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FABRÍCIO GARCIA IMBRIZI

UNDERSTANDING THE INFLUENCE OF PROJECT RISK MANAGEMENT ON INFORMATION SYSTEM / INFORMATION TECHNOLOGY PROJECT SUCCESS: A MULTIDIMENSIONAL ANALYSIS

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Thesis submitted to the Post-Graduate Program in Business Administration – PPGA of Nove de Julho University - UNINOVE, as a partial requirement for the degree of **Doctor in Business Administration**.

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Por

Fabrício Garcia Imbrizi

Tese apresentada ao Programa de Pós-Graduação em Administração - PPGA da Universidade Nove de Julho – UNINOVE, como requisito parcial para obtenção do título de Doutor em Administração, sendo a banca examinadora formada por:

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À minha esposa Isabella e filha Lara

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RESUMO

Diversos estudos têm sido realizados para melhor compreender as principais causas das falhas de projeto e como combatê-los na área de sistemas de informação / tecnologia da informação (SI/TI). O gerenciamento de riscos do projeto (PRM) tem sido reconhecido como um fator crítico de sucesso para apoiar o atingimento do sucesso do projeto. Apesar dos benefícios conhecidos advindos com o gerenciamento de riscos do projeto, seu uso efetivo tem sido discutido em alguns estudos buscando os motivos pelos quais os gerentes de projeto não adotam as melhores práticas de gerenciamento de riscos do projeto durante o ciclo de vida geral do projeto. O principal objetivo deste trabalho foi analisar se o gerenciamento de riscos do projeto influencia o sucesso do projeto em projetos de SI/TI. Diferentemente de outros estudos encontrados na revisão da literatura, este levou em consideração muitas dimensões dos dois constructos, gerenciamento de risco do projeto e sucesso do projeto. Uma abordagem quantitativa foi realizada, usando uma pesquisa baseada na web para coletar dados de 156 profissionais de gerenciamento de projetos em todo o mundo de vários países e empresas. Este estudo contribuiu para a teoria mostrando que o gerenciamento de risco do projeto influencia positivamente o sucesso do projeto, mas esse efeito positivo ocorre apenas em duas das cinco dimensões do gerenciamento de risco do projeto, a saber, cultura de gerenciamento de risco e planejamento de resposta ao risco em relação as quatro de cinco dimensões do sucesso do projeto, a saber, eficiência do projeto, impacto no cliente, impacto na equipe do projeto e sucesso nos negócios.

Palavras-chave: sistema de informação, tecnologia da informação, gerenciamento de risco de projeto, sucesso de projeto, desenvolvimento de software, abordagem multidimensional.

ABSTRACT

Several studies have been carried out to better understand the main causes for project failures and how to tackle them in the information system/information technology (IS/IT) field and project risk management (PRM) has been recognized as a critical success factor to support the achievement of the project success. Despite the known benefits brought with project risk management, its effective usage have been discussed in some studies looking for the reasons due to project managers disengage from adopting best practices of project risk management through the overall project life cycle. The main objective of this work was to analysis if the project risk management influences project success in IS/IT projects. Differently from other studies found in the literature review, this one took into consideration many dimensions of the both constructs, project risk management and project success. A quantitative approach was carried-out, using a web-based survey to gather data from 156 project management practitioners worldwide from several countries and companies. This study contributed to theory by showing that project risk management influences positively the project success, but this positive effect occurs only for two out of five dimensions of project risk management, namely risk management culture and risk response planning, in relation to four out of five dimensions of project success, namely project efficiency, impact on the customer, impact on the project team and business success.

Keywords: information system, information technology, project risk management, project success, software development, multidimensional approach

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LIST OF ACRONYMS

AC	Absorptive Capacity
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
APM	Association for Project Management
BN	Bayesian Networks
BNCC	Bayesian Networks with Causality Constraints
CAPM	Certified Associate in Project Management
CEFR	Common European Framework of Reference for Languages
CI	Choquet Integral
CMMI	Capability Maturity Model Integration
CPN	Colored Preti Nets
DEMATEL	Decision Making Trial and Evaluation Laboratory
EMV	Expected Monetary Value
ERP	Enterprise Resource Planning
EIS	Executive Information System
FCM	Fuzzy Cognitive Maps
GDSP	Geographically Distributed Software Projects
GDSRM	Goal-driven Software Development Risk Management Model
IBM	International Business Machine
ICT	Information and Communication Technology
IF	Impact Factor
IS	Information Systems
ISD	Information Systems Development
ISM	Interpretive Structural Modeling
IT	Information Technology
ITO	Information Technology Outsourcing
ITIL	Information Technology Infrastructure Library
ITSM	Information Technology Service Management
JCR	Journal Citation Report
KBRM	Knowledge-Based Risk Management

MACOM	Multi-Agents Cognitive Map
OECD	Organization for Economic Co-operation and Development
ORD	Organizational Risk Diagnosing
OTS	Off-The-Shelf
PERT	Program Evaluation and Review Technique
PMI	Project Management Institute
PPM	Project Portfolio Management
PPM	Professional in Project Management
PMP	Project Management Professional
PRM	Project Risk Management
PLS	Partial Least Squares
MCDM	Multi Criteria Decision-Making Methodology
MD	Medical Devices
NPD	New Product Development
R&D	Research and Development
RBS	Risk Breakdown Structure
RM	Risk Management
SD	Software Development
SDLC	Software Development Life Cycle
SEM	Structural Equation Modeling
SJR	SCImago Journal Rank
SLM	Service Level Management
SME	Small and Medium Enterprise
SPRM	Software Project Risk Management
STT	Socio-Technical Theory
TTF	Task-Technology Fit
TMO	Temporary Multi-Organizational

1 INTRODUCTION

In the digital era, even more organizations have been deployed projects by investing a significant amount of time and resources as a mean to achieve their business goals, strategies and objectives. These projects may be of different types, such as the development of new products and services, research and development of new technologies, (re)design of new or ancient processes, procedures and/or organizational structures, development, configuration, deployment and/or maintenance of information systems, and so on (Aven, 2016; Shenhar, Dvir, Levy, & Maltz, 2001).

The undertaking of Information Technology (IT)/Information System (IS) projects is one of the biggest challenge for several companies worldwide (Bannerman, 2008; Keil, Rai, & Liu, 2013; S. Liu, 2016; Taylor, Artman, & Woelfer, 2012) and today’s part of their core business. As a result of these initiatives, The Standish Group showed in the CHAOS Report 2016 that of 50,000 projects studied around the world on software development industry, 19% have failed, 52% were challenging and only 29% had successful. It means that 71% of the projects are still facing significant and stressful issues over the time, incurring, at different levels, in loss-making projects. Moreover, this scenario in the last five years has not changed significantly, varying by +/- 3% in average (Standish Group International, 2016). Hence, since last century, thousands of studies (de Bakker, Boonstra, & Wortmann, 2010; Keil et al., 2013; Samadi, Nazari-Shirkouhi, & Keramati, 2014; Tesch, Kloppenborg, & Frolick, 2007; Vrhovec, Hovelja, Vavpotič, & Krisper, 2015) have been carried out to better understand the main causes for project failures and how to tackle them in diverse areas, such as construction, educational, government, healthcare, industry, IS/IT and so on.

For instance, in the Project Management Institute (PMI) Pulse of Profession 2017 survey, 27% of 3,234 project management practitioners said that undefined opportunities and risks was one of top three primary causes for projects failures, considering the projects started in the past 12 months (Project Management Institute, 2017b). One relevant knowledge area in the project management field is Project Risk Management (PRM), which has been recognized as a critical success factor to support the achievement of project goals. Project risk management have been received much attention in the last years and has many opportunities for future studies (Aven, 2016; Lehtiranta, 2014; Sanchez, Benoit, Bourgault, & Pellerin, 2009; Zhang, 2011; Padalkar & Gopinath, 2016; Persson, Mathiassen, Boeg, Madsen, & Steinson, 2009).

Several best practices - methods, processes, activities, techniques, tools, principles and guidelines - have also been proposed by well-established project management organizations and other international organizations for project risk management that may support project managers on their journeys, such as the PMBOK® guide or Practice Standard for Project Risk Management owned by the PMI (Project Management Institute, 2009, 2017a), PRINCE2® or Management of Risk (M_o_R) formerly owned by the Office of Government Commerce (OGC) but now managed and developed by AXELOS, a joint venture company by the Government of the United Kingdom and Capita plc (AXELOS, 2012, 2017) and ISO 31000:2009 Risk Management - Principles and guidelines (ISO, 2009).

Both, academic literature and best practices commonly cite four sequential and cyclic process of project risk management, namely risk identification, risk analysis, risk response planning, and risk monitoring and control. Several studies have been given attention for each one of these process, for example, to identify contextual risk factors (Aloini, Dulmin, & Mininno, 2007a), to propose risk checklists and risk ontologies (Salmeron & Lopez, 2010), to identify risks related to IT service delivery (Nazımoğlu & Özsen, 2010), to investigate the risk perceptions of different roles over the risk identification process (S. Liu, Zhang, Keil, & Chen, 2010), to assess the interdependency between risks (Kwan & Leung, 2011), to prioritize risks (Samadi et al., 2014), to identify avoidance and mitigation strategies (Hung, Hsu, Su, & Huang, 2014) and their effectiveness and efficiency tackling key risks, to propose models and frameworks to identify risks (Ohtaka & Fukazawa, 2010), access risks (Büyüközkan & Ruan, 2010), plan responses to risks (Dey, Clegg, & Cheffi, 2013), monitor risks and looking for a better understanding of their behavior over the software development life cycle (SDLC) in IS/IT projects (Yu, Chen, Klein, & Jiang, 2013) supporting the decision making of project stakeholders.

These studies bring relevant findings to the project risk management field, but they do not demonstrate, with few exceptions, which of these processes are contributes more to the project success. To tackle this, some studies examined the influence of different categories, groups, sources, and dimensions of risk on project success (Han & Huang, 2007; Jun, Qiuzhen, &

Qingguo, 2011; S. Liu & Wang, 2014; Mishra, Das, & Murray, 2016; Na, Simpson, Li, Singh, & Kim, 2007; Reed & Knight, 2010; Sharma, Sengupta, & Gupta, 2011; Sicotte & Bourgault, 2008; Wallace, Keil, & Rai, 2004a, 2004b), the influence of project risk management on project success (Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010; de Bakker, Boonstra, & Wortmann, 2011, 2012; Islam, Mouratidis, & Weippl, 2013; Jun et al., 2011; S. Liu, 2015b, 2015a; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011), the moderating effects of risk or contingency factors on the relationship between risk or risk management on project success (Carvalho & Rabechini Junior, 2014; Jun et al., 2011; Keil et al., 2013; S. Liu, 2015b, 2015a; S. Liu & Wang, 2014; Teller & Kock, 2013; Teller, Kock, & Gemünden, 2014; Wallace et al., 2004b; Zwikael & Ahn, 2011), and the influence of portfolio risk management on project portfolio success (Teller, 2013; Teller & Kock, 2013; Teller et al., 2014). These studies conceptualize project risk management and project success as multi and/or unidimensional and examine their potential relationship in different perspectives.

In the last years studies have considered project risk management and project success as multidimensional constructs. Project risk management has been described as an extension of the well-known processes in the academia and best practices while project success have been described based on the five dimensions proposed by Shenhar (Shenhar & Dvir, 2007; Shenhar et al., 2001), namely project efficiency, impact on the customer, impact on the team, business and direct success and preparation for future. In general, these undertakings consider one or another dimension of project risk management against one or another dimension of project success, but no study has demonstrated the relationships of all well-known dimensions of both constructs.

Despite the known benefits brought with project risk management, its effective usage have been discussed in some studies looking for the reasons due to project managers disengage from adopting best practices of project risk management over the project life cycle (Kutsch, Denyer, Hall, & Lee-Kelley, 2013). Some reasons have been appointed, such as resources, costs and time constraints, fear to exposure issues and lack of control to stakeholders, unclear benefits of the project risk management outcomes, and so on. Looking at the main four processes previously cited, risk identification and risk analysis were the main processes followed by project managers with rare effective application of risk response planning, and monitoring and control

(Bannerman, 2008; Kutsch, Browning, & Hall, 2014; Kutsch et al., 2013; Kutsch & Hall, 2009, 2010; Kutsch & Maylor, 2011; Taylor et al., 2012; Wickboldt et al., 2011).

This sheds light on current common project risk management processes and opens opportunities to better comprehend the effective influence of project risk management on project success. The main objective of this work is to analyze if project risk management influences project success in IS/IT projects. Differently of the other studies found in the literature review, this current work taking into consideration the many dimensions of the both constructs, project risk management and project success in order to confirm, review and make practical recommendations to guarantee the effective use of project risk management best practices once they have been recognized as critical success factor to support the achievement of business objectives. Therefore, this study proposes the following research question, "*Does project risk management influence project success in IS/IT projects?*" with an eyes on both, the multi dimensions of project risk management and project success. For the purpose of this study, our interest is more on the negative effect of project risk due to the fact that organizations should first focus on protecting their business before engaging in new opportunities and due to the project failures already mentioned in chapter one.

1.1 Objectives

The main objective of this study is to analyze if project risk management influences project success in IS/IT projects. This will provide insights of the influence of common process of project risk management on common dimensions of project success, namely project efficiency, impact on the customer, impact on the project team, business success, and preparing for the future.

To achieve the main objective, a set of specific objectives were established, to know:

a) Analyze the relationship between project risk management and project success;
b) Analyze the relationship between project risk management dimensions and project success;
c) Analyze the relationship among each project risk management dimension and project success dimension;

A quantitative approach is proposed to carry-out this research, using a web-based survey to gather data from project management practitioners worldwide from several countries and companies, which were requested to select the ***latest completed project*** they have been worked, being the project the unit of analysis.

1.2 Justification

There are some practical and academic justifications to undertake this study. First, despite the recognized relevance of project risk management, it is still little applied in the organizations day-by-day (Bannerman, 2008; Kutsch et al., 2013). Second, millions of dollars are wasted every year by companies who do not achieve their business goals, strategies and objectives due to failed projects (de Bakker et al., 2010; Samadi et al., 2014; Tesch et al., 2007; Vrhovec et al., 2015). Third, in spite of the availability of several standards, processes and best practices published, they are not been effectively carried out by project managers in IS/IT field. Forth, while prior studies has tended to examine the influence of project risk management as a single construct, no study has investigated project risk management in regard to project success both being designed as multidimensional constructs. For project risk management field in IS/IT projects, it can shed light on the four sequential and cyclic processes of project risk management as well as on the risk management culture and risk management process formalization to enhance the discussion of the influence of project risk management on project success, sometimes described as being positive or limited, as well as the disengagement of project managers over these processes.

1.3 Thesis Structure

This study is structured into seven chapters, considering this introduction. Second chapter presents the literature review of project risk management and project success. Chapter three presents the conceptual model and hypotheses. Chapter four presents the methodological aspects of this research, including the nature of the research, the systematic review undertaking in this study, the instrument of measurement, the pre-test, the data collection method, the population sampling, the construct reliability and validity methods, and the data analysis methods. Chapter five presents the results. Chapter six presents the analysis and discussion based on the collection of evidences and methodological review. Finally, chapter seven presents the conclusion summarizing the findings of this research, the implications for theory, the implications for practice, the limitations of the study, and suggestions for future works. *Figure 1* shows the thesis structure.

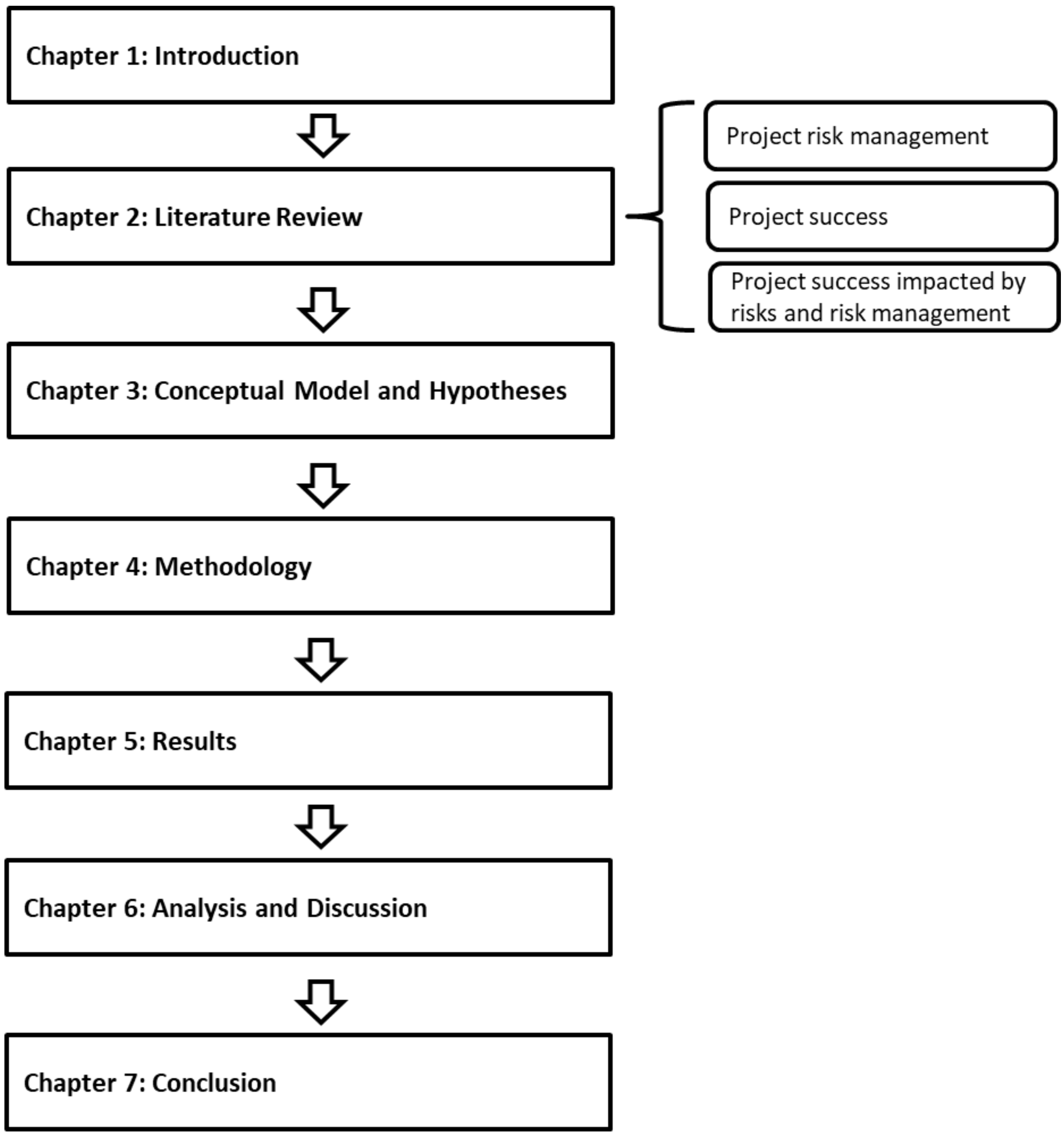

Figure 1. Thesis Structure

Source: created by the author

2 LITERATURE REVIEW

Project risk is defined by well-disseminated body of knowledge of project management organizations. The PMI defines risk as “an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives” (Project Management Institute, 2017a) and the Association for Project Management (APM), in a similar way, defines risk as “an uncertain event or set of circumstances that, should it occur, will have an effect on the achievement of the project’s objectives” (Association for Project Management, 2012).

This chapter presents the literature review carried-out on two topics covered by this research, namely Project Risk Management (PRM) and Project Success (PS). Most of the papers cited here date from 2007 to 2016, are related to studies in IS/IT field and were searched by a systematic review developed for this study as described in section 4.2.

2.1 Overview of Project Risk Management

In the last 40 years, several studies have been conducted to investigate the concepts, ontologies, strengths, weaknesses, opportunities, challenges, models, methods, and frameworks related to project risk management in different fields of study and IS/IT have developed significant contributions to that (Alter & Ginzberg, 1978; Barki, Rivard, & Talbot, 1993; Boehm, 1991; Keil, Cule, Lyytinen, & Schmidt, 1998; Lyytinen, Mathiassen, & Ropponen, 1996; McFarlan, 1981; Schmidt, Lyytinen, Keil, & Cule, 2001). Recent systematic reviews, for instance, were developed to discuss conceptual/theoretical issues (Aven, 2016; Zhang, 2011; Padalkar & Gopinath, 2016) and practical issues on risk management (Lehtiranta, 2014; Persson et al., 2009; Sanchez et al., 2009). These studies reinforce the relevance of this field of study, showing that there are much more opportunities for new research questions, at least, in the IS/IT context.

In the context of conceptual/theoretical issues, project risks can be categorized as an objective fact or as a subjective construction (Zhang, 2011). Risk as an objective fact means that risk exists independently of people's beliefs, values and thought, it is epistemologically probabilistic, its studies are focused on development of (semi)quantitative methods, processes and practices of risk analysis which is considered a technical and objective activity, and risk communication is a one-way information dissemination. Risk as a subjective construction means that risk is a subjective mental construction of people or organizations, it is epistemologically multi-dimensional, its research are focused on social, cultural and psycho aspects, and risk communication is a two-way collaborative construction. Moreover, risk studies can be divided in two main tasks: 1. to use risk assessments and risk management to investigate risk of a specific area of study (e.g. Supply chain, IT project management), and 2. to perform generic risk research to deal with risks in general (Aven, 2016). These groups should not be viewed as rigid definitions and merging between them is welcome, such as understand risk as an objective fact and seen risk communication as a two-way activity.

In the context of practical issues, it is still more common find out studies on risk management practices for project management instead of program management or project portfolio management (Sanchez et al., 2009). For example, a recent systematic review with 105 papers addressed challenges on project risk management in temporary multi-organizational (TMO) in software industry recommending a holistic, integrative and participative approach for project risk management that could in turn result into a better risk management effectiveness (Lehtiranta, 2014). Its findings show that:

a) Risks are perceived much more as threats then opportunities or uncertainty as the holistic view - both threat and opportunity - so TMOs are not prepared to seize opportunities in risk management;
b) Risk are treated as anticipated events instead of unanticipated or unrealistic assumptions, so risk management is more focused on a proactive approach in opposite to reactive or aware approaches;
c) The involvement of all players to manage jointly internal and external risks are mature; and
d) Risk responsibility is almost delegated to the software supplier, leaving the client out of the discussion and decisions.

