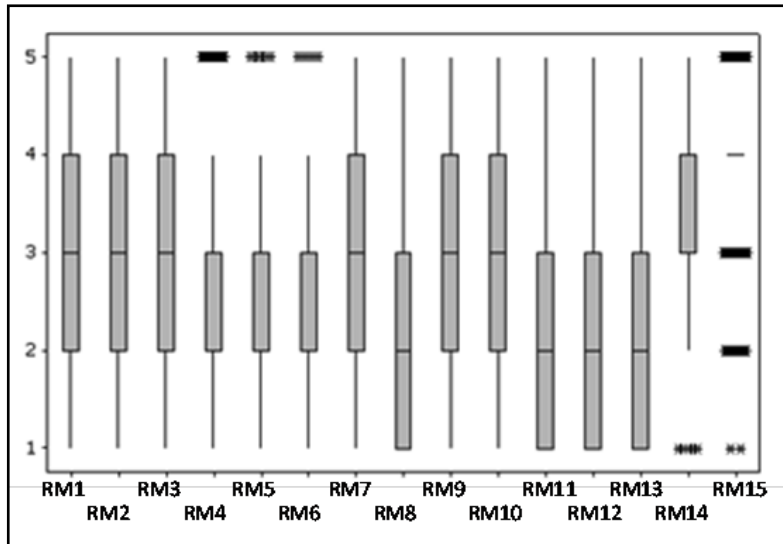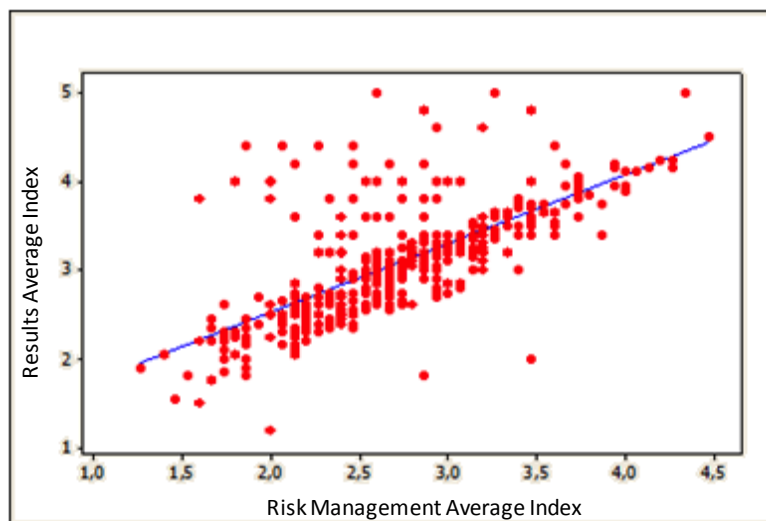
Figure 2. Assessment of Risk Management

Figure 3. Relationship between management average and results average.

position of the six factors to present communality (ratio of the variance with which each variable is made explicit in the factorial solution) over 0.60. The variable that dealt with treatment of the risk events (RM7) was withdrawn. The six factors identified for the analysis were: (i) risk management processes, techniques and tools; (ii) care with uncertainties; (iii) personal risk evaluation; (iv) specific risk assessment; (v) personal knowledge and (vi) simulation of timeframes and costs. The factorial analysis is presented in Table 3.

Logistic regression model

The parameters of estimation of the models at input were 5% significant and 10% for output. Based on building the binary logistic regression model available in Table 4, it was possible to verify which factors (independent variables) most contribute to the efficiency of the timeframe. Table 3 shows the summary binary logistic regression for the response variable perception of success.

In the interpretation of the estimated coefficients, it is possible to verify that factor 2, care with uncertainties, shows a positive coefficient, therefore it has a positive influence on

Variables	Factors	Components					
		1	2	3	4	5	6
RM12	Factor 1 – Risk management processes, technique and tools	0.856	0.163	-0.016	0.137	0.1	0.067
RM8		0.807	0.022	-0.024	0.014	0.132	-0.029
RM13		0.793	0.142	0.022	0.243	0.068	0.171
RM11		0.714	0.016	0.018	-0.042	0.112	0.419
RM6		0.594	0.416	0.187	0.233	-0.283	-0.002
RM7		0.519	0.442	0.082	0.17	-0.173	0.127
RM5		0.507	0.418	0.138	0.331	-0.273	-0.236
RM3	Factor 2 – Care with uncertainties	0.061	0.869	0.121	0.044	0.057	0.052
RM4		0.287	0.822	-0.069	0.032	-0.026	0.081
RM2		0.008	0.701	0.218	0.023	0.315	-0.048
RM14	Factor 3 – Individual knowledge of business	0.11	0.158	0.799	0.016	-0.093	0.048
RM15		-0.075	0.041	0.773	0.033	0.257	0.08
RM9	Factor 4 – Specific risk assessment	0.245	0.071	0.029	0.898	0.114	0.176
RM1	Factor 5 – Individual knowledge of project management	0.197	0.161	0.137	0.101	0.813	-0.101
RM10	Factor 6 – Simulation of timeframe/costs	0.214	0.079	0.14	0.177	-0.126	0.854

Table 3. Factorial analysis.