Taken into account the objectives of these studies previously cited, we understand that, from theoretical lenses, risk is an objective fact, methods, processes and practices of risk evaluation are useful to deal with risks, but it is epistemologically multi-dimensional and risk communication is a two-way collaborative construction. Furthermore, from practical perspective, this study was developed looking for better understanding of the usage of project risk management by project managers in different IS/IT projects, companies and countries, and its influence on project success dimensions as defined by the literature. Project risk in this study is understood as an uncertain event which may occur could affect negatively the project's objectives. There is nowadays a concern about the effective usage of these well-known and established methods, processes and practices, despite the several years of research in this area.

Project risk management has an important function in managing software projects as it is well recognized in the literature as a critical success factor to achieve the business objectives. Nevertheless, risk management theory needs to evolve on practical requirements to deal with the uncertainties challenged by software projects bridging the gap between the practice and academic prescriptions of risk management (Bannerman, 2008; Wickboldt et al., 2011). This is also in line with recent studies inquiring the effective application of project risk management by project managers (Kutsch & Hall, 2009, 2010, Kutsch et al., 2013, 2014; de Bakker et al., 2010; Wickboldt et al., 2011; Zwikael & Ahn, 2011; de Bakker et al., 2011, 2012). It opens new doors for several studies to better understand the influence of project risk management processes on project success and to develop theoretical and practical alternatives to enhance the usage of project risk management. Several reasons have been presented why project managers disengaged from project risk management best practice standards in IS/IT projects (Kutsch & Hall, 2009, 2010, Kutsch et al., 2013, 2014). These findings suggest that the main reasons for project managers not applying formal project risk management are:

1. Resources, costs and time constraints;
2. Focus on familiar and measurable risks;
3. Fear to exposure issues and lack of control to stakeholders;
4. Avoidance of intangible, imperceptible and unreal events;
5. Tendency to be optimistic;
6. Unclear benefits of the project risk management outcomes; and
7. Lack of authority in their own projects.

Besides that, project managers over and underestimate risks under certain conditions, respectively, in high and low performing projects, ignoring risks and delaying responses to them (Kutsch & Maylor, 2011), especially those where they are very familiar, which in turn implies persisting engaging in failing IT projects ahead (Jani, 2011). Process and behavior should be considered when managing project risks as behavior acts as a mediator that influences negatively the effective use of project risk management and should not be ignored. The ability of project managers to identify and assess risks in advance is not trivial as best practice standards described in some body of knowledge compendiums (Kutsch & Maylor, 2011). These findings also reinforce the relevance of social, cultural and psycho aspects over project risk management.

In most projects, project risk management was followed until some level of inspection, been identification and assessment the main processes followed by project managers with rare effective application of risk response planning, and monitoring and control – follow-up. These four processes are common observed in the literature review, as will be described in more detail in the next section. *Figure 2* shows the stepwise disengagement from risk management by project managers in the study developed by Kutsch et al., 2013.

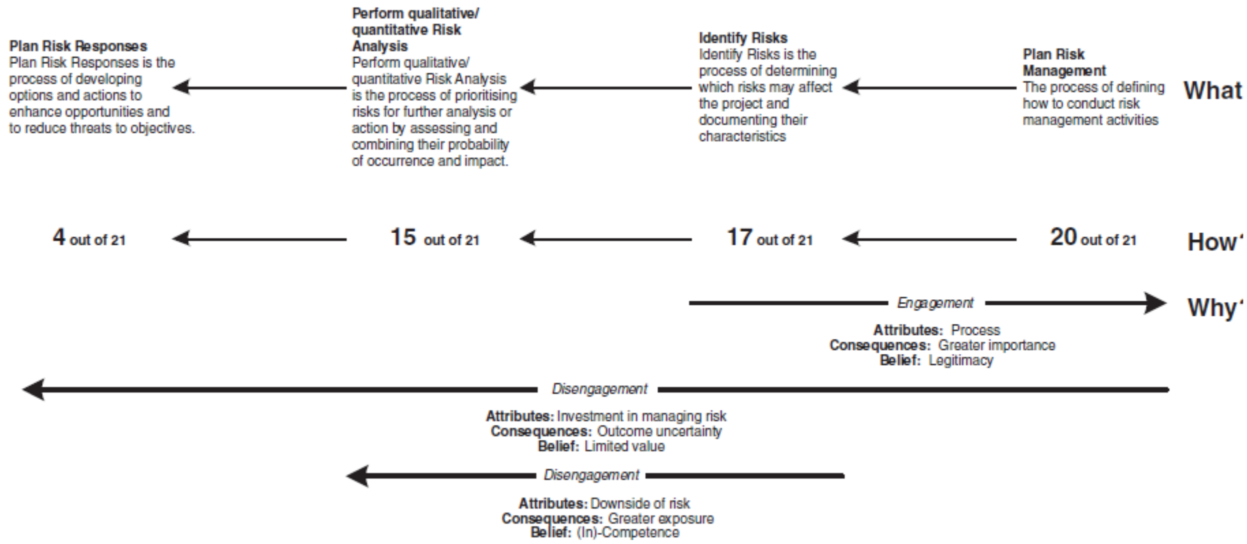

Figure 2. Stepwise disengagement from risk management

Source: adapted from Kutsch et al. (2013)

Addressing the gap between IT project risk management research and practice is a big challenge to tackle the main issues pointed out before. Alternatives as contingency and holistic approaches have been proposed as an alternative to evaluate the level of well-known dimensions of risks in literature, instead of a traditional probabilistic-impact method of assessing project risks (Taylor et al., 2012). These approaches have showed to be effective to detect risks in early stages and establish right management strategies to deal with them gathering the engagement of project managers.

Summarizing, risk management is critical for project success, there are many challenges on its effective application over different stages of well stablished project risk management processes and there are recent studies willing to overcome this challenges and issues. In line with these points and considering the scope of this study, the next sections describe recent studies related to the four well-known processes for an effective project risk management, namely risk identification, risk analysis, risk response planning, and risk monitoring and control, as well the understanding of risk management culture, risk management process formalization, and project success concepts and the relationship between project risk management and project success. This review will support the development of the suggested conceptual model and hypotheses of this study according to the proposed research question and objectives described early. *Figure 3* summarizes the main topics covered in this section.

Theme	**Specific topic studied**	**Authors**
Conceptual / theoretical issues reviews	Constructs of risk	(Padalkar & Gopinath, 2016; Zhang, 2011)
	Types of risk studies	(Aven, 2016)
Practical issues reviews	General application of risk management	(Sanchez et al., 2009)
	Risk management in specific context	(Lehtiranta, 2014; Persson et al., 2009)
Usage of project risk management	Gap between theory and practice	(Bannerman, 2008; Wickboldt et al., 2011)
	Disengagement from risk management	(Jani, 2011; Kutsch et al., 2014, 2013, Kutsch & Hall, 2009, 2010)
	Addressing the gap between theory and practice	(Kutsch & Maylor, 2011; Taylor et al., 2012)

Figure 3. Summary of topics cited in the overview section

Source: created by the author

2.2 Project Risk Management

The academic literature and common best practices on project risk management describe four sequential and cyclic process of project risk management that organizations should deploy: (i) risk identification, (ii) risk analysis, (iii) risk response planning, and (iv) risk monitoring and control. Risk identification aims to identify and categorize risks that if materialized could impact the business objectives. Risk analysis aims to assess risks, individually and collectively, by qualitative and/or quantitative methods and prioritize them according to the business appetize to risks. Risk response planning aims to select the best strategy and action plans to tackle risks, preventively or proactively. Risk monitoring and control aims to monitor and control the mitigations actions and reassess known risks as well new risks emerging over the project life cycle.

On top of that, organizations should have a clear set of internal policies and key principles for project risk management to be shared among internal and external stakeholders, such as, employees, partners, suppliers and customers. They should clearly state the company's tolerance to risk, how company identify, analyses, response to and monitors risks, what are the main tools for registering, reporting, communicating, and following risks. These embrace the so called risk management culture and risk management process formalization.

The next six sections describe the main findings of recent studies about each one of these four major processes, as well as about the risk management culture and the risk management process formalization. It will support our better understanding of what the academic literature is saying about these themes and will support our research goal. *Figure 4* shows the four sequential and cyclic processes of project risk management supported by risk management culture and by risk management process formalization.

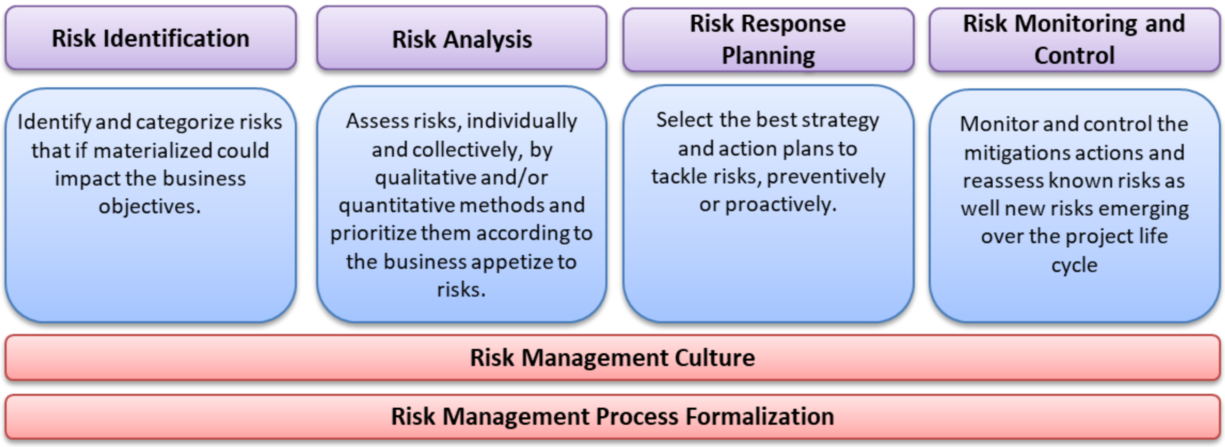

Figure 4. Common process of project risk management supported by risk management culture and by risk management process formalization

Source: adapted from Teller & Kock (2013)

2.2.1 Risk identification

In the project risk management, risk identification is the process aimed to identify and categorize risks that if materialized could impact the business objectives. Several studies on risk identification were performed to identify contextual risk factors (Aloini et al., 2007a; Büyüközkan & Ruan, 2010; Chua, 2009; Reed & Knight, 2010; Sharma & Gupta, 2012; Sharma et al., 2011; Tesch et al., 2007; Wallace et al., 2004a), to propose risk checklists and risk ontologies (Chao Peng & Baptista Nunes, 2009a, 2009b; Salmeron & Lopez, 2010), to identify risks related to IT service delivery (Aundhe & Mathew, 2009; Nazımoğlu & Özsen, 2010), to propose models/frameworks to identify and manage risks (Dey et al., 2013; Holzmann & Spiegler, 2011; Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano, & Villanueva, 2014; Ohtaka & Fukazawa, 2010; Vrhovec et al., 2015; Yu et al., 2013; Yu, Chen, Klein, & Jiang, 2015) and to investigate the risk perceptions of different roles over the risk identification process (Keil, Li, Mathiassen, & Zheng, 2008; S. Liu et al., 2010; Sharma et al., 2011; Tiwana & Keil, 2006). These studies contribute to the academia bringing insights, experiences and expertise in order to support project managers in current and future undertakings.

Identification of risk factors was extensively studied in the past (see *Figure 5*) like one widely cited paper (Wallace et al., 2004a) which validated an instrument using a sample of 507 respondents to assess six dimensions of software project risk composed of 27 risks, namely *project complexity, user, requirements, organizational environment, team, and planning & control*, but risk identification is still being under investigation by studies on IT field. For instance, one literature review on 75 peer-reviewed papers, dated between 1999 and 2006, identified and categorized 19 risk factors by the following dimensions: *research aim* - ERP selection, ERP implementation, ERP risk management, IT/ERP project, *sector* - multiple sector, small and medium enterprise, large corporate-enterprises, *research type* - empirical, conceptual/theoretical, conceptual/theoretical and empirical, and *methodology* - positive/descriptive, normative/prescriptive (Aloini et al., 2007a). Other study reviewed 92 risks of IT projects from previous research papers and regrouped them into six main categories: *sponsorship/ownership, funding and scheduling, personnel and staffing, scope, requirements and relationship management* (Tesch et al., 2007).

Author (year)	**Research area**	**Dimensions**	**Software risks**
McFarlan (1981)	Common	3	54
Boehm (1991)	Common	0	10
Barki et al. (1993)	Common	5	35
Summer (2000)	ERP	6	19
Longstaff et al. (2000)	Systems integration	7	32
Cule et al. (2000)	Common	4	55
Kliem (2001)	BPR	4	38
Schmidt et al. (2001)	Common	14	33
Houston et al. (2001)	Common	0	29
Murthi (2002)	Common	0	12
Addison (2003)	E-commerce	10	28
Carney et al. (2003)	COTS	4	21
Wallace et al. (2004)	Common	6	27

Figure 5. Summary of risks in software development in older studies

Source: Han and Huang (2007)

Even more recent, built on a meta-case analysis of eight well documented failed IT project, i.e. those abandoned either over their development or post-implementation, 13 risk factors were identified and grouped in four dimensions, namely *people-related*, *process-related*, *technical, and extra-project (external environment) risk factors*, and a model was proposed to fit them in the main stages of the lifecycle of the IT project, to know initiation, development, and implementation (Chua, 2009), and other 13 software development risks were identified and grouped in three dimensions, *product engineering, development environment and program constraints* (Büyüközkan & Ruan, 2010).

In a survey with 150 IT practitioners, 55 risk were identified by the literature and focus group/interviews and seven of them, namely *cultural or language differences, hidden agendas impact the project, inadequate technical resources, insufficient knowledge transfer, lack of project team cohesion, loss of key resources that impact the project, and resource inexperience with company and it's process* were pointed out as being key and greater risks when performing IT projects by virtual software development teams in comparison against traditional co-located teams (Reed & Knight, 2010) and 23 software risks factors were identified grouped after the factor analysis as *software requirement specification variability, dependability, team composition, and control processes* (Sharma & Gupta, 2012; Sharma et al., 2011). These studies found risks that may affect the business objectives, such as bad management conduct, ineffective communication system, low top management involvement, ineffective project management techniques, and poor leadership.

Identification of risk checklists and proposition of risk ontology/taxonomy are extensively studied in ERP projects due to its complexity. For example, one study proposed one risk checklist to facilitate the risk identification, assessment, mitigation, and monitoring of 40 ERP post-implementation risks related to technical, operational, analytical, and organizational aspects and also proposed an ERP risk ontology to highlights them and their causal relationships (Chao Peng & Baptista Nunes, 2009a, 2009b). In a similar way, (Salmeron & Lopez, 2010) suggested a general ERP maintenance risk taxonomy with 30 risks identified by an extensive literature review and experts judgment, and classified them according to the seven phases described in the IEEE Standard 1219 for Software Maintenance, namely, *Problem/modification identification, classification and prioritization; analysis; design; implementation; regression system testing; acceptance testing; and delivery*. Supported by these research papers, practitioners and academics may take advantage from this risk ontology and checklist managing potential risks and evolving the development of risk management in ERP post-implementation scenarios.

Besides the risks inherent to the IT project level, identification of risks related to IT service delivery are extremely relevant for IT suppliers. One study identified the key risks that an IT service provider tackle in offshore IT outsourcing engagements with its customers summarized as three main categories of risks, namely *project specific risks, relationship specific risks and macroeconomic risks* (Aundhe & Mathew, 2009). Similarly, one study carried out at International Business Machine (IBM) supported by Information technology Service Management (ITSM) Metrics Model identified nine risks related to IT service delivery and their effect on the most three risky processes of Information Technology Infrastructure Library (ITIL): Service Level Management (SLM), service desk and change management (Nazımoğlu & Özsen, 2010). These investigations showed also the concern of IT service providers in the identification of key risks that can hazard any IT undertaking apart from projects it selves.

While one group of study is interested in risk at project level (Aloini et al., 2007a; Büyüközkan & Ruan, 2010; Chao Peng & Baptista Nunes, 2009a, 2009b; Salmeron & Lopez, 2010; Tesch et al., 2007) the other one is interested in risks at service level (Aundhe & Mathew, 2009; Nazımoğlu & Özsen, 2010) and both contribute for the understanding of key risks that may affect IT projects and initiatives.

The identification of risk is normally carried out by different models/frameworks according to the project type, size, complexity and other organizational factors. Key risks can be identified by separating phenomena that are source of future problem from those in the current project providing a holistic view of causes and effects of phenomena in the earlier phases of the project and over the whole project life cycle too (Ohtaka & Fukazawa, 2010). With the adoption of a risk breakdown structure (RBS), key risks can be identified and communicated to all project stakeholders via content and cluster analyses based on existing information of previous projects (Holzmann & Spiegler, 2011). Risks can be classified in ERP projects hierarchically, such as *external engagement, program management, work stream and work package*, and by categories, namely *technical, schedule, operational, business and organizational* (Dey et al., 2013). For small and medium enterprises (SMEs), one new methodology adapted from known PRM methodologies took into account the project alignment with company’s strategy, limitation of resources and result-oriented management, proposing simple tools, such as checklists, templates and indicators, and it was based on an extensive research in 72 Spanish companies and tested in five different types of projects, such as innovation, IS management, and information and communication technology (ICT) implementations (Marcelino-Sádaba et al., 2014).

In addition to the practical approaches available, one study suggested an organizational risk diagnosing (ORD) framework based on the Resistance to Change Theory to study the root causes of organizational risks in software projects from different stakeholder's point of view and found that some organizational risks may have root causes that are not easy to identify and it is essential to understand them to propose the effective risk response (Vrhovec et al., 2015). Based on Socio-Technical Theory (STT), other study proposed a framework extending this theory to identify actors involved, structural relationships, technology implemented, and task performed risks in each stage of the SDLC in a multi-case study within seven companies headquartered in Twain and three in the USA with a total of 18 participants (Yu et al., 2013), and another applied this theory in addition with Task-Technology Fit (TTF) theory to identify risks and the relationship between these four categories of risks in one Executive Information System (EIS) project carried out in Government agencies in Republic of China (Yu et al., 2015). These previous studies show that practical and theoretical approaches are useful to identify risks over the project life cycle.

No evidences were verified on how internal and external stakeholders perceive the risk identification process in regard to the project success. To tackle it partially, one investigated the risk perceptions of different roles over the risk identification and found that risk checklists aid practitioners to identify more risks but role, being project manager or external consultant, does not influence either their perception or decision-making (Keil et al., 2008). Key risks identified on risk checklists influenced their decision-making but the number of risks do not affected them and the risk checklists also supported them to identify more risks than those previously mapped. Project managers are more focused on lower-level of risk, such as requirements, users and technology, and senior executives are more focused on high-level risks, such as politics, organizational structure, process and culture according to one study using a Delphi method in China (S. Liu et al., 2010).

In a study with 300 respondents of 32 Indian software companies, four risk dimensions, namely *software requirement specification variability, dependability, team composition, and control processes* were perceived differently in relation to project success by three group of respondents according to their roles, to know a) project, technical and consultancy leaders; b) project, senior and account managers; and c) C-levels executives. The last two groups perceived risks as more controllable and having less impact on project success compared against the first group (Sharma et al., 2011).

Based on the knowledge transformation logic in the requirements elicitation literature, other study found that *functionality risks* - the risks that the completed software will not meet its users' needs - can explain significant 21% of the variance in overall project risk managerial perception, being them, in other of importance, *methodological fit to the project characteristics, customer involvement, use of formal project management practices, related technical knowledge, project complexity risks, and requirements volatility – changings of initial requirements.* Different from previous studies, *methodological fit to the project characteristics* was identified as the most significant factor compared against the others suggesting that choosing the right development methodology can reduces the exposure to the other risk factors and project managers value more factors that they perceived as being controllable (Tiwana & Keil, 2006). These studies show that risk factors may be perceived and tackled differently according to whom is identifying, analyzing, responding, and monitoring them.

Even though several studies were undertaken to identify risks factors based on distinct approaches, methods, models and frameworks, and some attempts were made to better understand the stakeholder's perception on risk identification, those studies do not show the effects of risk identification to the project success opening an opportunity to discuss it which will part of this study as stated further in the chapter 3.

2.2.2 Risk analysis

In the project risk management, risk analysis is the process aimed to assess risks, individually and collectively, by qualitative and/or quantitative methods and prioritize them according to the business appetize to risks. Many studies suggested models and frameworks to assess risks and support decision making (Büyüközkan & Ruan, 2010; Costa, Barros, & Travassos, 2007; Cuellar & Gallivan, 2006; Du, Keil, Mathiassen, Shen, & Tiwana, 2007; Salmeron & Lopez, 2010), to assess the interdependency between risks (Büyüközkan & Ruan, 2010; Chang Lee, Lee, & Li, 2009; Fu, Li, & Chen, 2012; Hu, Zhang, Ngai, Cai, & Liu, 2013; Kwan & Leung, 2011), to assess the risks interdependencies in ERP projects (Aloini, Dulmin, & Mininno, 2012a, 2012b; Lopez & Salmeron, 2014; Ojiako, Papadopoulos, Thumborisuthi, & Fan Yang, 2012) and to prioritize risks (Huang & Han, 2008; Neves, da Silva, Salomon, da Silva, & Sotomonte, 2014; Samadi et al., 2014) for different perspectives, point of view and using different methods, tools, frameworks and approaches.

Assessment of ex-ante risks tries to anticipate future behaviors on specific context and some studied were carried out on this way. For example, one proposed a methodology for assessing ex-ante software project risk based on Absorptive Capacity (AC) theory to discover the risk that a new technology deployed in an organization could not be used as designed or could not achieve the business objectives (Cuellar & Gallivan, 2006), other supported by a CASE tool was used to estimate the probability distribution of earnings and losses incurred by an organization according to its software project portfolio (Costa et al., 2007), and other one probabilistic model based on design structured matrix was used to evaluate the risk of software requirement change propagation in the early stages of software development projects from the requirements gathering to the software architecture design (Fu et al., 2012). These studies shed light on the relevance of risk analysis for decision-making by management in advance.

Similarly, risk assessment tool can also significantly impact decision-making but had no impact on risk perception, level of expertise implies more perception of higher levels of risks but had no impact on decision-making on how to continue a project, and perceived control influenced significantly both risk perception and decision-making (Du et al., 2007). One Multi Criteria Decision-Making Methodology (MCDM) approach, namely two-addictive Choquet Integral (CI), addressed interdependent software risks that most affect the decision making of undertaking one or another project (Büyüközkan & Ruan, 2010). With another MCDM approach, Analytic Hierarchy Process (AHP), one research estimated the probability, impact and exposure - probability x impact - of 30 ERP maintenance risks distributed in seven phases of software maintenance process and found that the Identification phase has the most impacting risks suggesting managers should focus strongly on them (Salmeron & Lopez, 2010). These examples show how these approaches of risk assessment can influence the risk perception and decision making in different businesses and contexts.

Moreover, recent studies have been investigated the interdependency between risks and their all possible causal relationships suggesting different approaches. Examples of these approaches are: Multi-Agents Cognitive Map (MACOM) to assess IS project risks taken into consideration all relevant internal and external risk factors (Chang Lee et al., 2009); two-addictive Choquet Integral (CI) to address interdependencies between software development risks (Büyüközkan & Ruan, 2010); re-estimation of each risk considering their interdependency effects in terms of severity, priority, impact, consequences, response strategy, and proposed mitigation actions (Kwan & Leung, 2011); a probabilistic model based on design structured matrix to show the evaluation of risk propagation of each component in the overall software architecture and the interdependency of risks which provides insights of the potential impacts in terms of costs and schedule (Fu et al., 2012); and identifying/validating new/existing causal relationships between risk factors and project outcomes based on Bayesian networks with causality constraints (BNCC) (Hu, Zhang, et al., 2013).

Several studies have been carried out to investigate the risks interdependencies in ERP projects which is a well-known relevant area of research. For example, Colored Preti Nets (CPN) and Interpretive Structural Modeling (ISM) system engineering theories were used to model the interdependency of risk factors and evaluate their effects on project success, mainly in the risk evaluation and risk treatment stages (Aloini et al., 2012a, 2012b); Fuzzy Cognitive Maps (FCM) was used to evaluate the effects of risks in ERP maintenance projects which can support the project manager identifying the risks affecting the project outcomes, provide causality information between risks, and give the possibility to create what-if analysis based on their dynamic behavior, quantifying the effect of risks on project outcomes (Lopez & Salmeron, 2014); and Thai project managers framed variability for categorized risk factors on ERP projects and the findings suggest that framing is not necessarily cultural, internal and external risk factors had a strong impact on project success, and the impact of inter-relationships between critical risks and success factors may affect the project success (Ojiako et al., 2012).

These approaches give project managers the opportunity to evaluate all possible combinations of risk factors for a better decision-making; avoiding missing any relevant link and provide a variety of risk information modeling, processing and reporting forms, facilitating the interpretation of risk factors and their relationships; contribute to a better communication between projects teams due the necessity of exchange information between projects; could be used to reevaluate the design of components in order to reduce software project risks; and support the achievement of an effective risk analysis and risk control of software development projects.

In terms of risk prioritization, one key activity within risk analysis, some techniques were proposed to prioritize key risk factors. For instance, Fuzzy Analytic Network Process (Fuzzy ANP) was used in one information technology outsourcing (ITO) project to prioritize risks and to respond to five of them since they were considered the most relevant (Samadi et al., 2014) and knowledge management techniques were used by project managers and developers most during risk identification, analysis and prioritization in software development projects of micro and small Brazilian Incubated Technology-Based companies (Neves et al., 2014). One study found that risk exposures related to user, requirements, planning and control, and team risk dimensions were more affected by project duration in opposite to project complexity and organizational environment risk dimensions showing that project managers should prioritize more or less risks according to the project duration characteristic (Huang & Han, 2008).

Although many studies were undertaken to assess risks and support decision making, to assess the interdependency between risks, including ERP projects and to prioritize risks using different methods, tools, frameworks and approaches those studies do not show the effect of risk analyses to the project success opening so an opportunity to discuss it which will part of this study as stated further in the chapter 3.

2.2.3 Risk response planning

In the project risk management, risk response planning is the process aimed to select the best strategy and action plans to address risks. Risks can be tackled proactively, before the risk materialization (ex-ante) or reactively, afterwards (post-ante) and the risk response can target the risk causes - etiological risk management - or the risk consequences - palliative risk management (Teller, 2013). *Figure 6* shows some examples of risk response measures based on the interrelation between ex-ante, ex-post, and etiological and palliative risk management measures. Several studies have been deployed to identify avoidance and mitigation strategies and their effectiveness and efficiency tackling key risks (Caffery, Burton, & Richardson, 2010; Chua, 2009; Gefen, Wyss, & Lichtenstein, 2008; Hu, Zhang, et al., 2013; Hung et al., 2014; Jingyue Li et al., 2008; J. Y.-C. Liu & Yuliani, 2016; S. Liu, 2016; Tesch et al., 2007) and to propose models and frameworks to implement the mitigation actions (Alhawari, Karadsheh, Nehari Talet, & Mansour, 2012; Caffery et al., 2010; Dey et al., 2013; Hu, Zhang, et al., 2013; Persson et al., 2009). These studies bring relevant contributions to investigations on project risk management field due to their practical recommendations in other to protect the business and maximize the chance of the project success.

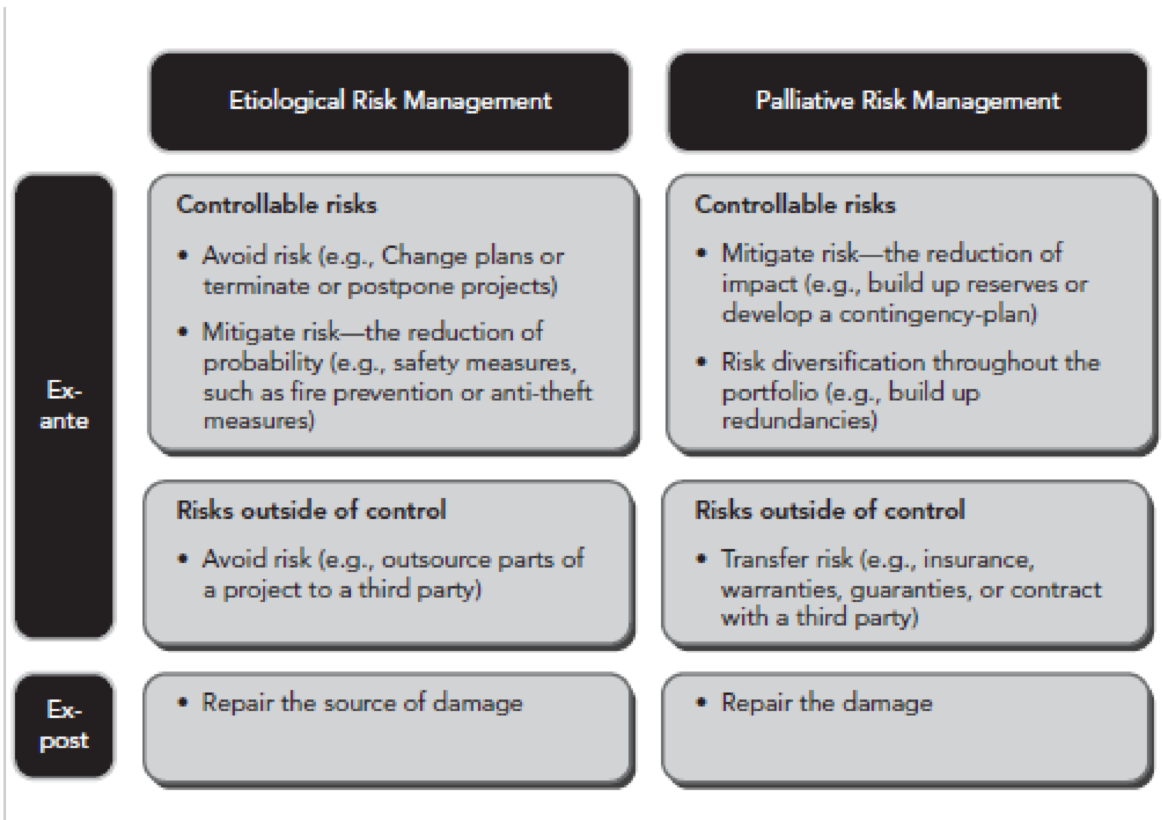

Figure 6. Classification of risk response measure

Source: Teller (2013)

Several studies also demonstrate that user risks, project management risks, measurement and debugging risks can reduce project success (Gefen et al., 2008; Hung et al., 2014; Jingyue Li et al., 2008; S. Liu, 2016) and while clients see as critical risks the lack of vendor selection criteria and process, vendors see as critical risks unclear requirements and lack of experience and expertise with project activities showing that they perceive risks differently in IT outsourcing projects (J. Y.-C. Liu & Yuliani, 2016). Several approaches of mitigation actions have been proposed to tackle these risks and protect the business.

For instance, business familiarity, the knowledge of the number of previous contracts with the vendor and their dollar amount (Gefen et al., 2008), adding more learning effort in the planning phase, evaluating the quality of Off-the-Shelf (OTS) software components used by assemblers and integrators of software applications in the selection phase, integrating unfamiliar components first, and monitoring the reputation of the components suppliers (Jingyue Li et al., 2008) help to tackle risks. People influence directly the failure of IT projects which demands the effective project management skills to adhere to the processes of scope, time and cost management. Technical expertise is also essential to avoid failure and delays, and external environment influences the ongoing projects causing damages if not properly managed (Chua, 2009). Perceived users` bonds with project and development team (Hung et al., 2014), user liaison`s understanding of development process (S. Liu, 2016), developers having some minimum level of business knowledge (Hung et al., 2014), and adopting partnering relationship (J. Y.-C. Liu & Yuliani, 2016) can all reduce the negative effect of risks on project success.

Some project risks dimensions may also be mitigated by organizational climate dimensions. For example, in the Indian software industry, dimensions such as effective and facilitative supervision, high standards of work tasks maintained by the team whilst executing the project, intrinsic fulfilment – individuals are motivated by internal factors, and clarity in roles and responsibilities may tackle risks dimensions through clear roles and responsibilities, creating an environment where people are encouraged to assume the responsibility of their actions, turning supervisor into facilitators rather than dictators to the software development team, stablishing high standards of work task, establishing an environment of internal review audits, making investments on research, training, and development of the team (Sharma & Gupta, 2012).

These studies suggest that managers should create mechanisms to incentive the engagement and commitment between users and development team, the creation of a group of work with a common set of goals and procedures for collaboration, guarantee that users have necessary knowledge on IS development process, keep a strong relationship with the user representatives, especially those with positive attitude, share the common outcome with other stakeholders, and the learning of suppliers and partners before any acquisition of solutions.

In place with risk reduction and risk mitigation techniques, some models and frameworks were proposed to implement mitigation actions. For example, one risk management capability model was proposed for medical devices (MD) software companies, adding 20 additional sub-practices, in order to better support them to get the CMMI certification and to be in accordance with current MD regulations, in terms of risk management practices, when developing software (Caffery et al., 2010), one integrative framework for software project risk management (SPRM), grouped by risk analysis and risk planning, in which the former is used to evaluate the potential success of the project and the latter is to recommend the minimal effort in terms of cost of implementing mitigation actions was proposed due to the its capability to take into consideration many-to-many relationship between risks and mitigation actions (Hu, Du, et al., 2013).

In complement to models and frameworks, a practical and useful framework to manage risks in the context of geographically distributed software projects (GDSPs) was proposed consisted of three main elements, namely risk management planning, risk assessment and risk resolution (Persson et al., 2009), one Knowledge-based Risk Management (KBRM) framework was suggested to drive the better understanding of the relationship between knowledge management, risk management and process in IT projects (Alhawari et al., 2012), and other one was developed to drive the risk assessment for ERP projects classifying risks hierarchically and by categories allowing choosing the right risk owners responsible to deal with risks properly getting a better analysis in terms of risk impact and probability, and recommended mitigation actions (Dey et al., 2013). These models and frameworks are attempts to better deal with risk but it not clear their effectiveness against the project success.

Although many studies were undertaken to identify avoidance and mitigation strategies and their effectiveness and efficiency tackling key risks, and to propose models and frameworks to implement the mitigation actions those studies showed partially the effect of risk response planning to the project success opening so an opportunity to discuss more in detail it which will part of this study as stated further in the chapter 3.

2.2.4 Risk monitoring and control

In the project risk management process, risk monitoring and control aims to monitor and control the mitigations actions and reassess known risks as well new risks emerging over the project life cycle. Some studies have been proposed frameworks to analyze and monitor risks, looking for a better understanding of their behavior over the SDLC in IS/IT projects (Dey, Kinch, & Ogunlana, 2007; Hwang, Hsiao, Chen, & Chern, 2016; Lin & Parinyavuttichai, 2015; Yu et al., 2013). They provide insights on the key risks in each project phase and/or software development phase.

For instance, one user friendly framework from developers' perspective completely integrated with the SDLC and englobing all stakeholders was developed in a study case in a public organization in Barbados (Dey et al., 2007), the Decision Making Trial and Evaluation Laboratory (DEMATEL) method, based on network theory, contributed by identifying the interrelationships between risk factors over an information systems development (ISD) project life cycle in Taiwan, providing insights in terms of better mitigation strategy to apply and the influence of risk factors over the phases and proposing a new interdependency indicator in addition to the traditional risk exposure indicator (Hwang et al., 2016). One study based on STT showed that structure risks are dominant in all phases, followed by task and actor risks in almost similar level, and technology risks were more apparent in the later stages and have lower frequency them others, but the materialization of risks seems to be more frequent in late stages of the SDLC for all risks of the two subsystems, social subsystem and technical subsystem, being the implementation phase the more frequent of the four categories of risks (Yu et al., 2013).

Similarly, a case study of an IS project showed that new different risks arise during the project life cycle due to social-psychological escalation factors (e.g. lack of managerial support, changing environment, self-interest, collective commitment) that were both antecedent to and a consequence of risk management decisions (Lin & Parinyavuttichai, 2015). Despite the known benefits of the factor-based approach, like anticipatable, predictable and controllable, seeing project risks as an emergent phenomenon that gain life during the project life cycle it's a better approach and the relationship of risk cause and effect is not always direct due to mediator factors and collateral outcomes (e.g. emergence of new risks) from previous actions or decision made over pre-mapped risks.

These recent studies reinforce the relevance of the risk monitoring and control for the project success, as old risks change and new risks arise during the project development affecting each phase of the project in different ways but they do not show empirically the effect of risk monitoring and control to the project success opening so an opportunity to discuss more in detail it which will part of this study as stated further in the chapter 3.

2.2.5 Risk management culture

A well-established risk management culture is essential for the properly deployment of an effective risk management process (Sanchez et al., 2009). Risk management culture implies the open, honesty and transparent communication by risk responsible to all project stakeholders; the sense of responsibility by risk owners for the risks and their associated response action plans; everybody is responsibility to manage pro-actively and every day the risks in their area of responsibility; and employees at all levels of the project are conscious of the necessity of the risk management - high risk awareness (Teller, 2013; Teller et al., 2014).

Top management support, project leaders' support and a risk awareness culture is vital, otherwise, project risk management process will not likely be implemented properly which in turn could not bring the expected benefit for the project success (Cagliano, Grimaldi, & Rafele, 2015; Yeo & Ren, 2009). An open culture gives the project team the chance to be aware of the current situation as soon as possible avoiding bad surprises in the last minute, and allowing manage risks proactively (Yeo & Ren, 2009). Moreover, an early planning enhance the collaborative culture with the active involvement of the project stakeholders, such as the project team, the support functions, suppliers, partners, and customers, leading to better understand and sense making of the risks that should affect the business objectives (Thamhain, 2013).

On the other hand, some project managers stop adopting project risk management process over the overall project life cycle (Kutsch et al., 2013) due to reasons like the fear to exposure issues and lack of control to stakeholders, unclear benefits of the project risk management outcomes; focus on familiar and measurable risks, lack of authority in their own projects, and so on (Kutsch & Hall, 2009, 2010, Kutsch et al., 2013, 2014). Despite that, it is clear the importance and relevance of a well-employed project risk management culture in the organization to influence the project success.

2.2.6 Risk management process formalization

An established project risk management process has been recognized as an key contributor to the project success (Aloini et al., 2012a; Cagliano et al., 2015; Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010; Teller, 2013). A Risk policy should describe the risk definition agreed by one organization, the risk management model covering all interested parts of the organization, the risk organizational structure, and the risk tolerance acceptance by the management. Roles and responsibilities should be clearly defined and documented in the risk management process in order to guarantee the comprehensive execution of risk management across the organization, for each business engagement a risk responsible should be nominated. In addition to that, for each risk or set of risks a risk owner should be nominated, being the accountable for the risk assessment, risk response planning and risk monitoring and control of such risk (Teller, 2013; Teller & Kock, 2013).

The project risk management process should be described in detail in a guide, manual or other document of the organization, stating the steps of the process, such as the one described in the previous chapter, the four sequential and cyclic processes of project risk management. Standardized forms for project risk management should be created as applied for the common understanding of all stakeholders in a way that everyone in the organization knows how to interpret each contents and the structure of the risk management evaluation. Least, but not least, the risk policy, roles and responsibilities, risk management process and standardized forms should be well-communicated for all members of the organization (Teller, 2013; Teller et al., 2014).

On the other hand, some authors highlighted that risk management process can be perceived by project managers, project team and stakeholders as a cumbersome set of activities, enforcing extra work, cost and time (Aloini, Dulmin, & Mininno, 2007b) and under certain circumstances cannot be effective (Atkinson, Crawford, & Ward, 2006; de Bakker et al., 2010). *Figure 7* summarizes the main topics covered in the section.

Theme	Specific topic studied	Authors
Risk Identification	Risk factors	(Aloini et al., 2007a), (Chao Peng & Baptista Nunes, 2009a, 2009b), (S. Liu et al., 2010)
	Risk perception	Keil et al. (2008), (S. Liu et al., 2010); (Sharma et al., 2011; Tiwana & Keil, 2006)
	New frameworks, methods or approaches	(Ohtaka & Fukazawa, 2010),(Holzmann & Spiegler, 2011), Marcelino-Sádaba et al. (2014), (Vrhovec et al., 2015), Yu et al. (2013) Yu et al. (2015)
	Knowledge-based Risk Management	Alhawari et al. (2012), (Neves et al., 2014)
Risk Analysis	New frameworks, methods or approaches	(Cuellar & Gallivan, 2006), Costa et al. (2007), Fu et al. (2012), (Dey et al., 2013), (Hu, Du, et al., 2013)
	Risk perception	Du et al. (2007), (Ojiako et al., 2012), (Lopez & Salmeron, 2014)
	Risk prioritization	(Huang & Han, 2008), Samadi et al. (2014), (Neves et al., 2014)
	Risks interdependencies	(Chang Lee et al., 2009), (Kwan & Leung, 2011), (Kwan & Leung, 2011), (Aloini et al., 2012a, 2012b), Hu et al. (2013), (Lopez & Salmeron, 2014)
Risk Response Planning	Effectiveness of actions	Gefen et al. (2008), Li et al. (2008)
	Users' knowledge and collaboration	(Hung et al., 2014), (S. Liu, 2016), (J. Y.-C. Liu & Yuliani, 2016)
	Regulations	Caffery et al. (2010)
	Organization climate dimensions	(Sharma & Gupta, 2012)
Risk Monitoring and control	Risk behaviors over SDLC	(Dey et al., 2007; Hwang et al., 2016; Lin & Parinyavuttichai, 2015; Yu et al., 2013)
Risk Management Culture	Main aspects of culture	(Cagliano et al., 2015; Sanchez et al., 2009; Teller, 2013; Teller et al., 2014; Thamhain, 2013; Yeo & Ren, 2009)
Risk Management Process Formalization	Main aspects of formal process	(Aloini et al., 2012a; Cagliano et al., 2015; Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010; Teller, 2013; Teller & Kock, 2013; Teller et al., 2014)
	Counterpoints	(Aloini et al., 2007b; Atkinson et al., 2006; de Bakker et al., 2010)

Figure 7. Summary of topics cited in the project risk management process section

Source: created by the author

2.3 Project Success

Project success has been studied in depth in the project management field. Furthermore, several studies have investigated the influence of risks and risk management on project success. One relevant action study (Thamhain, 2013) investigated the understanding of dynamics of risks impacting project success and the human side of dealing with risks in complex projects and found that risks do not affect projects in the same way and effective project risk management involves complex variables, tasks, tools, people and organizational environment, suggesting that it should go beyond analytical methods then proposing nine lessons to be taken into consideration for future studies:

1) Early recognition of undesirable events is a critical precondition for managing risk;
2) Unrecognized risk factors are common in complex project environments;
3) Unchecked contingencies tend to cascade and penetrate wider project areas;
4) Cross-functional collaboration is an effective catalyst for collectively dealing with threats to the project environment;
5) Senior management has a critical role in conditioning the organizational environment for effective risk management;
6) People are one of the greatest sources of uncertainty and risk in any project undertaking, but also one of the most important resources for reducing risk;
7) Project leaders should have the authority to adapt their plans to changing conditions;
8) Testing project feasibility early and frequently during execution reduces overall project risk; and
9) Reducing work complexity and simplifying work processes will most likely reduce risk.