	B	Stand-Error	Wald	p	Exp (B)	95.0% C.I. for EXP(B)	
						Inferior	Superior
Factor 2	0.336	0.107	9.859	0.002	1.399	1.135	1.726
Factor3	0.483	0.11	19.319	0	1.62	1.307	2.009
Risk Manager	1.354	0.663	4.167	0.041	3.873	1.055	14.216
Constant	1.753	0.656	7.152	0.007	5.772		

Table 4. Logistic regression.

		R5		
	R5	Predicted		% correct
	Observed	0	1	
R5	0	56	109	33.9
	1	43	207	82.8
% correct				63.4

Table 5. Classification Grid (variable R5 – success).

constructing the model, that is, the higher the value of this coefficient, the greater the probability of the project being perceived as a success.

Factor3 has a positive coefficient; therefore it has a positive influence on constructing the model, that is, the higher the value of this coefficient, the greater the probability of the project being perceived as a success.

The risk manager showed a positive coefficient meaning that when the company has the position of risk manager, the project has a greater chance of being perceived as a success. The perception is that having a risk manager has a greater impact on the perception of success – having a risk manager has a 3.9 higher chance of perception of success than not having a risk manager.

As verified in Table 4, the data from the Wald statistic were significant. With this the null hypothesis that the coefficients in the equation are equal to zero and that the independent variables selected do not produce an effect on the dependent variable is rejected (Table 5).

It is verified that the model has predictive power of 63.4%, i.e., it can correctly identify in 33.9% of projects the lack of perceived success, and correctly predicts 82.8% of the projects perceived as success.

Once the results of the variables in the study are presented, the hypotheses will be discussed in the next section.

	Variable R5	N	Average places	Sum of places	Statistics U	z	p
Factor 1 - Risk management processes, techniques and tools	0	165	193.95	32001			
	1	250	217.28	54319			
	Total	415			18306	1.939	0.052*
Factor 2 – Care with uncertainties	0	165	183.42	30264			
	1	250	224.22	56056			
	Total	415			16569	3.392	0.001**
Factor 3 – Individual knowledge of business	0	165	177.08	29219			
	1	250	228.4	57101			
	Total	415			15524	4.266	0.000**
Factor 4 – Specific risk assessment	0	165	210.67	34760			
	1	250	206.24	51560			
	Total	415			20185	0.368	0.713
Factor 5 – Individual knowledge of project management	0	165	202.36	33389			
	1	250	211.72	52931			
	Total	415			19694	0.779	0.436
Factor 6 – Simulation of timeframes/costs	0	165	200.18	33030			
	1	250	213.16	53290			
	Total	415			19335	1.079	0.281

Table 6. Test of the H01 Hypothesis.
Note: *Significant for 90% reliability and ** Significant for 99%.

Discussion of the results and hypotheses

Of the four hypotheses formulated in this study, two were refuted, H01 and a H04, presenting evidence to those interested for the study of risk management in projects. All the hypotheses were tested against the variable general success (R5), considered statistically 0 for the non-success – responses 1, 2 and 3, and 1 for success – responses 4 and 5. The H01 hypothesis, broken down into 6 factors following the discussion that took place in the data analysis section (see Table 3), presented results about the level of confidence degree of trust that will be used for analysis, represented in Table 6.

Note that among the six factors analyzed, three can be considered significant, since factors 2 and 3 show 99% reliability. As a result it is possible to say that factor2 "care with uncertainties" and factor3 "individual knowledge of the business" have a significant impact on project success. The proof of this statement was possible due to evaluation and analysis of the binary logistic regression. In this view, the importance of understanding the concepts of uncertainty and risk evidenced in the studies of De Meyer et al. (2002) and of Perminova et al. (2008) make a contribution to the development of risk management as a discipline. Considering that care with project risks is a strategic concern from the management point of view due to generating better results, and thus project managers can thus invest better in management practices. In this line of reasoning, the work of De Meyer et al. (2002) provides important elements in decisions about the type of uncertainty to be administered – foreseeable uncertainties and the variability can be the initial target depending on the type of project. More sophisticated processes and practices can be adopted in projects that are under the incidence of risks/unforeseeable uncertainties. Moreover, with respect to hypothesis H01, with a great degree of confidence/reliability (90%), factor 1 "risk management processes, techniques and tools" that groups 7 research variables under risk management, is also revealed to have a positive impact on the perception of success in projects.