Several studies defined project success splitting it into process and product performance which product performance refers to the success of the system developed in terms of reliability, meeting the requirements, user’s expectation, and process performance refers to the success of the development process itself in terms of on schedule and within budget (Han & Huang, 2007; S. Liu & Wang, 2014; Nidumolu, 1996; Wallace et al., 2004b, 2004a). Product performance sometimes appears in other studies named as system performance which is the extent to which the project is delivered with reliable outcomes and with satisfying functional requirements embodying the functionality and quality of the system (S. Liu, 2015a, 2015b; S. Liu & Wang, 2014). Likewise, project success can be measured as two dimensions, namely efficiency (on time and within budget) and effectiveness (meeting client specifications, meeting technical specifications, goal achieved, pride and quality achieved) which presents small variations in relation to the previous studies (Sicotte & Bourgault, 2008). Similarly, one study evaluate project success as four variables, namely cost overrun, schedule overrun, achievement of project scope target, and customer satisfaction (Zwikael & Ahn, 2011).

Some authors argue that these studies evaluate the project success subjectively – by the opinion of practitioners working in the projects - and that an objective assessment of project success should be also taken into account including more quantifiable measures (e.g. in percentage), such as cost, effort, project margin, and schedule overrun, having subjective and objective performance measures (Na et al., 2007). For instance, earned value management (EVM) metrics, notably the Schedule Performance Index (SPI) and the Cost Performance Index (CPI) were used to create a composite performance metric, Schedule-Cost Performance Index (SCPI) for the dependent variable project success (Mishra et al., 2016).

Differently, some studies claim that the traditional definition does not fit some IT projects and a more elaborated view of project success should be considered. According to them, there are some weaknesses in the three main assumptions that this definition is constructed, to know the amount of time, budget, and requirements can be defined at the outset of the project; the project’s success is the same for each project stakeholder; and the project’s success can be determined at the moment the project has produced its deliverables (de Bakker et al., 2010, 2011, 2012).

Last studies have been defined project success as indicators of scope, quality, customer satisfaction, team satisfaction and sustainability (Carvalho & Rabechini Junior, 2014; Rabechini Junior & Carvalho, 2013; Mir & Pinnington, 2014) structuring project success based on five dimensions proposed by Shenhar (Shenhar & Dvir, 2007; Shenhar et al., 2001), namely project efficiency, impact on the customer, impact on the team, business and direct success, and preparation for future. For example, Mir & Pinnington (2014) developed a well-cited study on the influence of project management performance on project success, both been defined as multidimensional constructs, adopting the dimensions proposed by Shenhar.

These previous studies considered either a traditional vendor-oriented definition of project success as commonly stated in the literature and a broader view of project success that includes the opinion of stakeholders on various project characteristics, being the broader view at some extend an extension of the traditional view. For the propose of this study, the multidimensional construct proposed by Mir & Pinnington (2014) which is adapted from Shenhar (Shenhar & Dvir, 2007; Shenhar et al., 2001) is adopted and explained further in more detail in the chapter 3. *Figure 8* shows the five elements that compose the multidimensional construct Project Success.

Figure 8. Project success dimensions

Source: adapted from Shenhar et al. (2001)

2.4 Project Success Impacted by Risks and Risk Management

Several studies were undertaken to investigate the influence of either risks or project risk management on project success. Some of them examined the influence of different categories, groups, sources, and dimensions of risk on project success (Han & Huang, 2007; Jun et al., 2011; S. Liu & Wang, 2014; Mishra et al., 2016; Na et al., 2007; Reed & Knight, 2010; Sharma et al., 2011; Sicotte & Bourgault, 2008; Wallace et al., 2004a, 2004b), the influence of project risk management on project success (Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010, 2011, 2012; Islam et al., 2013; Jun et al., 2011; S. Liu, 2015b, 2015a; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011), the moderating effects of risk or contingency factors on the relationship between risk or risk management on project success (Carvalho & Rabechini Junior, 2014; Jun et al., 2011; Keil et al., 2013; S. Liu, 2015b, 2015a; S. Liu & Wang, 2014; Teller & Kock, 2013; Teller et al., 2014; Wallace et al., 2004b; Zwikael & Ahn, 2011), and the influence of portfolio risk management on project portfolio success (Teller, 2013; Teller & Kock, 2013; Teller et al., 2014). Diverse findings were retrieved from these studies to comprehend how risk and risk management affect the project success.

Adopting the Socio-Technical Theory (STT), Wallace et al. (2004a) investigated the impact of six risk dimensions on project success and found that social subsystem risk influenced positively technical subsystem risk and the latter influenced positively project management risk, which in turn, affected negatively the project success, represented by process performance and product performance. Based on the same theory, a recent research undertaken in many industries in China with 128 IT projects, 77 internal and 51 outsourced, analyzed the influence of risks on performance found that social subsystem and project management risks had direct negative impact on system performance in both internal and outsourced projects, being greater in outsourced projects for social subsystem, but technical subsystem risks affected negatively only internal projects (S. Liu & Wang, 2014).

Moreover, several findings were identified in other studies related to the Wallace et al.'s risk dimensions. For instance, there is nonlinear and inverse relationship between the software risks and project success (Han & Huang, 2007), managing project complexity is key for low and medium projects risk but other dimensions, such as requirements, organizational environment and planning & control risks are more relevant for high risk projects (Wallace et al., 2004b), there is a signification impact on project success as moving from low to high risk projects (Wallace et al., 2004b), and requirements risk was found as the principal factor affecting the project success (Han & Huang, 2007) which also influences positively the residual performance risk in 123 software development projects of the three largest software companies in Korea (Na et al., 2007). In addition to that, standardization influence negatively residual performance risk which in turn affects positively cost and schedule overrun, and functional development risk - early stage risks related to specification requirements, design, and code and unit testing - influences positively system development risk – later stage risks related to product integration and implementation - which in turn affects negatively project success measures, namely process and product performance (Na et al., 2007). These studies show how these six dimensions can influence negatively the project success in different ways.

Other studies were carried out to investigate similar and additional risk factors affecting project success. For example, in one study in 308 new product development (NPD) projects of 154 companies in Quebec, Canada, *technical & project uncertainty and market uncertainty* acts as strong moderators on the relationship between two independent variables, human resource competence and project methods, and NPD projects' performance dimensions - effectiveness and efficiency, *fuzziness and instability of requirements specification* affects directly both dimensions, and *complexity* influences weakly only effectiveness (Sicotte & Bourgault, 2008), in another survey, 150 IT practitioners were asked to assess the impact of 55 risks on project success completion being measured by time, budget and requested requirements in a three-point Likert scale (Reed & Knight, 2010), in another one, 300 respondents of 32 Indian software companies were required to rate 23 software risk factors on the success of the latest project undertaken on a scale of 1 - no effect to 5 - too much effect (Sharma et al., 2011).

Furthermore, from vendor's perspective of ISD projects in Chinese software houses, project uncertainty has a negative effect on process and product performance, planning & control and internal integration have a positive effect on process performance, and user participation and internal integration have a positive effect on product performance (Jun et al., 2011) and one study in 82 federal technology projects in the United States showed that *complexity risk, contracting risk and execution risk* have a negative effect on project success, and higher levels of process maturity, assessed by the Capability Maturity Model Integration (CMMI), moderate negatively this impact only at high level of project risk, whereas at low level of project risk, higher levels of process maturity can moderate positively the impact between project risks and project success, being the latter measured by the composite performance metric SCPI (Mishra et al., 2016).

In addition to studies related to the influence of risk on project success, most recently studies have investigated the influence of project risk management on project success (Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010, 2011, 2012; Islam et al., 2013; Jun et al., 2011; Keil et al., 2013; S. Liu, 2015b, 2015a; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011). A well-cited meta-analysis of 29 empirical studies published between 1997 and 2009 (see APPENDIX B - GENERAL) was undertaken to answer if project risk management contributes to IS/IT project success considering four main characteristics, namely the project risk management approach, project success approach, risk management and project success evidence, and research characteristic (de Bakker et al., 2010). This study found that only evaluation approach to project risk management cannot be used to achieve project success due to the fact that this approach propose identification of risk instead of management of risks, but the effectiveness of the management approach is unclear and the empirical knowledge is still anecdotal. They concluded that project risk management can be effective only in specific IT project conditions. *Figure 9* shows the main types of each characteristic and its description and number of papers related with.

Characteristic	**Main types**	**Description**	**#**
Project risk management approach	Management	Management tool by which information is gathered and analyzed to support the decision making in one specific project, direct contribution to project success, sensing specific risks	14
	Evaluation	An analysis process to identify risk factors for, information of project failure and its causes its gathered ex-post, indirect contribution to project success, sensing generic risks	12
	Contingency	Project success depends on how well the project deals with uncertainties in a specific context	03
Project success approach	Traditional	Compliance with time, cost and/or requirements	16
	Non-traditional	Compliance with additional criteria beyond time, cost and/or requirement, such as stakeholders` expectations	10
Risk management and project success evidence	Statistical	Empirical studies	16
	Anecdotal	Anecdotal information	07
Research characteristic	Case-study	Single or multiple case-studies	11
	Survey	Application of questionnaire	15

Figure 9. Four characteristics evaluated in the meta-analysis of de Bakker et al. (2010)

Source: adapted from de Bakker et al. (2010)

Looking for a better understanding of the relationship between project risk management and project success, de Bakker et al. (2011, 2012), supported by the theoretical lenses of *instrumental action* and *communicate action* (Habermas, 1984), carried out multiple case-studies in seven companies with nineteen stakeholders (IT suppliers, clients and project managers) that have implemented ERP systems to investigate how them perceive the effects of individual project risk management activities on IS/IT project success. They argued that in addition to the instrumental action based on rational problem solving which have being commonly adopted in the risk management literature (de Bakker et al., 2010), communicative action - the action of an individual actor to create common understanding of the situation and collaboration with other actors - should also be taken into consideration to investigate this relationship. Their findings show that risk identification was the most influential risk management activity followed by risk reporting, risk registration and risk allocation, risk analysis, and finally risk control and all have contributed to project success, except risk management planning that was not considered due to limited score in the study. *Figure 10* shows the list of project risk management activities defined by the authors (de Bakker et al., 2011, 2012).

Risk management activity	**Description of the activity**
Risk management planning	Writing a plan or writing a paragraph in the project plan about how risk management will be executed on the project (NOT an initial list of risks!)
Risk identification	Naming and identifying risks with the use of e.g. filling out questionnaires, consulting experts, doing brainstorm sessions, conducting interviews
Risk registration	Recording and maintaining the list of risks in e.g. a database, one or more documents, spreadsheets
Risk analysis	Analyzing risks, e.g. by estimating probability and impact, doing simulations (e.g. Monte Carlo), root cause analysis
Risk allocation	Appointing a person to be responsible for taking care of a particular risk
Risk reporting	Distributing information about risks and the status of risks to other people, e.g. by dedicated risk status reports or as part of project progress reports
Risk control	Holding meetings with various people in which status and actions of risks are discussed

Figure 10. Risk management activities defined by de Bakker et al. (2012)

Source: de Bakker et al. (2012)

A variety of risk management practices should be taken to increase positively the influence of project risk management on project success. They may influence individual perception of stakeholders, creating positive feelings and acceptance of risk, agreeing on common situation in terms of objective and subjective word, indicating impact of consequences, establishing trust, creating commitment and awareness, stimulation of stakeholders to take effective actions, and creating and maintaining interpersonal relationships in the social world of stakeholders (de Bakker et al., 2011, 2012).

This is in line with other recommendations, like as risk management should be integrated into project management processes instead of a separate knowledge area, adding the responsibility of risk management to functional managers and discussing risks in an open forum with relevant team members and stakeholders (Zwikael & Ahn, 2011), internal and external stakeholders should be aware of business knowledge and project uncertainties, adjusting their expectations and estimates in regard to project success (Carvalho & Rabechini Junior, 2014; Rabechini Junior & Carvalho, 2013), projects should have a dedicated risk manager (Rabechini Junior & Carvalho, 2013), one Goal-driven Software Development Risk Management Model (GDSRM) was proposed providing early warnings more focused on engineering requirements, change management, and user satisfaction which can influence budget and schedule constraints affecting positively the software project success (Islam et al., 2013), and user liaisons should be closer to the development team sharing goals, values, norms and practices (S. Liu, 2015a, 2015b).

Some studies considered the moderating effects of risk or contingency factors on the relationship between risk or risk management on project success. For example, strategic applications have greater complexity then information or transactional applications, outsourced projects have higher level of team and planning & control risks than insourcing projects (Wallace et al., 2004b), uncertainty can moderate the relationship between planning & control and project success, and between user participation and product performance (Jun et al., 2011), user risk and requirements risk moderate negatively the effects of formal and informal controls on process performance of IT projects, composed of four control variables related to the project, namely duration, outsourcing arrangement, and strategic orientation (Keil et al., 2013), external and internal dynamics can increase the relationship between portfolio risk management and risk management quality, which in turn can affect positively the project portfolio success (Teller &

Kock, 2013), and the impact of risks on performance is greater on more strategic projects no matter if they are internal or outsourced projects (S. Liu & Wang, 2014).

In addition, complexity risk, team risk and planning & control risk moderated the positive effect of behavior control, outcome control, clan control and self-control on IS project success from the user liaisons perspective (S. Liu, 2015a, 2015b). The effect of self-control and behavior control on performance reduced with high complexity risk, and clan control and the effectiveness of outcome control increased, suggesting that the last two controls should be choose to manage complex projects. Complexity was also appointed as moderator between risk management, read as soft and hard skills, and project success (Carvalho & Rabechini Junior, 2014). Research and development (R&D) focused of project portfolios, external turbulence and portfolio dynamics can also moderate the relationship between formal project risk management and integration of risk information into project portfolio management, individually or linked, and project portfolio success (Teller et al., 2014).

Slightly different, one international multi-industry study with 701 respondents in three countries, Japan, New Zealand and Israel has designed risk management planning – defined as risk identification, scoring, ranking and creation of mitigation plan - as a moderator between the level of project risk and project success showing that i) the level of risk perceived varies across industries and countries, ii) the level of risk do not directly affect the project success and its depends on moderating variables such as risk management planning, iii) risk management planning is ineffective in projects with low level of risks, iv) the level of perceived risk and the application of risk management planning are lower in countries characterized by low levels of uncertainty avoidance (e.g. Japan and Israel) and industries with immature project management practices, and v) risk management planning reduces the impact of risk levels and, consequently, increase the project success rates (Zwikael & Ahn, 2011).

As a complement to investigations related to the influence of risk management on project success, there are theoretical and empirical studies been undertaken to investigate this relationship in regard to project portfolio management (PPM) (Costa et al., 2007; Sanchez et al., 2009; Teller, 2013; Teller & Kock, 2013; Teller et al., 2014). For example, (Teller, 2013) proposed a theoretical framework supported by eleven propositions to explore the indirect influence of project portfolio risk management - conceptualized as organization, process and risk management culture - on project portfolio management that is mediated by what she called risk management quality, which in turn was defined by three dimensions, namely risk transparency, risk coping and risk management efficiency. Supported by a slightly adaptation of this previous study, one empirical study (Teller & Kock, 2013) carried out on 176 German companies found that portfolio risk identification, risk management process formalization and risk management culture influenced positively risk transparency; risk prevention, risk monitoring, and integration of risk management into PPM influenced positively risk coping capacity; and risk transparency and risk coping, grouped as risk management quality, affected positively the project portfolio success. (Teller et al., 2014) extended their previous work and found that formal project risk management process and the integration of risk information into project portfolio management are positively associated with increased project portfolio success; risk management carried out by both levels of management (project portfolio responsible and senior manager) increased the positive effect on project portfolio success; formal project risk management is even more relevant for R&D project portfolios; and the integration of risk information into project portfolio is even greater for project portfolios with higher external turbulence and portfolio dynamics.

This section summarizes the main effects of risk and project risk management on project success showing updated studies in this field trying to better understand and drive the challenges inherent to IS/IT projects. *Figure 11* summarizes the main topics covered in this section.

Theme	Specific topic studied	Authors
Project success definition	Traditional definition	(Han & Huang, 2007; S. Liu, 2015a, 2015b, S. Liu & Wang, 2014, 2014; Nidumolu, 1996; Sicotte & Bourgault, 2008; Wallace et al., 2004b, 2004a; Zwikael & Ahn, 2011)
	Quantifiable measures	(Mishra et al., 2016; Na et al., 2007)
	Broader definition	(Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010, 2011, 2012; Mir & Pinnington, 2014; Rabechini Junior & Carvalho, 2013; Shenhar & Dvir, 2007; Shenhar et al., 2001)
Project success influenced by risks and risk management	Categories, groups, sources, and dimensions of risk	(Han & Huang, 2007; Jun et al., 2011; S. Liu & Wang, 2014; Mishra et al., 2016; Na et al., 2007; Reed & Knight, 2010; Sharma et al., 2011; Sicotte & Bourgault, 2008; Wallace et al., 2004a, 2004b)
	Socio-Technical Theory (STT)	(S. Liu & Wang, 2014; Wallace et al., 2004a; Yu et al., 2015)
	Instrumental and communicative actions	(de Bakker et al., 2011, 2012)
	Recommended actions	(Carvalho & Rabechini Junior, 2014; Islam et al., 2013, 2013; Jun et al., 2011; S. Liu, 2015b, 2015a; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011)
	Moderating effects by risk or contingency factors	(Carvalho & Rabechini Junior, 2014; Jun et al., 2011; Keil et al., 2013; S. Liu, 2015b, 2015a; S. Liu & Wang, 2014; Teller & Kock, 2013; Teller et al., 2014; Wallace et al., 2004b; Zwikael & Ahn, 2011)
	Portfolio risk management	(Teller, 2013; Teller & Kock, 2013; Teller et al., 2014)

Figure 11. Summary of topics cited in the project success and project success impacted by risks and risk management sections

Source: created by the author

3 CONCEPTUAL MODEL AND HIPOTHESES

The chapter before presented an extensive literature review with the objective of identifying the studies on project risks management in IS/IT field in the last ten years supported by a systematic review done for this study and the aim of identifying the common and acceptable understanding of project success. As previously described, project risk management has been seen in the literature as a critical success factor which undertaking is fundamental to influence and support the achievement of project objectives (Bannerman, 2008; Carvalho & Rabechini Junior, 2014; Islam et al., 2013; S. Liu, 2015a; Rabechini Junior & Carvalho, 2013; Teller, 2013; Teller & Kock, 2013; Teller et al., 2014; Thamhain, 2013). Recognizing this criticality, several studies were undertaken to investigate the influence of risks or project risk management on project success, the moderating effects of risk or contingency factors on the relationship between risk or risk management on project success, and the influence of portfolio risk management on project portfolio success.

Those studies which investigated the influence of risk on project success (Han & Huang, 2007; Jun et al., 2011; S. Liu & Wang, 2014; Mishra et al., 2016; Na et al., 2007; Reed & Knight, 2010; Sharma et al., 2011; Sicotte & Bourgault, 2008; Wallace et al., 2004a, 2004b) although are not designed to explicitly lead with project risk management dimensions, such as risk identification, risk analysis, risk response planning, and risk monitoring and control, they are extremely relevant as bases for further studies intended to develop risk management strategies and practices to deal with risks affecting the project success, especially when taken into consideration the levels of project risks and project characteristics. Project risk management, as process, is cited briefly in one and another section of these studies, usually in the end of the papers as part of the final remarks.

Those studies aimed at understanding the effect of project risk management on project success (Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010, 2011, 2012; Islam et al., 2013; Jun et al., 2011; S. Liu, 2015b, 2015a; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011) bring valuable insights that pave the way for new contributions taking into consideration some gaps identified in these studies and stated by them in regard to their own literature review and conclusions. In line with this, the meta-analysis developed by de Bakker (de

Bakker et al., 2010) is key for the development of this study due to two main reasons. First, their study covered papers in the literature review (1997-2009) that, with few exceptions, were not covered in this study. Second, their findings show that the effectiveness of the risk management approaches is still unclear, the empirical knowledge up to 2009 is still anecdotal and project risk management can be effective only in specific IT project contexts. Nevertheless, they developed further studies (de Bakker et al., 2011, 2012) to fill-out some of the gaps identified in their previous research. Similarly, other studies were undertaken to find risk management practices that should be taken to increase positively the influence of them on project success (Carvalho & Rabechini Junior, 2014; Islam et al., 2013; S. Liu, 2015a, 2015b; Rabechini Junior & Carvalho, 2013; Zwikael & Ahn, 2011).

On the other hand, recent studies have been inquired the effective application of project risk management by project managers in IS/IT projects and arguing that project risk management theory should focus on practical requirements to deal with the uncertainties challenged by IS/IT projects bridging the gap between the practice and academic prescriptions (Kutsch & Hall, 2009, 2010, Kutsch et al., 2013, 2014; Wickboldt et al., 2011; Bannerman, 2008). The reasons behind this phenomenon are diverse, like costs and time constraints, focus on familiar topics, lack of agreements, authority or inspection, avoidance of self-exposure, unclear RM outcomes, etc. (Kutsch et al., 2014, 2013, Kutsch & Hall, 2009, 2010; Kutsch & Maylor, 2011).

Based upon these recent findings, it is worth to investigate the relationship between project risk management and project success. This is even more relevant in a context with continuous changings and application of different approaches to manage projects (e.g. agile) in addition to traditional approaches. Therefore, this study posits that project risk management contributes directly to project success and the following hypothesis is proposed based on above discussion:

Hypothesis 1. *The project risk management influences positively the project success.*

The literature review covered in the previous chapter presented several studies about the four sequential and cyclic processes of project risk management: risk identification, risk analysis, risk response planning, and risk monitoring and control. In identifying project risks, studies showed the identification of contextual risk factors, of risk checklists, of risk ontologies, and of risks related to IT service delivery, the proposition of models/frameworks to identify and manage risks, and investigations of the risk perceptions of different roles over this process.

Despite the extensive literature on risks in software development as summarized in one study (Han & Huang, 2007) and the fact that most of them have been continually cited in the recent studies (Barki et al., 1993; Boehm, 1991; McFarlan, 1981; Schmidt et al., 2001), more thirteen studies on risk identification were related to contextual risks in IT field (Aloini et al., 2007a; Aundhe & Mathew, 2009; Büyüközkan & Ruan, 2010; Chao Peng & Baptista Nunes, 2009a, 2009b; Chua, 2009; Nazımoğlu & Özsen, 2010; Reed & Knight, 2010; Salmeron & Lopez, 2010; Sharma & Gupta, 2012; Sharma et al., 2011; Tesch et al., 2007; Wallace et al., 2004a). In addition to that, seven studies were related to models/frameworks for risk identification (Dey et al., 2013; Holzmann & Spiegler, 2011; Marcelino-Sádaba et al., 2014; Ohtaka & Fukazawa, 2010; Vrhovec et al., 2015; Yu et al., 2013, 2015) and four are related to risk perceptions of different roles over the risk identification process (Keil et al., 2008; S. Liu et al., 2010; Sharma et al., 2011; Tiwana & Keil, 2006). A total of twenty-four studies were entirely dedicated to risk identification in this study.

For example, numerous studies focused on the identification of risk factors of ERP projects (Aloini et al., 2007a, 2012a; Chao Peng & Baptista Nunes, 2009b; Dey et al., 2013; Lopez & Salmeron, 2014; Ojiako et al., 2012) and on the proposition of new risk management frameworks for ex ante software project risks assessment (Cuellar & Gallivan, 2006), for integrated developer’s view within the SDLC (Dey et al., 2007), for a bird`s-eye view of cause and effect (Ohtaka & Fukazawa, 2010), for risk identification by using a RBS (Holzmann & Spiegler, 2011), for KBRM (Alhawari et al., 2012; Neves et al., 2014), for agile risk-management of IT project (Lee & Baby, 2013; Shrivastava & Rathod, 2015), for risk management in small business (Marcelino-Sádaba et al., 2014; Poba-Nzaou & Raymond, 2011), for ORD RM (Vrhovec et al., 2015) and for Socio-Technical Theory (Yu et al., 2013, 2015).

These studies found risks that may affect the business objectives, but they do not show empirically the effective impact of risk identification on project success. Nevertheless, risk identification was cited as the main process followed by project managers (Bannerman, 2008; Kutsch et al., 2014, 2013, Kutsch & Hall, 2009, 2010; Kutsch & Maylor, 2011; Taylor et al., 2012; Wickboldt et al., 2011) and the most influential risk management activity (de Bakker et al., 2011, 2012) but its cannot be used to achieve project success alone (de Bakker et al., 2010). Therefore, this study posits that project risk identification contributes directly to the project success and to each dimension of project success. The following hypotheses are proposed based on above discussion:

Hypothesis 2. *Project risk identification is positively related to the project success.*

Hypothesis 2a. *Project risk identification is positively related to the project efficiency.*

Hypothesis 2b. *Project risk identification is positively related to the impact on the customer.*

Hypothesis 2c. *Project risk identification is positively related to the impact on the project team.*

Hypothesis 2d. *Project risk identification is positively related to the business success.*

Hypothesis 2e. *Project risk identification is positively related to the preparing to the future.*

In project risk analysis, studies showed models and frameworks to assess risks and risks interdependencies in different type IT projects, and to prioritize risks supporting the decision making of management. Five studies investigated frameworks for risk assessment (Büyüközkan & Ruan, 2010; Costa et al., 2007; Cuellar & Gallivan, 2006; Du et al., 2007; Salmeron & Lopez, 2010), nine studies explorer the interdependency between risks in different types of IT projects begin a subject of increasing interest in recent scientific investigations (Aloini et al., 2012a, 2012b; Büyüközkan & Ruan, 2010; Chang Lee et al., 2009; Fu et al., 2012; Hu, Zhang, et al., 2013; Kwan & Leung, 2011; Lopez & Salmeron, 2014; Ojiako et al., 2012) and three studies discussed the risk prioritization (Huang & Han, 2008; Neves et al., 2014; Samadi et al., 2014). A total of seventeen studies were entirely dedicated to risk assessment in this study.

Different methods and approaches were proposed to assess risks, such as the usage of MACOM (Chang Lee et al., 2009), CPN theory (Aloini et al., 2012a), ISM theory (Aloini et al., 2012b), probabilistic models (Costa et al., 2007; Fu et al., 2012), intelligent SPRM (Hu, Du, et al., 2013), BNCC (Hu, Zhang, et al., 2013; Jianping Li, Li, Wu, Dai, & Song, 2016), Fuzzy methods (Lopez & Salmeron, 2014; Rodríguez, Ortega, & Concepción, 2016; Samadi et al., 2014; Samantra, Datta, & Mahapatra, 2014; Yucel, Cebi, Hoege, & Ozok, 2012), DEMATEL (Hwang et al., 2016) and others (Kwan & Leung, 2011; Lin & Parinyavuttichai, 2015; Yu et al., 2013).

These studies do not show empirically the effective impact of risk assessment on project success. Nevertheless, risk analysis was cited as one of the main processes followed by project managers (Bannerman, 2008; Kutsch et al., 2014, 2013, Kutsch & Hall, 2009, 2010; Kutsch & Maylor, 2011; Taylor et al., 2012; Wickboldt et al., 2011). Therefore, this study posits that project risk analysis contributes directly to the project success and to each dimension of project success. The following hypotheses are proposed based on above discussion:

Hypothesis 3. *Project risk analysis is positively related to the project success.*

Hypothesis 3a. *Project risk analysis is positively related to the project efficiency.*

Hypothesis 3b. *Project risk analysis is positively related to the impact on the customer.*

Hypothesis 3c. *Project risk analysis is positively related to the impact on the project team.*

Hypothesis 3d. *Project risk analysis is positively related to the business success.*

Hypothesis 3e. *Project risk analysis is positively related to the preparing to the future.*

In project risk response planning, studies showed the identification of avoidance and mitigation strategies and their effectiveness and efficiency tackling key risks and the proposition of models and frameworks to implement the mitigation actions. Nine studies investigated the identification of avoidance and mitigation strategies (Caffery et al., 2010; Chua, 2009; Gefen et al., 2008; Hu, Zhang, et al., 2013; Hung et al., 2014; Jingyue Li et al., 2008; J. Y.-C. Liu & Yuliani, 2016; S. Liu, 2016; Tesch et al., 2007) and five the proposition of frameworks (Alhawari et al., 2012; Caffery et al., 2010; Dey et al., 2013; Hu, Zhang, et al., 2013; Persson et al., 2009). A total of fourteen studies were entirely dedicated to risk assessment in this study.

These studies do not show empirically the effective impact of risk response planning on project success, but most of them explore the impact of some kind of risk on project success and make recommendations how to tackle this risks, but the effectiveness of this actions were not evaluated. Therefore, this study posits that project risk response planning contributes directly to the project success and to each dimension of project success. The following hypotheses are proposed based on above discussion:

Hypothesis 4. *Project risk response planning is positively related to the project success.*

Hypothesis 4a. *Project risk response planning is positively related to the project efficiency.*

Hypothesis 4b. *Project risk response planning is positively related to the impact on the customer.*

Hypothesis 4c. *Project risk response planning is positively related to the impact on the project team.*

Hypothesis 4d. *Project risk response planning is positively related to the business success.*

Hypothesis 4e. *Project risk response planning is positively related to the preparing to the future.*

In risk monitoring and control, the last process of the four sequential and cyclic processes of project risk management, only four studies proposed frameworks to analyze and monitor risks, looking for a better understanding of their behavior over the software development life cycle in IS/IT projects (Dey et al., 2007; Hwang et al., 2016; Lin & Parinyavuttichai, 2015; Yu et al., 2013). Despite that, these studies do not show empirically the effective impact of risk monitoring and control on project success. Therefore, this study posits that project risk monitoring and control contributes directly to the project success and to each dimension of project success. The following hypotheses are proposed based on above discussion:

Hypothesis 5. *Project risk monitoring and control is positively related to the project success.*

Hypothesis 5a. *Project risk monitoring and control is positively related to the project efficiency.*

Hypothesis 5b. *Project risk monitoring and control is positively related to the impact on the customer.*

Hypothesis 5c. *Project risk monitoring and control is positively related to the impact on the project team.*

Hypothesis 5d. *Project risk monitoring and control is positively related to the business success.*

Hypothesis 5e. *Project risk monitoring and control is positively related to the preparing to the future.*

On top of the four sequential and cyclic processes, risk management culture is crucial for the properly employment of an effective risk management process (Sanchez et al., 2009). The defined aspects related to project risk management culture, such as communication transparency and openness, sense of responsibility, risk awareness, management support, early planning, early alerts, and the active involvement of several stakeholders support the achievements of projects objectives and influence the project success. On the other hand, some project managers stop adopting project risk management process over the overall project life cycle (Kutsch & Hall, 2009, 2010, Kutsch et al., 2013, 2014). Therefore, this study posits that project risk management culture contributes directly to the project success and the following hypotheses are proposed based on above discussion:

Hypothesis 6. *Project risk management culture is positively related to the project success.*

Hypothesis 6a. *Project risk management culture is positively related to the project efficiency.*

Hypothesis 6b. *Project risk management culture is positively related to the impact on the customer.*

Hypothesis 6c. *Project risk management culture is positively related to the impact on the project team.*

Hypothesis 6d. *Project risk management culture is positively related to the business success.*

Hypothesis 6e. *Project risk management culture is positively related to the preparing to the future.*

On top of that, organizations should have a clear set of internal policies and key principles for project risk management to be shared among diverse stakeholders. They should clearly state the company's tolerance to risk, how company identify, analyses, response to and monitors risks, what are the main tools for registering, reporting, communicating, and following risks. A defined project risk management process has been influence directly and indirectly the project success (Aloini et al., 2012a; Cagliano et al., 2015; Carvalho & Rabechini Junior, 2014; de Bakker et al., 2010; Teller, 2013; Teller & Kock, 2013; Teller et al., 2014).

Despite that, some authors argues that risk management process can be perceived as a overload set of activities, requesting extra work, cost and time, and being not effective under specific contexts (Aloini et al., 2007b; Atkinson et al., 2006; de Bakker et al., 2010). Therefore, this study posits that project risk management process formalization contributes directly to the project success and the following hypotheses are proposed based on above discussion:

Hypothesis 7. *Project risk management process formalization is positively related to the project success.*

Hypothesis 7a. *Project risk management process formalization is positively related to the project efficiency.*

Hypothesis 7b. *Project risk management process formalization is positively related to the impact on the customer.*

Hypothesis 7c. *Project risk management process formalization is positively related to the impact on the project team.*

Hypothesis 7d. *Project risk management process formalization is positively related to the business success.*

Hypothesis 7e. *Project risk management process formalization is positively related to the preparing to the future.*

Figure 12 shows the conceptual model proposed in the research.

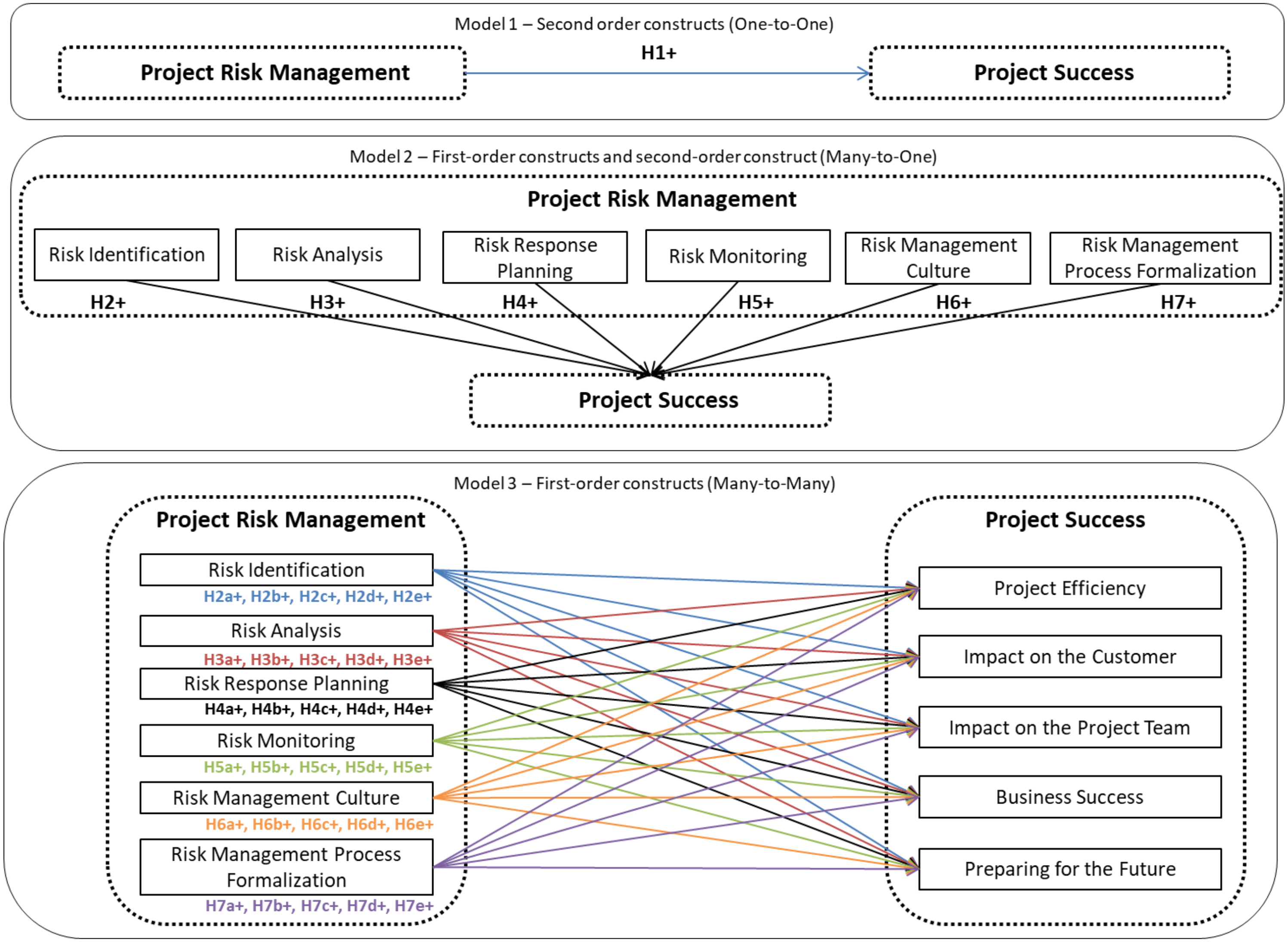

Figure 12. Proposed conceptual model

Source: created by the author

4 METHODOLOGY

This chapter presents the methodological aspects of this research, including the nature of the research, the systematic review approach used to identify the main and recent papers on project risk management of IS/IT projects used as reference to support this study, the instrument of measurement followed by the argumentations supporting the choices of this study, the pre-test, the data collection method, the population sampling, the construct reliability and validity methods, and the data analysis methods.

4.1 Nature of the Research

This research selected hypothetical-deductive as research design by the identification of a research gap, followed by the formulation of hypotheses supported by the literature review and testing a set of observable data. *Figure 13* shows a summary of the nature of this research.

Characteristic	**Selected approach**
Research goal	Conclusive
Research design	Hypothetical-deductive model
Procedural methods	Quantitative
Unit of analysis	Latest completed project
Data collection	Web-based survey
Data analysis method	Partial Least Squares - Structural Equation Modeling (PLS-SEM)

Figure 13. Nature of the research

Source: created by the author

4.2 Systematic Review on Project Risk Management in IS/IT Projects

A literature review was undertaken by adopting a systematic review approach following a set of scientific methods that aim to reduce biases (Petticrew & Roberts, 2006). According to the research objective, our target is on subjects related to project risk management in the IS/IT field. Four research criteria were chosen for the search of papers in the database. First, only papers dated from 2007 to 2016 were selected, in accordance to our intent of retrieving the most updated studies. Second, only papers and reviews of journals were selected to emphasize the academic rigor of this study. Books, book reviews, editorials and papers in conference proceedings and/or in commercial journals were not considered in the search.

Third, only papers in English were considered due to the availability of the broad academic literature of project risk management and validated constructs' variables in English and due to our target respondents. Four, some keywords were used in the literature search in the paper's title and abstract, namely *risk, uncertainty, project management, program management, portfolio management, software development, ERP, information system, information technology, project IT, IT project, software risk, project risk*. The database *Scopus* was selected to this review and the following search string was proposed to retrieve papers: *TITLE (risk OR uncertainty) AND TITLE-ABS ("project management" OR "program management" OR "portfolio management" OR "information system" OR "software development" OR "ERP" OR "project IT" OR "information technology" OR "software risk" OR "project risk" OR "IT project" OR "system integration") AND DOCTYPE (ar OR re) AND PUBYEAR > 2006 AND PUBYEAR < 2017 AND (LIMIT-TO (SRCTYPE , "j ")) AND (LIMIT-TO (LANGUAGE , "English ")).*

A total of 2680 papers were retrieved in the first round. Afterwards, an extensive review of the paper's title and abstract was made to take out those not explicitly focused on PRM. A subtotal of 519 papers remained in the second round. After that, another review of the paper's title and abstract was made to take out those not explicitly focused on IS/IT. The most common fields of study found were, namely construction/infrastructure, health/drugs/disease/ genetic, chemical, information security, geographic information system, and supply chain. A subtotal of 302 papers remained in the third round (including those which field of study is unclear).

Finally, remaining papers were reviewed in-depth to confirm if they are effectively focused on PRM in IS/IT, are published in rigorous academic journals with double-blind review, are empirical studies, and have clearly cited the method of research. From that, 58 were took out due to not related to PRM in IS/IT, 143 were took out due to reasons such as full versions of the paper availability, no empirical studies, and no research method explicitly stated in the paper. A total of 101 papers achieved these criteria and they compose the literature review of this study.

Figure 14 shows the overall steps of the systematic review described above and *Figure 15* shows the distribution of selected journal papers and their citation scores, confirming that this study has chosen relevant papers from rigorous academic journals.

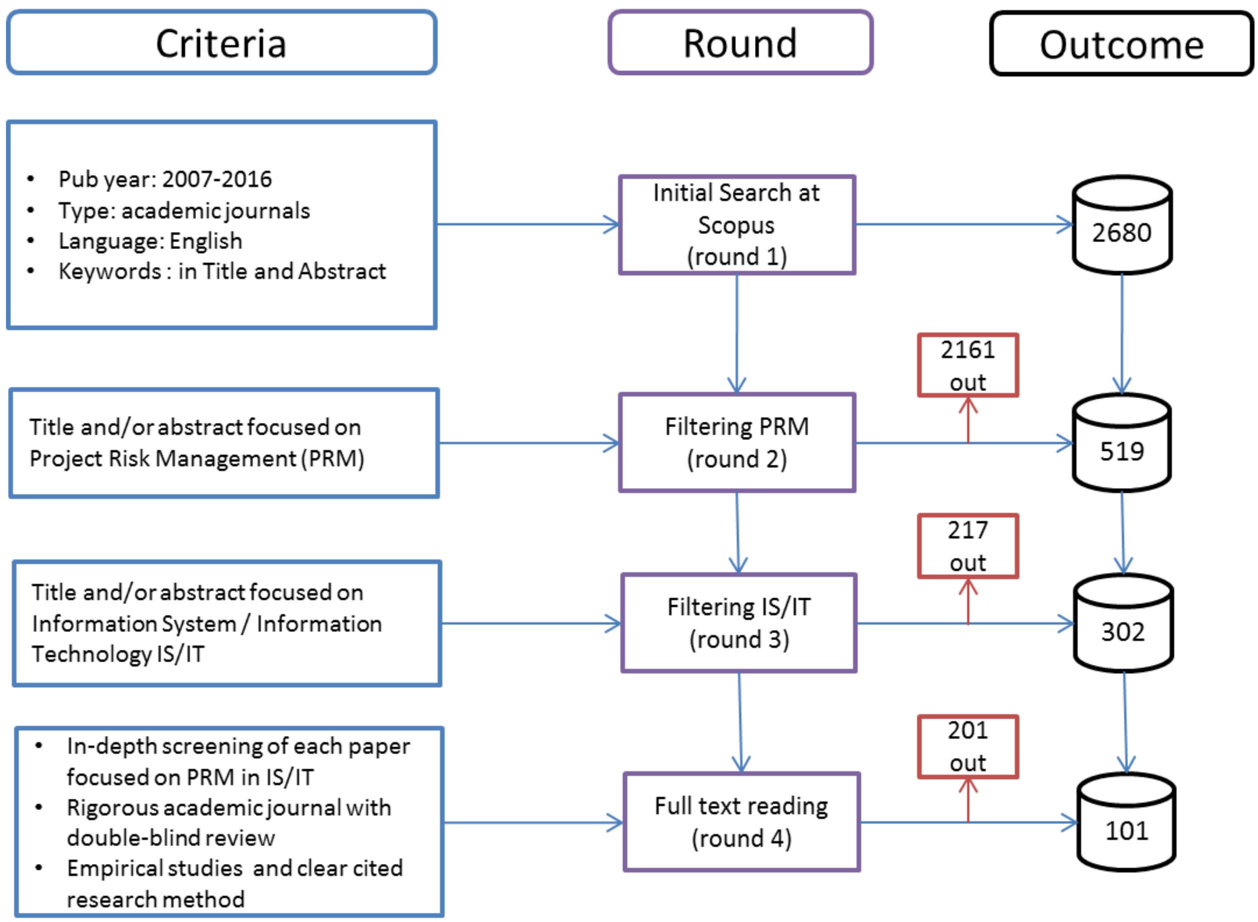

Figure 14. Systematic review framework

Source: created by the author

#	Journals	# of papers	SJR	Cite Score	JCR FI
1	Australasian Journal of Information Systems	1	0.183	0.54	N/A
2	Computer Networks	1	0.652	3.68	2.516
3	Decision Support Systems	3	1.806	4.67	3.222
4	European Journal of Information Systems	2	2.424	4.16	2.819
5	European Journal of Operational Research	3	2.505	3.83	3.297
6	European Management Journal	1	1.078	2.98	2.481
7	Expert Systems with Applications	3	1.433	4.70	3.928
8	IEEE Transactions on Engineering Management	2	0.743	1.88	1.188
9	IEEE Transactions on Software Engineering	2	0.934	5.51	3.272
10	Industrial Management and Data Systems	3	0.768	2.59	2.205
11	Information and Management	4	1.628	5.25	3.317
12	Information and Software Technology	4	0.788	3.61	2.694
13	Information Development	1	0.295	0.77	1.691
14	Information Sciences	3	1.910	5.37	4.832
15	Information Systems	1	0.909	3.33	2.777
16	Information Systems Journal	1	1.883	4.07	4.122
17	International Journal of Information Management	3	1.252	5.68	3.872
18	International Journal of Information Technology and Decision Making	3	0.472	1.19	1.664
19	International Journal of Managing Projects in Business	1	0.436	1.13	N/A
20	International Journal of Production Research	1	1.463	2.67	2.325
21	International Journal of Project Management	16	1.396	4.58	4.034
22	International Journal of Project Organisation and Management	1	0.173	0.28	N/A
23	Journal of Computer Information Systems	4	0.738	1.87	0.675
24	Journal of Enterprise Information Management	2	0.575	2.40	N/A
25	Journal of Information Technology	2	0.912	3.07	6.952
26	Journal of Operations Management	1	4.599	6.01	5.207
27	Journal of Risk Research	1	0.443	1.00	1.340
28	Journal of Systems and Software	7	0.640	3.10	2.444
29	Journal of Technology Management and Innovation	1	0.259	0.68	N/A
30	Journal of the American Society for Information Science &Technology	1	#N/D	#N/D	2.322
31	Journal of the Association of Information Systems	2	2.012	4.26	2.109
32	MIS Quarterly: Management Information Systems	1	6.687	11.37	7.268
33	Production and Operations Management	2	3.163	2.48	1.950
34	Production Planning and Control	1	1.073	2.45	2.369
35	Project Management Journal	10	1.473	3.04	2.714
36	R&D Management	1	#N/D	#N/D	2.444
37	Research-Technology Management	1	#N/D	#N/D	2.429
38	Risk Analysis	1	0.955	2.21	2.518
39	Software Quality Journal	2	0.456	1.67	1.816
40	Systems Engineering	1	0.520	1.67	N/A

Figure 15. Distribution of selected journal papers and their citation scores

Source: created by the author

4.3 Instrument for Measurement

This study is built upon two second-order constructs, project risk management and project success, and both were designed on a multidimensional basis, following the literature review described in the previous chapters. Project risk management is composed by six first-order constructs, namely *risk identification, risk analysis, risk response planning, risk monitoring and control, risk management culture and risk management process formalization*, and projects success is composed by five first-order constructs, namely *project efficiency, impact on the customer, impact on the project team, business success, and preparing for the future*. These dimensions and their respective variables were retrieved from the literature which provided reliable and valid instruments to measure them. *Figure 16* shows the thirty-seven hypotheses developed for this study and *Figure 17* shows the two second-order constructs and their respective first-order constructs, the number of items to evaluate each dimension and the list of references from the literature review that support each dimension. Each construct and their items were assessed by respondents based on the scales proposed in the referred studies. In total, 44 variables compose the overall proposed conceptual model.