The literature on project risk management (PMI, 2008, Keelling, 2006, Carvalho and Rabechini Jr., 2011, Hillson, 2002, DOD, 2002, Raz et al. 2002, Wideman, 1992), reviewed for this study, recommends that organizations develop processes, techniques and tools aimed at achieving efficiency in managing processes and improving performance for project results. These recommendations adhere to the results found here, considering the perception of respondents with respect to project success.

It is worth emphasizing however that factors 4 specific risk assessment, 5 individual knowledge of project management, and 6 simulation of timeframe/costs, do not present significant values in terms of reliability, showing that from the practical point of view it was not possible to establish a secure connection about what is said in the theoretical literature that studied the matter and the study results.

Another hypothesis refuted was H04, and thus it was possible to conclude that the presence of a risk manager influences the perception of project success. This hypothesis was tested by the chi-square test and was refuted by $\chi^2 = 4,776$; $p = 0.029$. Thus it was verified that there is a 3.9 greater chance of perceiving success in projects in which there is a risk manager dedicated to the function of administering risks for the duration of the entire undertaking.

As already mentioned in the logistic regression analysis, the study showed that with the presence of a risk manager there is a greater (3.9) chance of success.

The risk manager is a new function established in the scope of project management, still little studied by the specialized literature on the subject. Despite this, it was possible to establish a connection between the results encountered with the work developed by Akintoye and MacLeod (1997). The relationship of perceived success to the presence of a risk manager in projects is an important piece of information that served as a touchstone to better understand this figure in the field of studies of project management.

The two hypotheses related to moderating variables tested in the study, company revenue and type of project, were not rejected, i.e. they did not influence the perception of project success or performance. To test both hypotheses (H02 and H03), the non-parametric Kruskal-Wallis test for a 5% level of significance was applied without significant results.

With respect to the variable company revenue, it was expected that larger companies would have organized processes and as a result would have a moderating impact between risk management and perception of success (Zwikael and Ahn, 2011).

It was also expected that in line with arguments sustained by Shenhar and Dvir (2010) that the type of project variable would have a significant impact as moderator between risk management and perception of success.

Discussion

Through verification of two of the four hypotheses established for this article and supported in theory it was possible to understand which factors condition project risk management and the perception of success, considering the study sample.

The data revealed evidence for the existence of two factors interconnected with the perception of success reported by the professionals involved in the 411 projects in the sample. The first dimension took into account a set comprised of six factors and three of them have a significant impact on the perception of project success: (i) conceptual understanding and care with uncertainties; (ii) utilization of processes, techniques and tools, and (iii) knowledge of the business. From the practical point of view, paying attention to uncertainties during the project, making use of the risk management techniques and deeply understand the business environment are critical success factors, demanding attention of project managers and risk managers.

The presence of a project risk manager, constituted the second significant variable to understand the relationship between risk management and project success. This finding, in practice, suggests that project managers should assign a specialized professional to deal with risk management activities. This study can be a source of information for practitioners and academics in order to better understand the risk management requirement but also the state of practice in Brazilian companies. It was not possible to confirm the contingent effect of the type of project, as suggested by the literature. The contingent effect of industry sector should also be address on a future research agenda.

This research showed the limitations inherent to the methodological choices adopted for the field research. First, it adopts a non-probability sample and based on the respondents' perception of project success, which could lead to bias in the research results. On the other hand, this is the first specific study of the project risk management area in Brazil with a sample of this magnitude, producing important insights for new studies and bases for cross country comparison.

APPENDIX A. RESULTS VARIABLES.

Variable	Description	Scale
R1	Scope	5 point Likert scale
R2	Quality	5 point Likert scale
R3	Customer satisfaction	5 point Likert scale
R4	Team	5 point Likert scale
R5	Overall	5 point Likert scale

APPENDIX B. RISK MANAGEMENT VARIABLES.

Factor	# of Questions	Scale
Factor 1 – Risk management processes, technique and tools	5 questions	5 point Likert scale
Factor 2 – Care with uncertainties	3 questions	5 point Likert scale
Factor 3 – Individual knowledge of business	2 questions	5 point Likert scale
Factor 4 – Specific risk assessment	1 questions	5 point Likert scale
Factor 5 – Individual knowledge of project management	1 questions	5 point Likert scale
Factor 6 – Simulation of timeframe/costs	1 questions	5 point Likert scale

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