Out of six dimensions of the project risk management second-order construct, four were adapted from the studies of Teller and others (Teller, 2013; Teller & Kock, 2013; Teller et al., 2014), to know risk management process formalization, risk management culture, risk response planning, and risk monitoring and control. Despite the fact that their studies are related to the indirect influence of project portfolio risk management on project portfolio management, there are several reasons that support our decision. First, most of the literature used to measure the dimensions of the construct portfolio risk management in their study is derived from project risk management. Second, as stated by the author when discussing about the overall quality of risk management, "*no distinction is drawn between the project and the portfolio level in terms of risk management quality*" (Teller, 2013). Third, those two first reasons are reinforced by the fact that in their last paper (Teller et al., 2014), the authors put a clear focus on project side and the construct used there "formal project risk management" is exactly the same as referred by "risk management process formalization" in the first two papers. Forth, they are the only studies identified in the systematic literature review carried out in this study that clearly presented, in spare, dimensions that reflect at some level the four sequential and cyclic processes of project risk management. Last but not least, these are well-cited papers in the literature as observed in Google Academics citation and Scopus.

The remaining two dimensions, risk identification and risk analysis are suggested separately in opposite to their proposition because we assume that these dimensions represent different steps, activities, tools and management approaches, in line with other studies and best practices (Alhawari et al., 2012; Aloini et al., 2012b; Dey et al., 2013, 2007; Hu, Du, et al., 2013; Hu, Zhang, et al., 2013; Jianping Li et al., 2016; Project Management Institute, 2009, 2017a). Respondents were asked to assess each item on a 7-point Likert-type scale ranging from 1 ("strongly disagree") to 7 ("strongly agree") as proposed by Teller & Kock. *Figure 18* presents the construct's dimensions and variables.

Project Success is a well-known multidimensional construct in the project management literature (Hung et al., 2014; Jun et al., 2011; S. Liu, 2015b; Wallace et al., 2004b, 2004a). This study adopted the second-order construct and its respective first-order constructs and instrument proposed by Mir and Pinnington (Mir & Pinnington, 2014). Respondents were asked to assess each item on a 5-point Likert-type scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). *Figure 19* presents the construct's dimensions and variables.

The demographic questions (respondent background, organization characteristic and project characteristic) are adapted from various studies (Kutsch et al., 2013; S. Liu, 2015b, 2015a, 2016; S. Liu et al., 2010; Reed & Knight, 2010) and some additional items were proposed allowing us to evaluate some conditions accordingly to the proposed hypotheses. Respondents were asked to assess 20 items according to the measure scale presented in *Figure 20*, *Figure 21* and *Figure 22*.

#	Hypotheses
H1	The project risk management influences positively the project success.
H2	Project risk identification is positively related to the project success.
H2a	Project risk identification is positively related to the project efficiency.
H2b	Project risk identification is positively related to the impact on the customer.
H2c	Project risk identification is positively related to the impact on the project team.
H2d	Project risk identification is positively related to the business success.
H2e	Project risk identification is positively related to the preparing to the future.
H3	Project risk analysis is positively related to the project success.
H3a	Project risk analysis is positively related to the project efficiency.
H3b	Project risk analysis is positively related to the impact on the customer.
H3c	Project risk analysis is positively related to the impact on the project team.
H3d	Project risk analysis is positively related to the business success.
H3e	Project risk analysis is positively related to the preparing to the future.
H4	Project risk response planning is positively related to the project success.
H4a	Project risk response planning is positively related to the project efficiency.
H4b	Project risk response planning is positively related to the impact on the customer.
H4c	Project risk response planning is positively related to the impact on the project team.
H4d	Project risk response planning is positively related to the business success.
H4e	Project risk response planning is positively related to the preparing to the future.
H5	Project risk monitoring and control is positively related to the project success.
H5a	Project risk monitoring and control is positively related to the project efficiency.
H5b	Project risk monitoring and control is positively related to the impact on the customer.
H5c	Project risk monitoring and control is positively related to the impact on the project team.
H5d	Project risk monitoring and control is positively related to the business success.
H5e	Project risk monitoring and control is positively related to the preparing to the future.
H6	Project risk management culture is positively related to the project success.
H6a	Project risk management culture is positively related to the project efficiency.
H6b	Project risk management culture is positively related to the impact on the customer.
H6c	Project risk management culture is positively related to the impact on the project team.
H6d	Project risk management culture is positively related to the business success.
H6e	Project risk management culture is positively related to the preparing to the future.
H7	Project risk management process formalization is positively related to the project success.
H7a	Project risk management process formalization is positively related to the project efficiency.
H7b	Project risk management process formalization is positively related to the impact on the customer.
H7c	Project risk management process formalization is positively related to the impact on the project team.
H7d	Project risk management process formalization is positively related to the business success.
H7e	Project risk management process formalization is positively related to the preparing to the future.

Figure 16. List of hypotheses

Source: created by the author

Constructs		# Variables	Reference
Project Risk Management (PRM)	Risk Identification (RI)	3	(Alhawari et al., 2012; Aloini et al., 2012b; Dey et al., 2013, 2007; Jianping Li et al., 2016)
	Risk Analysis (RA)	4	(Alhawari et al., 2012; Aloini et al., 2012b; Dey et al., 2013, 2007; Hu, Du, et al., 2013; Hu, Zhang, et al., 2013)
	Risk Response Planning (RR)	4	(Teller & Kock, 2013)
	Risk Monitoring and Control (RM)	3	(Teller & Kock, 2013)
	Risk Management Culture (RC)	4	(Teller & Kock, 2013)
	Risk Management Process Formalization (RF)	4	(Teller & Kock, 2013; Teller et al., 2014)
Project Success (PS)	Project Efficiency (PE)	4	(Mir & Pinnington, 2014)
	Impact on the Customer (IC)	7	(Mir & Pinnington, 2014)
	Impact on the Project Team (IT)	3	(Mir & Pinnington, 2014)
	Business Success (BS)	4	(Mir & Pinnington, 2014)
	Preparing for the Future (PF)	4	(Mir & Pinnington, 2014)

Figure 17. Matrix of the proposed conceptual model

Source: created by the author

Dimensions	Variables
Risk Identification	RI1. Sources of risk and potential consequences are identified over the project RI2. Risks are identified based on tools and techniques (e.g., brainstorming, cause-effect diagram, checklists, lessons-learned documents, scenario analysis) RI3. Risks are registered and maintained in spreadsheets, systems or other type of record
Risk Analysis	RA1. Risks are assessed based on qualitative tools and techniques (e.g., AHP, expert judgment, interviews) RA2. Risks are assessed based on quantitative tools and techniques (e.g., decision tree analysis, EMV, Monte Carlo Simulation, PERT, sensitive analysis). RA3. Risks are prioritized according to the risk analysis RA4. Risks are assessed based on the probability versus impact (e.g. probability x impact matrix)
Risk Response Planning	RR1. We conduct intensive analyses of causes and deviations for in terms of the sources of risk. RR2. We take many actions aimed at the sources of risk (e.g., training, technical security precautions, improvement of work methods). RR3. We take many actions which minimize the impact when a risk event occurs (e.g., taking out insurance, planning reserves, hedging). RR4. We take many actions in advance, before the risk event occurs.
Risk Monitoring	RM1. We continuously monitor changes in the identified risks over time. RM2. We continuously monitor new risks which arise in addition to those already identified. RM3. We continuously monitor the impact of measures initiated for risk resolution.
Risk Management Culture	RC1. The individual risk managers communicate risks openly and honestly. RC2. The individual risk managers feel responsible for the risks and the associated measurements for their resolution. RC3. Employees at all levels of the project regard risk management as a part of their everyday business activities. RC4. Employees at all levels of the project are conscious of the necessity of the risk management (high risk awareness).
Risk Management Process Formalization	RF1. Responsibilities in risk management are clearly defined. RF2. The risk management process is explained in detail in a process description (e.g., manual). RF3. We use standardized forms for risk management. RF4. As a part of risk management there are extensive regulations regarding content, scope and the external form of risk documents (workflows).

Figure 18. Variables of the construct “Project Risk Management” (22 items)

Source: adapted from Teller & Kock (2013)

Dimensions	Variables
Project Efficiency	PE1. The project was completed on time PE2. The project was completed within budget PE3. The project was completed within project margin PE4. The completed project was managed in an efficient manner
Impact on the Customer	IC1. The project met functional performance requirements IC2. The project met technical specifications IC3. The project fulfilled customer's needs IC4. The customer is using the product IC5. The customer was highly satisfied IC6. The project improved the customer's performance IC7. There is a high chance that the customer would come back for additional business
Impact on the Project Team	IT1. Team members felt fulfilled and able to grow personally and professionally by working on this project IT2. Team members were highly energized at the end of the project (rather than exhausted) IT3. The project increased the loyalty of team members to the organization
Business Success	BS1. The project resulted in commercial success for the organization BS2. The project increased the organization's profitability or helped other organizational goals (for example, increased organizational assets or increased operational capabilities) BS3. The project improved organizational reputation and stature BS4. The project increased the organization's market share
Preparing for the Future	PF1. The project will lead to additional new business or new products or services PF2. The project will help create new markets or new customers/ users and increase organizational outreach PF3. The project created new technologies or new capabilities for future use PF4. The organization learnt many lessons from the project to improve future performance

Figure 19. Variables of the construct “Project Success” (22 items)

Source: adapted from Mir & Pinnington (2014)

Item	Measure
Academic background	High school or less Undergraduate/bachelor’s degree Postgraduate certificate/diploma Master’s degree Doctoral
Total work experience (years)	< decimal number>
Project management experience (years)	< decimal number>
Project risk management experience (years)	<decimal number >
Certified project/programme manager (PMP, CAPM, PPM, etc)	Yes No
English language skills	Beginner Elementary Intermediate Upper-Intermediate Advanced Proficiency

Figure 20. Demographics questions – respondent background (6 items)

Source: created by the author

Item	Measure
Number of Employee in Entire Organization	Fewer than 100 100 – 299 300 – 999 1,000 – 2,499 2,500 – 4,999 5,000 – 9,999 10,000 or more
Industry	Aerospace, Business services (advertising, marketing, staffing, etc.), Construction, Consulting, Engineering, Financial services, Food and beverage, Government, Healthcare, Information technology, Insurance, Legal, Manufacturing, Pharmaceuticals, Real Estate, Resources (Agriculture, Mining, Coal, Gas, Oil), Telecommunications, Training / education, Utility, Other, please specify:
How long have you been at the organization (years)?	<decimal number>
In what country do you work?	<List of all countries in the World>

Figure 21. Demographics questions – organization characteristics (4 items)

Source: created by the author

Item	Measure
Your role in the project team	Director of PMO; Portfolio Manager; Program Manager; Project Manager; Team Lead; Team Member; Other (please specify)
Project environment	Virtual Project; Co-located Project; Virtual and Co-located project
Type of approach	Traditional (e.g. Waterfall); Agile; Hybrid (Traditional/Agile); Other (please specify)
Type of IS/IT project	Application Management Application Development IT Infrastructure Management Software Package (Off-The-Shelf) Network Administration/Security Data Management/Recovery Other (please specify)
Project duration	1 to 6 months 7 to 12 months 13 to 18 months 19 to 24 months 25 to 30 months 31 to 36 months > 36 months
Project team size	1 to 4 members 5 to 9 members 10 to 14 members 15 to 19 members 20 to 35 members >35 members
Team language	1 Language; 2 Languages; 3 or more languages
Total project net value (without taxes)	lower than 250k EUR	220k GBP	310k USD	1M BRL between 250k EUR	220k GBP	310k USD	1M BRL and 1M EUR	880k GBP	1.2M USD	4M BRL between 1M EUR	880k GBP	1.2M USD	4M BRL and 5M EUR	4.4M GBP	6M USD	20M BRL between 5M EUR	4.4M GBP	6M USD	20M BRL and 10M EUR	8.8k GBP	12M USD	40M BRL bigger than 10M EUR	8.8k GBP	12M USD	40M BRL
Sourcing orientation	In-house; Outsourced
Project margin variation from the original target (Initial Business Case Target)	>-20% -20 to -10% -10 to 0% 0 to +10% 10 to 20% >20%

Figure 22. Demographics questions – project characteristics (10 items)

Source: created by the author

4.4 Pre-Test

A pre-tested was carried-out over a web-based survey with around 22 senior project management practitioners in IS/IT field to ensure the effectiveness and appropriateness of the questionnaire`s content, the wording, the sequence and the instruction. The survey was conducted in the SurveyMonkey platform and all respondents were invited by a personalized e-mail since they are professionals and academics closer to this author. Most of them work for IT companies. Based on responses from the respondents, the final version of the questionnaire were refined and adjusted. The main changes were related to demographics questions and those associated with the risk identification and risk analysis dimensions. As most of the questions came from previous studies (Mir & Pinnington, 2014; Teller & Kock, 2013; Teller et al., 2014) with minor changes, we were not expecting changes on it.

4.5 Data Collection

A web-based survey was conducted over three weeks in February, 2018 supported by the online platform SurveyMonkey and all respondents were invited by one of the following methods:

a) by email to the distribution list of project management practitioners of one multinational IT provider scattered around the world;
b) by message posted on Linkedin for all members of the author`s network with experience in project management (around 180 members);
c) by message posted on Linkedin for the following groups:
    a. #1 Project Manager (PM) Network I Business & Software I BlockChain & Crypto Consulting | FinTech (866,404 members);
    b. IT Project Management Professionals (16,160 members);
    c. PMI Credentialed PMPs (81,544 members);
    d. Project Management Research and Practice (3,010 members);
    e. Gerenciamento de Projetos (74,399 members).

A three-wave follow up approach was adopted, thus, soft reminders were sent to all participants and groups after one week interval.

The data collected in this study can be accessed in the following shared link: https://drive.google.com/file/d/1yJKRT9TsmEa7sd_HMCtauOkjR9R-hN62/view?usp=sharing. There are three sheets, one describing the constructs and its respective variables, one second describing the demographics variables and the third one showing all 156 valid respondents' answers.

4.6 Population and Sampling

4.6.1 Minimum sample requirement

Convenience sampling was adopted in this research, therefore, the participants and unit of analysis - *latest completed project* - were chosen by the facility to access them and their availability to answer the online questionnaire. Nevertheless, this study met the minimum requirement for a multivariate analysis which is supported by the calculation of the minimum size of the sample as suggested by the software G*Power 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2007). To find out the minimum acceptable sample size, this study selected *F tests* for test family, *linear multiple regression: fixed model,* R^2 *deviation from zero* as statistical test, *a priori: compute required sample size – given α, power, and effect size* as type of power analysis, following the values of 5% for statistical significant (*α err prob*), 95% for power (*power 1 – β err prob*) and 15% for effect size (*Effect size* f^2) as recommend by the literature (Hair Jr, Hult, Ringle, & Sarstedt, 2017), resulting in a required sample of, at least, 146 respondents.

4.6.2 Population size

The data collection returned an initial number of 217 questionnaires, but 61 were incomplete thus a final valid number of 156 respondents were selected for the analysis. The number of respondents is slightly above the minimum threshold (146) according to the criterion previously recommended. The population covered a wide variety of projects from small to large ones, thereby strengthening the generalizability of the findings. Next sections presents detailed consolidated data of the characteristics of the respondents' background, their respective organizations and the latest completed projects selected by them.

4.6.3 Respondents' background

The respondents are very experienced professional with 26.3 years in average of total work experience, 15.4 years in average of project management experience and 10.3 years in average of project risk management experience which is quite consistent numbers since it is expected to have more total work experience than project management experience and thereafter more than project risk management experience. The number of years of project management experience is also coherent when moving from low level to high level positions, such as team member, team lead, project manager, program manager, portfolio manager, and director of PMO. The project management experience varied from 5.6 years in average as team member to 22.4 years in average as directors of PMO.

The population, at the time of the latest completed project, was formed mostly by management position (82.7%), to know 38.5% of project managers, 20.5% of program managers, 10.9% of directors of PMO, 5.1% of portfolio managers, 5.1% of others who declared themselves in management positions, and 2.6% of risk managers. Moreover is extremely relevant for the purpose of this study have a significant average of project risk management experience (11.4 years) in all management position (risk manager, project manager, program manager, portfolio manager, and director of PMO), except, surprisingly, for the risk manager position (7 years). One of the reasons would be that those respondents considered their experience in the role of risk manager and not the overall experience with project risk management. *Table 1* shows the overall experience of respondents by role.

Table 1. Respondents' overall experience by role

Role in the project team	**Number (#)**	**Percentage (%)**	**Experience (in years)**		
			Total work	**Project management**	**Project risk management**
Project Manager	60	38.5%	26.6	14.6	10.2
Program Manager	32	20.5%	24.8	16.0	11.0
Director of PMO	17	10.9%	32.0	22.4	13.8
Others	16	10.3%	25.9	15.8	11.1
Team Lead	12	7.7%	23.1	10.6	5.5
Portfolio Manager	8	5.1%	25.9	18.3	15.0
Team Member	7	4.5%	22.7	5.6	2.1
Risk Manager	4	2.6%	27.5	20.0	7.0
Total	**156**	**100.0%**	**26.3**	**15.4**	**10.3**

Source: created by the author

Beyond their experience, the respondents showed a high level of academic background with 97.4% having a undergraduate/bachelor`s degree or higher and 78.8% having a post-graduate degree such as a postgraduate certificate/diploma, master's degree or doctoral. Only four respondents have high school or less but, despite that, they have 33 years in average of total work experience, 22 years in average of project management experience and 20 years in average of project risk management experience. *Table 2* shows respondents' academic background.

Table 2. Respondents' academic background

Academic background	**Number (#)**	**Percentage (%)**
Master's degree	65	41.7%
Postgraduate certificate/diploma	45	28.8%
Undergraduate/bachelor's degree	29	18.6%
Doctoral	13	8.3%
High school or less	4	2.6%
Total	**156**	**100.0%**

Source: created by the author

Finally, 60.3 % of the respondents have one or more type of certification related to project or programme management such as Project Management Professional (PMP), Certified Associate in Project Management (CAPM), Professional in Project Management (PPM) and others. Out of sixty project managers, a little more than half of them (31) have one certification and the other almost half (29) does not. The certification held by participants per role is more significant in the higher level positions, such as program managers who held 75.0% (24 out of 32), portfolio managers who held 75.0% (6 out of 8) and directors of PMO who held 82.4% (14 out of 17). *Table 3* shows the respondents' certified project/programme manager per role.

Table 3. Respondents' certified project/programme manager per role

	Certified project/programme manager (PMP, CAPM, PPM, etc)					
	Yes		**No**		**Number**	**Percentage**
Role in the project team	**(#)**	**(%)**	**(#)**	**(%)**	**(#)**	**(%)**
Project Manager	31	19.9%	29	18.6%	60	38.5%
Program Manager	24	15.4%	8	5.1%	32	20.5%
Director of PMO	14	9.0%	3	1.9%	17	10.9%
Other	9	5.8%	7	4.5%	16	10.3%
Portfolio Manager	6	3.8%	2	1.3%	8	5.1%
Team Lead	6	3.8%	6	3.8%	12	7.7%
Risk Manager	3	1.9%	1	0.6%	4	2.6%
Team Member	1	0.6%	6	3.8%	7	4.5%
Total	**94**	**60.3%**	**62**	**39.7%**	**156**	**100.0%**

Source: created by the author

English language skills is a relevant data for this research due to the fact that the web-based survey was managed only in English but for all participants worldwide, therefore one of the concerns of this study was to evaluate if respondents have the appropriate and minimum level of English language to understand and answer properly the questions. The six available answers in the questionnaire for English language skills question (beginner, elementary, intermediate, upper-intermediate, advanced and proficiency) were based on the Common European Framework of Reference for Languages (CEFR) (Council of Europe, 2001). Most of respondents, 74.4%, have advanced or proficiency level of English and 25.6% have intermediate or upper-intermediate level. Considering the technical and business language commonly described in the literature for project risk management and project success, the fact that is very common for professional working with IS/IT project have contact with English documents, and taking into consideration the definition for the overall reading comprehension as described in the CEFR, namely "*Can read straightforward factual texts on subjects related to his/her field and interest with a satisfactory level of comprehension*", this study states that, at least, intermediate level of English should be sufficient to participants comprehend each question, therefore, all 156 respondents were considered for further analysis. *Table 4* shows the respondents' English language skills.

Table 4. Respondents' English language skills

English language skills	Number (#)	Percentage (%)
Proficiency	74	47.4%
Advanced	42	26.9%
Upper-Intermediate	25	16.0%
Intermediate	15	9.6%
Total	**156**	**100.0%**

Source: created by the author

4.6.4 Organizations characteristics

The respondents, at the time of the latest completed project, were tied to a wide range of companies. Most of the respondents, 81.1%, came from large companies, here defined as those businesses with 300 employees or more which is quite similar to the definition of large enterprises (250 or more people) defined by the Organization for Economic Co-operation and Development (OECD) (OECD, 2005). The respondents have worked ten years in average in these companies.

This study could not gather the company's name due to during the pre-test, some respondents claimed that their companies have terms of confidentiality that do not allows them to expose any information related to the company, including its name. Despite that, we can state that not all respondents of companies with 10,000 or more employees came from the same organization due to over the survey collecting data period, some of the respondents have informed the author of this study they have responded the survey and its known which companies his or her worked. On the other hand, following our confidentiality as presented in the first page (introduction page) of the survey (see APPENDIX A – SURVEY QUESTIONNARIE) and moreover it is not possible to guarantee that these respondents have answered properly the questionnaire until the end, we cannot make any assertions regarding the exact number of different companies.

Table 5. Number of respondents per organization size

Number of employees in entire organization	**Number (#)**	**Percentage (%)**
Fewer than 100	19	12.2%
100 – 299	12	7.7%
300 – 999	12	7.7%
1,000 – 2,499	16	10.3%
2,500 – 4,999	12	7.7%
5,000 – 9,999	9	5.8%
10,000 or more	76	48.7%
Total	**156**	**100.0%**

Source: created by the author

In total, twenty one types of industries were represented in this study, with the biggest representation made by the information technology (IT) industry (44.9%) followed by consulting (7.7%), manufacturing (6.4%), telecommunications and government (5.8% each one), financial services (5.1%) and so on. These six industries constitute 75.6% of the total sample. Taking into consideration this study is focused on IS/IT projects and significant part of the potential sampling is from IT field (see section 4.5), it was expected to have most of respondents coming from the IT industry and correlated. *Table 6* shows the number of respondents per type of all industries identified in this study.

Table 6. Number of respondents per type of industry

Industry	**Number (#)**	**Percentage (%)**
Information Technology (IT)	70	44.9%
Consulting	12	7.7%
Manufacturing	10	6.4%
Telecommunications	9	5.8%
Government	9	5.8%
Financial Services	8	5.1%
Educational	7	4.5%
Engineering	4	2.6%
Insurance	3	1.9%
Retail	3	1.9%
Utility	3	1.9%
Resources (Agriculture, Mining, Coal, Gas, Oil)	3	1.9%
Healthcare	3	1.9%
Construction	2	1.3%
Conglomerate	2	1.3%
Pharmaceuticals	2	1.3%
Aerospace	2	1.3%
Business Services (advertising, marketing, staffing, etc.)	1	0.6%
Transportation	1	0.6%
Food and Beverage	1	0.6%
Training / Education	1	0.6%
Total	**156**	**100.0%**

Source: created by the author

In total, thirty countries were represented in this study, with the biggest representation made by Brazil (41.7%) followed by United States of America (17.9%) and United Kingdom of Great Britain and Northern Ireland (6.4%). These three countries constitute 66.0% of the total sample. *Table 7* shows number of respondents per all countries identified in this study. Moreover, by continent, the biggest representation was made South America (46.2%), mainly due to Brazil, followed by North America (21.2%), mainly due to United States of America, Europe (19.2%)

and Asia (9.0%). Oceania (2.6%), Africa (1.3%) and Central America and the Antilles (0.6%) were poorly represented. *Table 8* shows the number of respondents per continent.

Table 7. Number of respondents per country

Country	Number (#)	Percentage (%)
Brazil	65	41.7%
United States of America	28	17.9%
United Kingdom of Great Britain and Northern Ireland	10	6.4%
India	6	3.8%
France	5	3.2%
Uruguay	4	2.6%
Canada	4	2.6%
Netherlands	3	1.9%
Germany	3	1.9%
Australia	3	1.9%
Austria	3	1.9%
Saudi Arabia	2	1.3%
Belgium	2	1.3%
Argentina	2	1.3%
China	1	0.6%
Trinidad and Tobago	1	0.6%
Iran (Islamic Republic of)	1	0.6%
Mexico	1	0.6%
United Republic of Tanzania	1	0.6%
Cameroon	1	0.6%
Russian Federation	1	0.6%
New Zealand	1	0.6%
Singapore	1	0.6%
Norway	1	0.6%
Ireland	1	0.6%
Paraguay	1	0.6%
Kazakhstan	1	0.6%
Philippines	1	0.6%
Portugal	1	0.6%
Malaysia	1	0.6%
Total	**156**	**100.0%**

Source: created by the author

Table 8. Number of respondents per continent

Continent	Number (#)	Percentage (%)
South America	72	46.2%
North America	33	21.2%
Europe	30	19.2%
Asia	14	9.0%
Oceania	4	2.6%
Africa	2	1.3%
Central America and the Antilles	1	0.6%
Total	**156**	**100.00%**

Source: created by the author

4.6.5 Projects characteristics

The respondents were requested to answer the questionnaire considering as the unit of analyses the ***latest completed project*** that they were engaged. A set of project characteristics were collected in this survey, namely project environment, type of approach, type of IS/IT project, project duration, project team size, team language, total project net value (without taxes), sourcing orientation, and project margin variation from the original target (Initial Business Case Target).

Project environment refers to the configuration of the project team regarding their location, which can be co-located and/or virtual. Co-located means the project team is physically seated in one specific place that can be the supplier's site and/or costumer's site. Virtual means the project teams are dispersed geographically and can be in different sites, cites, countries or continents, for example. The majority of respondents said the projects were composed or virtual and co-located teams (62.8%), followed by co-located projects (32.1%) and a small portion of only virtual projects (5.1%). *Table 9* shows the number of projects per type of environment (virtual and/or co-located).

Table 9. Number of projects per type of environment (virtual and/or co-located)

Project environment	**Number (#)**	**Percentage (%)**
Virtual and Co-located project	98	62.8%
Co-located Project	50	32.1%
Virtual Project	8	5.1%
Total	**156**	**100.0%**

Source: created by the author

Type of approach refers to the project management approach adopted by the project team to manage its project, mainly traditional (e.g. waterfall), agile and others. The majority of projects were managed by a hybrid approach, traditional and agile (44.9%), followed by a traditional approach (37.2%) and few (12.2%) by an agile approach and others (5.8%). It was not possible to clearly state what others mean due to most of the respondents who selected this option added comments, such as “varies” or “all above”. *Table 10* shows the number of projects per type of project management approach.

Table 10. Number of projects per type of project management approach

Type of approach	**Number (#)**	**Percentage (%)**
Hybrid (Traditional/Agile)	70	44.9%
Traditional (e.g. waterfall)	58	37.2%
Agile	19	12.2%
Other (e.g. mix of several types, CCPN, product-oriented)	9	5.8%
Total	**156**	**100.0%**

Source: created by the author

Type of IS/IT project refers to the common types of products and/or service related to IS/IT market. Most of the projects were application development (39.1%), followed by others (16.0%), IT infrastructure management (15.4%), application management (14.1%) and software package (off-the-shelf) (10.9%). Data management/recovery and network administration/security were poorly cited, respectively, by 3.2% and 1.3% respondents. Looking in depth, others mean a mix of IS/IT products and/or services, such as software pack, application development and infrastructure, three comments on cloud implementations/migration, joint services with hardware and software, and so on. *Table 11* shows the number of projects per type of IS/IT project.

Table 11. Number of projects per type of IS/IT project

Type of IS/IT project	Numbe r (#)	Percentag e (%)
Application Development	61	39.1%
Others (e.g. Infrastructure, network and cloud implementation, process reengineering, and a mix of several types)	25	16.0%
IT Infrastructure Management	24	15.4%
Application Management	22	14.1%
Software Package (Off-The-Shelf)	17	10.9%
Data Management/Recovery	5	3.2%
Network Administration/Security	2	1.3%
Total	**156**	**100.0%**

Source: created by the author

Project duration refers to the estimation of total project length from the beginning to the end as the requested project should be completed. Most of the projects lasted 7 to 12 months (31.4%) and few projects lasted 25 to 36 months (7.7%). The others range were quite similarly cited by respondents. In general, this study covered relatively well the ranges of projects in terms of duration, but it is not possible to affirm looking just the duration of project if they are small or large projects since it usually varies according to the size of team, type of project and/or size of the company (supplier and/or customer) carrying out the project. *Table 12* shows the number of projects per total duration of the project.

Table 12. Number of projects per total duration of the project

Project duration	Number (#)	Percentage (%)
1 to 6 months	22	14.1%
7 to 12 months	49	31.4%
13 to 18 months	21	13.5%
19 to 24 months	24	15.4%
25 to 30 months	4	2.6%
31 to 36 months	8	5.1%
> 36 months	28	17.9%
Total	**156**	**100.0%**

Source: created by the author

The range of the number of members in each project was quite similarly represented by the proposed range. Projects with 35 members of more were the most cited by participants (24.4%), followed closely by 5 to 9 members and 10 to 14 members (both with 21.8%), 1 to 4 members (12.8%), 20 to 35 members (10.3%) and 15 to 19 members (9.0%). *Table 13* shows the number of projects per team size.

Table 13. Number of projects per team size

Project team size	Number (#)	Percentage (%)
1 to 4 members	20	12.8%
5 to 9 members	34	21.8%
10 to 14 members	34	21.8%
15 to 19 members	14	9.0%
20 to 35 members	16	10.3%
> 35 members	38	24.4%
Total	**156**	**100.0%**

Source: created by the author

Team language refers to the number of languages spoken by team members of the projects. Most of the projects have only one language spoken (44.2%), followed by two languages (38.5%) and, less cited, three or more languages (17.3%). In general, projects with two or more languages tend to be international projects with two or more countries. *Table 14* shows the number of projects per total languages spoken.

Table 14. Number of projects per total languages spoken

Team language	Number (#)	Percentage (%)
1 Language	69	44.2%
2 Languages	60	38.5%
3 or more languages	27	17.3%
Total	**156**	**100.0%**

Source: created by the author

Most of the projects has the total net value (excluded taxes) varying between one million and five millions Euros (32.1%), followed by projects with net value lower than 250 thousands Euros (23.1%), between 250 thousands and one million Euros (19.9%), bigger than ten millions Euros (14.1%) and between five millions and 10 million Euros (10.9%). *Table 15* shows the number of projects per the total project net value for different currencies, such as Euro, American Dollar, Brazilian Real and British Pound Sterling.

Table 15. Number of projects per the total project net value

Total project net value (without taxes)	**Number (#)**	**Percentage (%)**
lower than 250k EUR | 220k GBP | 310k USD | 1M BRL	36	23.1%
between 250k EUR | 220k GBP | 310k USD | 1M BRL and 1M EUR | 880k GBP | 1.2M USD | 4M BRL	31	19.9%
between 1M EUR | 880k GBP | 1.2M USD | 4M BRL and 5M EUR | 4.4M GBP | 6M USD | 20M BRL	50	32.1%
between 5M EUR | 4.4M GBP | 6M USD | 20M BRL and 10M EUR | 8.8k GBP | 12M USD | 40M BRL	17	10.9%
bigger than 10M EUR | 8.8k GBP | 12M USD | 40M BRL	22	14.1%
Total	**156**	**100.0%**

Source: created by the author

Sourcing orientation refers to the decision making of developing the project internally in the company or outsources the project for an external supplier such as an IT provider. Most of the responds developed the project in-house (65.4%). Considering that IT and consulting industries were the most cited by the respondents (52.6% of total - 82 responses), this study states that these respondents have assumed their project as being in-house, which means that despite the fact that most of them deliver product or services for others, they answered by their point of view and not by the others' point of view. At same time, this study recognizes that there is a risk of misinterpretation in this case. *Table 16* shows the number of projects per sourcing orientation, in-house or outsourced.

Table 16. Number of projects per sourcing orientation

Sourcing orientation	**Number (#)**	**Percentage (%)**
In-house	102	65.4%
Outsourced	54	34.6%
Total	**156**	**100.0%**

Source: created by the author

Project margin variation refers to the difference between the final project margin achieved by the project and the original target established in the initial business case, before starting the project. Tow-third of the projects proved to be profitable (67.9%) and one-third of the projects turned out to be unprofitable (32.1%). This data is extremely relevant and is compared further against the results of the question "The project was completed within project margin" which is related to project efficiency. *Table 17* shows the number of projects per project margin variation.

Table 17. Number of projects per project margin variation

Project margin variation from the original target (Initial Business Case Target)	**Number (#)**	**Percentage (%)**
<-20%	26	16.7%
-20 to -10%	10	6.4%
-10 to 0%	14	9.0%
0 to +10%	46	29.5%
+10 to +20%	33	21.2%
>+20%	27	17.3%
Total	**156**	**100.0%**

Source: created by the author

Table 18 shows the summary of all project characteristics.

Table 18. Summary of all project characteristics

Range	Number (#)	Percentage (%)
Project environment		
Virtual and Co-located project	98	62.8%
Co-located Project	50	32.1%
Virtual Project	8	5.1%
Type of approach		
Hybrid (Traditional/Agile)	70	44.9%
Traditional (e.g. waterfall)	58	37.2%
Agile	19	12.2%
Other	9	5.8%
Type of IS/IT project		
Application Development	61	39.1%
Others	25	16.0%
IT Infrastructure Management	24	15.4%
Application Management	22	14.1%
Software Package (Off-The-Shelf)	17	10.9%
Data Management/Recovery	5	3.2%
Network Administration/Security	2	1.3%
Project duration		
1 to 6 months	22	14.1%
7 to 12 months	49	31.4%
13 to 18 months	21	13.5%
19 to 24 months	24	15.4%
25 to 30 months	4	2.6%
31 to 36 months	8	5.1%
> 36 months	28	17.9%
Project team size		
1 to 4 members	20	12.8%
5 to 9 members	34	21.8%
10 to 14 members	34	21.8%
15 to 19 members	14	9.0%
20 to 35 members	16	10.3%
> 35 members	38	24.4%
Team language		
1 Language	69	44.2%
2 Languages	60	38.5%
3 or more languages	27	17.3%
Total project net value (without taxes)		
lower than 250k EUR	36	23.1%
between 250k EUR and 1M EUR	31	19.9%
between 1M EUR and 5M EUR	50	32.1%
between 5M EUR and 10M EUR	17	10.9%
bigger than 10M EUR	22	14.1%
Sourcing orientation		
In-house	102	65.4%
Outsourced	54	34.6%
Project margin variation from the original target (IBC Target)		
<-20%	26	16.7%
-20 to -10%	10	6.4%
-10 to 0%	14	9.0%
0 to +10%	46	29.5%
+10 to +20%	33	21.2%
>+20%	27	17.3%

Source: created by the author

4.6.5.1 Projects characteristics cross views

The majority of application development projects were managed by hybrid approaches (19.2%), followed by traditional approach (10.9%) and agile approach (7.7%). The same order was observed for software package (off-the-shelf) and others, but with a small difference of adoption of each project approach. Most application management projects were managed by traditional approaches (6.4%), followed by hybrid approach (5.8%) and agile approach (1.3%). The same order was observed for IT infrastructure management. Agile approach was not applied neither for data management/recovery and network administration/security. *Table 19* shows the number of projects analyzed by a cross view between project type versus project approach.

Table 19. Cross view between project type vs project approach

Project Type x Project Approach	**Hybrid**		**Traditional**		**Agile**		**Others**		**Total**	
	(#)	**(%)**	**(#)**	**(%)**	**(#)**	**%**	**(#)**	**(%)**	**(#)**	**%**
Application Development	30	19.2%	17	10.9%	12	7.7%	2	1.3%	61	39.1%
Application Management	9	5.8%	10	6.4%	2	1.3%	1	0.6%	22	14.1%
Data Management/Recovery	2	1.3%	2	1.3%	0	0.0%	1	0.6%	5	3.2%
IT Infrastructure Management	9	5.8%	11	7.1%	2	1.3%	2	1.3%	24	15.4%
Network Administration/Security	0	0.0%	2	1.3%	0	0.0%	0	0.0%	2	1.3%
Others	11	7.1%	10	6.4%	1	0.6%	3	1.9%	25	16.0%
Software Package (Off-The-Shelf)	9	5.8%	6	3.8%	2	1.3%	0	0.0%	17	10.9%
Total	**70**	**44.9%**	**58**	**37.2%**	**19**	**12.2%**	**9**	**5.8%**	**156**	**100.0%**

Source: created by the author

Considering the cross view between project net value versus project approach, most projects were managed by hybrid approach at a net value between 1 million and 5 million Euros (24 projects or 15.3% of total), followed by hybrid approach at a net value lower than 250 thousand Euros (17 projects or 10.8% of total), traditional approach at a net value between 1 million and 5 million Euros (16 projects or 10.3% of total), hybrid approach at a net value between 250 thousands and 1 million Euros (15 projects or 9.6% of total), by traditional approach at a net value between 250 thousands and 1 million Euros (12 projects or 7.6% of total) and by traditional approach at a net value lower than 250 thousands Euros (11 projects or 7.0% of total). These six groups represent 95 projects or 60.6% of total. Projects managed by traditional approach and at a net value bigger than 10 million Euros were also well represented (12 projects or 7.6% of total). Considering the cross view between project duration versus project approach, most projects were managed by traditional approach within 7 to 12 months (23 projects or 14.7%), followed by hybrid approach within 7 to 12 months (20 projects or 12.8%). Other many combinations between project duration and hybrid and traditional approaches varied between 9 and 12 projects. *Table 20* shows the cross view between project approach vs project duration vs project net value.

Table 20. Cross view between project approach vs project duration vs project net value

Project approach x duration x Net value	Hybrid		Traditional		Agile		Others		Total	
	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
1 to 6 months	**12**	**7.7%**	**6**	**3.8%**	**4**	**2.6%**	**0**	**0.0%**	**22**	**14.1%**
lower than 250k	7	4.5%	5	3.2%	3	1.9%	0	0.0%	15	9.6%
between 250k and 1M	2	1.3%	1	0.6%	1	0.6%	0	0.0%	4	2.6%
between 1M and 5M	3	1.9%	0	0.0%	0	0.0%	0	0.0%	3	1.9%
7 to 12 months	**20**	**12.8%**	**23**	**14.7%**	**2**	**1.3%**	**4**	**2.6%**	**49**	**31.4%**
lower than 250k	8	5.1%	3	1.9%	0	0.0%	2	1.3%	13	8.3%
between 250k and 1M	7	4.5%	10	6.4%	0	0.0%	2	1.3%	19	12.2%
between 1M and 5M	3	1.9%	7	4.5%	2	1.3%	0	0.0%	12	7.7%
between 5M and 10M	1	0.6%	2	1.3%	0	0.0%	0	0.0%	3	1.9%
bigger than 10M	1	0.6%	1	0.6%	0	0.0%	0	0.0%	2	1.3%
13 to 18 months	**10**	**6.4%**	**7**	**4.5%**	**2**	**1.3%**	**2**	**1.3%**	**21**	**13.5%**
lower than 250k	0	0.0%	2	1.3%	1	0.6%	0	0.0%	3	1.9%
between 250k and 1M	1	0.6%	0	0.0%	0	0.0%	0	0.0%	1	0.6%
between 1M and 5M	7	4.5%	3	1.9%	1	0.6%	2	1.3%	13	8.3%
between 5M and 10M	2	1.3%	2	1.3%	0	0.0%	0	0.0%	4	2.6%
19 to 24 months	**10**	**6.4%**	**9**	**5.8%**	**5**	**3.2%**	**0**	**0.0%**	**24**	**15.4%**
lower than 250k	1	0.6%	0	0.0%	0	0.0%	0	0.0%	1	0.6%
between 250k and 1M	4	2.6%	1	0.6%	1	0.6%	0	0.0%	6	3.8%
between 1M and 5M	3	1.9%	2	1.3%	3	1.9%	0	0.0%	8	5.1%
between 5M and 10M	2	1.3%	2	1.3%	0	0.0%	0	0.0%	4	2.6%
bigger than 10M	0	0.0%	4	2.6%	1	0.6%	0	0.0%	5	3.2%
25 to 30 months	**2**	**1.3%**	**2**	**1.3%**	**0**	**0.0%**	**0**	**0.0%**	**4**	**2.6%**
between 1M and 5M	1	0.6%	2	1.3%	0	0.0%	0	0.0%	3	1.9%
bigger than 10M	1	0.6%	0	0.0%	0	0.0%	0	0.0%	1	0.6%
31 to 36 months	**5**	**3.2%**	**1**	**0.6%**	**2**	**1.3%**	**0**	**0.0%**	**8**	**5.1%**
lower than 250k	0	0.0%	0	0.0%	1	0.6%	0	0.0%	1	0.6%
between 1M and 5M	3	1.9%	0	0.0%	0	0.0%	0	0.0%	3	1.9%
between 5M and 10M	2	1.3%	0	0.0%	0	0.0%	0	0.0%	2	1.3%
bigger than 10M	0	0.0%	1	0.6%	1	0.6%	0	0.0%	2	1.3%
> 36 months	**11**	**7.1%**	**10**	**6.4%**	**4**	**2.6%**	**3**	**1.9%**	**28**	**17.9%**
lower than 250k	1	0.6%	1	0.6%	0	0.0%	1	0.6%	3	1.9%
between 250k and 1M	1	0.6%	0	0.0%	0	0.0%	0	0.0%	1	0.6%
between 1M and 5M	4	2.6%	2	1.3%	2	1.3%	0	0.0%	8	5.1%
between 5M and 10M	2	1.3%	1	0.6%	1	0.6%	0	0.0%	4	2.6%
bigger than 10M	3	1.9%	6	3.8%	1	0.6%	2	1.3%	12	7.7%
Total	**70**	**44.9%**	**58**	**37.2%**	**19**	**12.2%**	**9**	**5.8%**	**156**	**100.0%**

Source: created by the author

4.7 Construct Reliability and Validity

The reliability and validity of the measurement model were verified for three different groups according to the specific objectives of this study: one-to-one constructs, many-to-one constructs and many-to-many constructs. It was performed by four stepwise analyses for the measurement model: convergent validity, composite reliability, internal consistency and discriminant validity.

1. Convergent validity was measured by the average variance extracted (AVEs) which is a portion of data (variables) that is explained by each construct and acceptable values are greater than 0.50 (AVE > 0.50) so each construct can explain more than half the variance of its measured variables on average (Fornell & Larcker, 1981).
2. Composite validity was measured by the composite reliability indicator ρ (Rho) of Dillon-Goldstein which prioritize the variables according to their reliabilities and acceptable values are greater than 0.70 ($\rho > 0.70$) (Hair Jr et al., 2017).
3. Internal consistency was measured by the Cronbach's alpha (α) coefficient which is based on the mutual relationship of variables and acceptable values are greater than 0.70 ($\alpha > 0.7$) (Hair Jr et al., 2017).
4. Discriminant validity means that the latent constructs or variables are independent of each other and was measured by two criteria: analyzing the cross loading that are indicators with higher factor loading in their respective constructs than in others (Chin, 1998) and by comparing the square roots of the AVE values of each construct which should be bigger than the correlations between the constructs (Fornell & Larcker, 1981).

Dependent variable: Project success was modeled as a second-order construct and includes project efficiency (four items), impact on the customer (seven items), impact on the project team (three items), business success (four items), and preparing for the future (four items) as its constitutive first-order constructs.

***Independent variables*:** Project risk management was modeled as a second-order construct and includes risk identification (three items), risk analysis (four items), risk response planning (four items), risk monitoring and control (three items), risk management culture (four items), and risk management process formalization (four items) as its constitutive first-order constructs. This study used multiple item reflective measures for all constructs.

4.8 Data Analysis

Partial least squares - structural equation modeling (PLS-SEM) was considered the most suitable data analysis method due to the research objective of identifying the relationship between project risk management dimensions and project success dimensions, the presence of many dependent variables (first-order constructs), and due to the small population (Ringle, Silva, & Bido, 2014), despite the achievement of the minimum sample requirement (see section 4.6.1). The software SmartPLS 3.2.7 was chosen to perform the evaluation of the measurement model and of the structural model.

This research followed the step-wise recommended by Ringle et al. (Ringle et al., 2014) and adopted the PLS Algorithm for the evaluation of measurement model and the R^2 with the following recommended set of parameters, namely "weighting scheme"=path, "maximum iterations"=1000 and "stop criterion (10^-X)"=7 (Hair Jr et al., 2017).

The evaluation of the structural model was followed by three stepwise analyses. First, the structural model analysis considered the Pearson coefficient of determination (R Squared or R^2) which gives the percentage variation in the dependent variable explained by independent variables and indicates the quality of the adjusted model. For the social and behavioral science field, R^2=2% means minor effect, R^2=13% means medium effect and R^2=26% means significant effect (Cohen, 1988).

Second, the analysis evaluated if the correlations are significant ($p \leq 0.05$ or test-t > 1.96) and it was performed by bootstrapping analysis which is a test that relies on random sampling. This study used the recommended set of parameters for the bootstrapping, namely "sign changes"= individual changes, "subsample"=1000, "significance level"= 0.05, and "test type"= two tails (Hair Jr et al., 2017).

Lastly, the analysis evaluated the values of two quality indicators, predictive validity (Q^2) - Stone-Geisser indicator and effect size (f^2) - Cohen indicator. The former assess how much the model predict what was expected of it and values greater than zero should be obtained as evaluation criterion. A perfect model would have $Q^2=1$ that means the model reflects the reality perfectly. The latter assess how much each construct is "useful" for model adjustment. Values of 0.02, 0.15 and 0.35 are considered small, medium and large, respectively (Hair Jr et al., 2017). Both values are obtained by blindfolding analysis with default values. Next chapter presents the results of the data analysis according to the four-steps described in the section 4.7 and according to the three steps described in this section. *Figure 23* shows the summary of adjustment of measurement model and structural model.

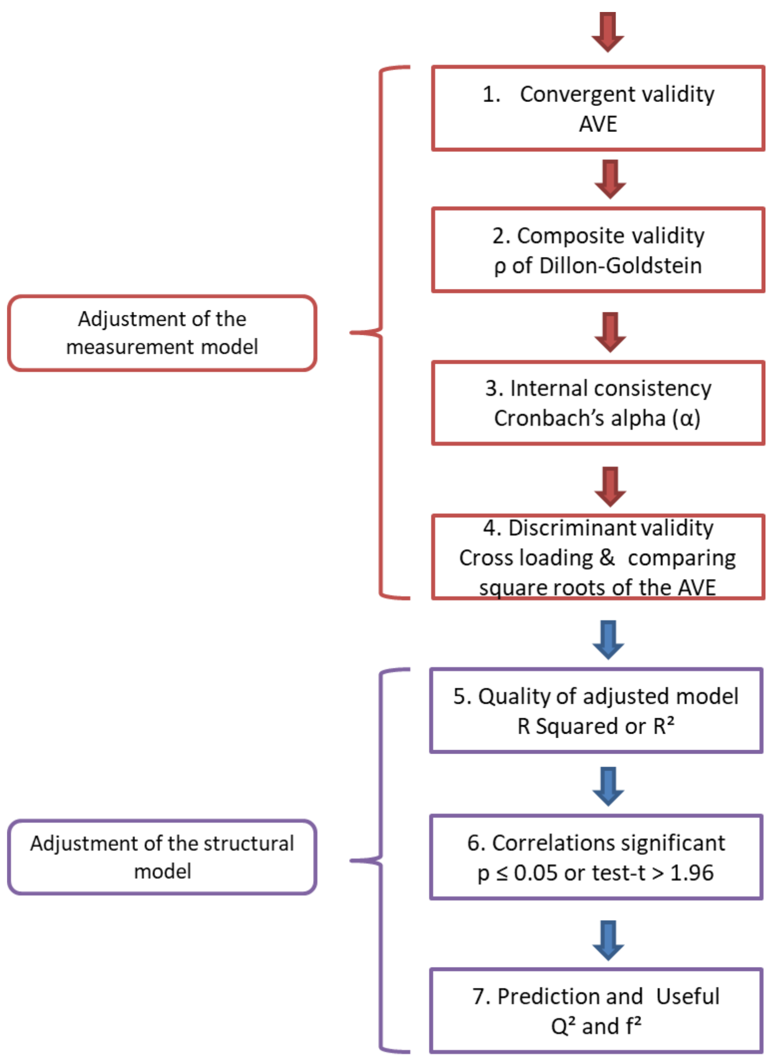

Figure 23. Summary of the adjustment of measurement model and structural model

Source: created by the author

5 RESULTS

This chapter presents three main sections, each one describing the adjustment of the measurement model and of the structural model for the three different groups according to the specific objectives of this study: one-to-one constructs, many-to-one constructs and many-to-many constructs. The sequence of the content follows the proposed in the previous *Figure 23*.

5.1 Second-Order Constructs (One-to-One)

This section is related to the relationship between the second-order constructs project risk management and project success and, consequently, the hypothesis H1 - The project risk management influences positively the project success. For the sake of this section, the term “one-to-one constructs” used here and onwards is related to this relationship.

5.1.1 Adjustment of the measurement model of the one-to-one constructs

First, the PLS Algorithm was loaded over the original proposed model. *Figure 24* shows the measurement model with the values of the correlations between the manifest variables (MV) and the latent variables (LV), the R^2 of each dependent variable and the coefficient of linear regression between each LV. In this current work, I am using the nomenclature suggested by (Hair Jr et al., 2017), when LV is in independent position of the SEM, I use the term exogenous construct. When the LV is in a dependent position of the SEM, I used the term endogenous construct. So, in this work, the use of term Latent Variable (LV) it means synonymous of the term construct. In accord of the position in the SEM, this LV will be exogenous (independent position) or endogenous (dependent position). Hence, the items of the measuring those constructs I am denominating by indicators (I) or also manifest variable (MV) as synonymous. The value of AVE was below the recommend threshold of 0.50 for the construct Project Success (PS) (AVE=0.435). *Table 21* shows the outcomes of the original model for AVE, composite reliability, R square, R square adjusted and Cronbach’s alpha.

Following the step-wise recommended by Ringle et al. (Ringle et al., 2014), this study removed manifest variables of each latent construct with AVE below 0.50, one by one, reloading the PLS Algorithm. AVE is the mean of factor loadings squared, thus in order to increase the value of AVE, variables with factor loadings (correlations) of lower value must be removed. Manifest variables PF2 (factor loading=0.335), PF3 (factor loading=0.434), PF4 (factor loading=0.493), BS4 (factor loading=0.525) and IC4 (factor loading=0.573) were removed until all values of AVE, composite reliability and Cronbach's alpha (α) were above the recommend threshold, respectively, 0.50, 0.70 and 0.70. *Table 22* shows the outcomes of the adjusted model for AVE, composite reliability, R square, R square adjusted and Cronbach's alpha and *Figure 25* shows the path final adjusted model of the one-to-one constructs.

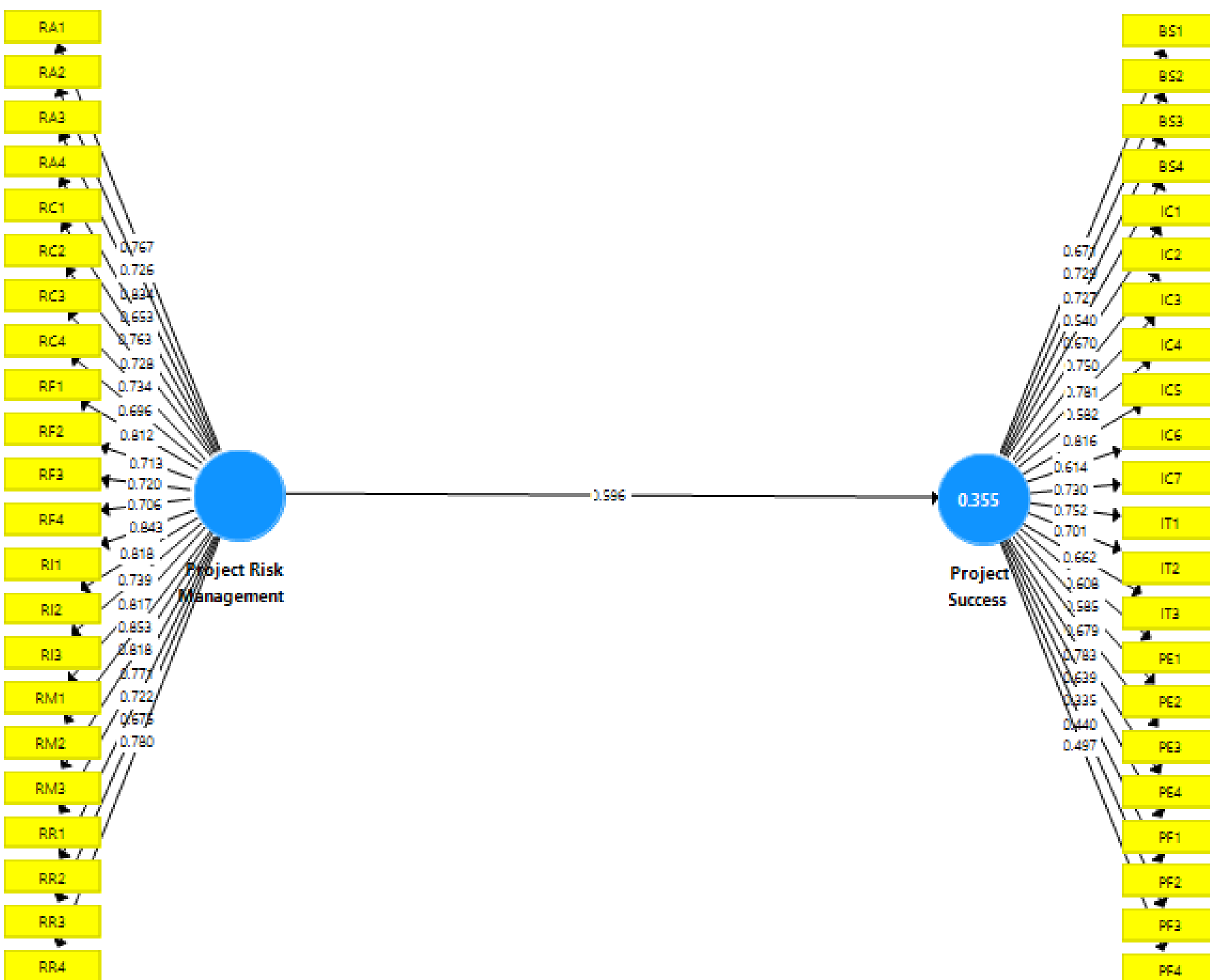

Figure 24. Path model of the one-to-one constructs (original model)

Source: created by the author

Table 21. Quality criteria of the one-to-one constructs (original model)

Second-order constructs	AVE	Composite Reliability	R Square	R Square Adjusted	Cronbach's Alpha
Project Success	**0.435**	0.943	0.355	0.351	0.936
Project Risk Management	0.578	0.968			0.965

Source: created by the author

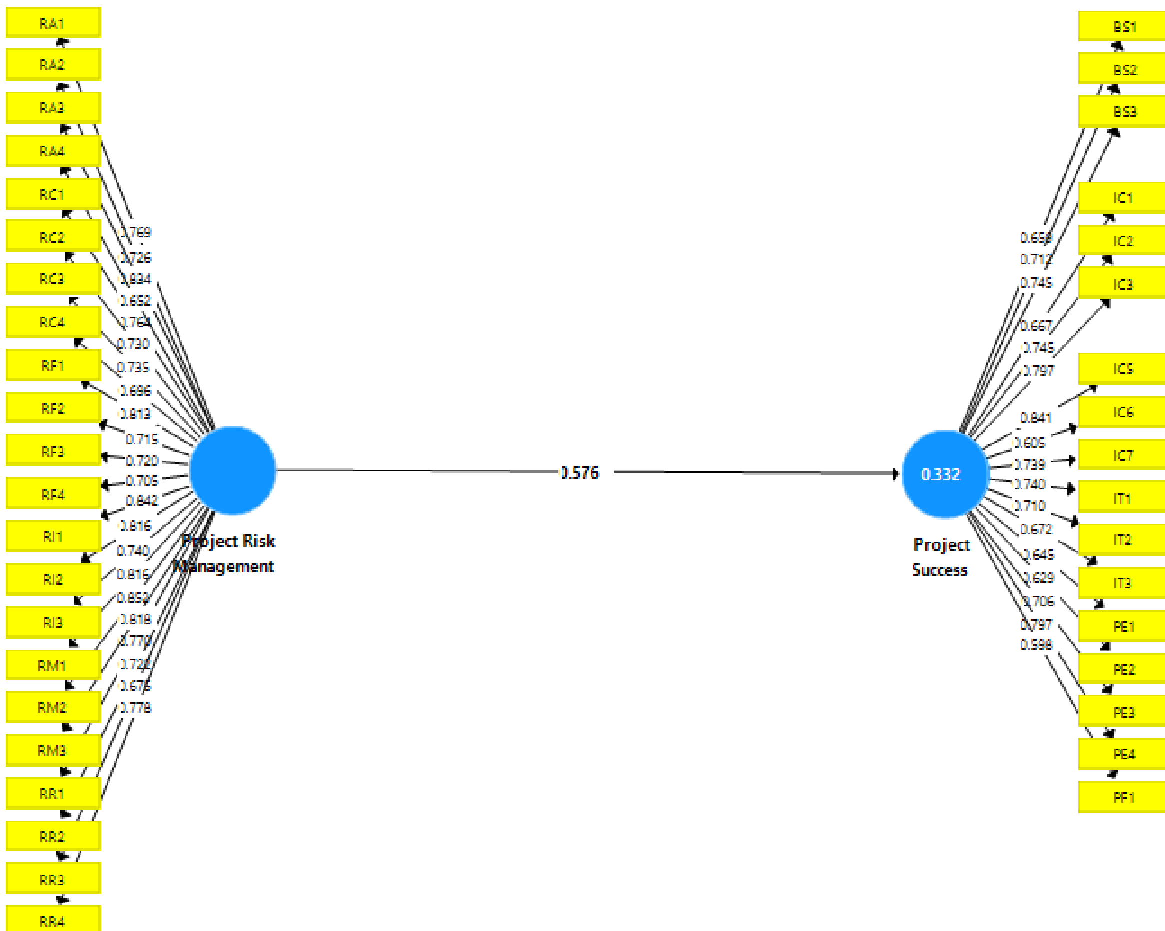

Figure 25. Path model of the one-to-one constructs (final adjusted model)

Source: created by the author

Table 22. Quality criteria of the one-to-one constructs (final adjusted model)

Second-order constructs	**AVE**	**Composite Reliability**	**R Square**	**R Square Adjusted**	**Cronbach's Alpha**
Project Success	0.503	0.945	0.332	0.328	0.937
Project Risk Management	0.578	0.968			0.965

Source: created by the author

The discriminant validity assessed by the cross loading showed that factor loadings of each manifest variable is higher on its associated construct than on other constructs (see *Table 24*). The discriminant validity assessed by comparing the square roots of the AVE values of each construct concerning the correlations between the constructs showed that square roots of the AVE values of all constructs were bigger than the correlations between them (see *Table 23*).

Table 23. Fornell-Larker criterion of the one-to-one constructs (final adjusted model)

	PRM	**PS**
PRM	0.761	
PS	0.576	0.709

Source: created by the author

Table 24. Cross loading results of the one-to-one constructs (final adjusted model)

Manifest variables X Second-order constructs	PRM	PS
BS1	0.411	0.659
BS2	0.418	0.712
BS3	0.425	0.745
IC1	0.322	0.667
IC2	0.403	0.745
IC3	0.349	0.797
IC5	0.451	0.841
IC6	0.274	0.605
IC7	0.331	0.739
IT1	0.461	0.740
IT2	0.436	0.710
IT3	0.440	0.672
PE1	0.346	0.645
PE2	0.378	0.629
PE3	0.352	0.706
PE4	0.596	0.797
PF1	0.376	0.598
RA1	0.769	0.455
RA2	0.726	0.413
RA3	0.834	0.388
RA4	0.652	0.275
RC1	0.764	0.479
RC2	0.730	0.479
RC3	0.735	0.459
RC4	0.696	0.418
RF1	0.813	0.425
RF2	0.715	0.362
RF3	0.720	0.315
RF4	0.705	0.352
RI1	0.842	0.468
RI2	0.816	0.422
RI3	0.740	0.352
RM1	0.816	0.496
RM2	0.852	0.515
RM3	0.818	0.417
RR1	0.770	0.400
RR2	0.722	0.459
RR3	0.675	0.536
RR4	0.778	0.539

Source: created by the author

5.1.2 Adjustment of the structural model of the one-to-one constructs

After the adjustment of the measurement model, the next step is the analysis of the structural model. As described in the section 4.8, the analysis considered first the Pearson coefficient of determination (R^2) and *Table 22* shows that R^2 is above 26% which means a significant effect (Cohen, 1988) on the dependent variables. Second, bootstrapping analysis was carried out to evaluated if the correlation are significant ($p \leq 0.05$ or test-t > 1.96) and *Table 25* shows that test-t value is bigger than 1.96 and p-value is lower than 0.05.

Table 25. Path coefficients of the one-to-one constructs (final adjusted model)

Path coefficients	Original Sample	Sample Mean	Standard Deviation	Test-t	P Values
Project Risk Management -> Project Success	0.576	0.592	0.052	11.036	0.000

Source: created by the author

Moreover, the quality indicators predictive validity (Q^2) and Effect Size (f^2) of the adjusted model were assessed and *Table 26* shows that Q^2 value is greater than zero and f^2 values are bigger than 0.3, so both are satisfactory.

Table 26. Quality indicators Q^2 and f^2 of the one-to-one constructs (final adjusted model)

First-order constructs	Q^2	f^2
Project Success	0.147	0.416
Project Risk Management		0.507

Source: created by the author

5.2 First-Order Constructs and Second-Order Construct (Many-to-One)

This section is related to the relationships between the first-order constructs of Project Risk Management (PRM), concerning the test for relationship of the each dimension, and the second-order construct Project Success (PS) and, consequently, to the hypotheses H2 - Project risk identification is positively related to the project success, H3 - Project risk analysis is positively related to the project success, H4 - Project risk response planning is positively related to the project success, H5 - Project risk monitoring and control is positively related to the project success, H6 - Project risk management culture is positively related to the project success and H7 - Project risk management process formalization is positively related to the project success. For the sake of this section, the term “many-to-one constructs” used here and onwards is related to these relationships.

5.2.1 Adjustment of the measurement model of the many-to-one constructs

First, the PLS Algorithm was loaded over the original proposed model. *Figure 26* shows the measurement model with the values of the correlations between the manifest variables (MV) and the latent variable (LV), the R^2 of the LV project success and the coefficient of linear regression between each LV. The values of AVE were all above the recommend threshold of 0.50, except for the second-order construct Project Success (PS) (AVE=0.436). *Table 21* shows the outcomes of the original model for AVE, composite reliability, R square, R square adjusted and Cronbach’s alpha.

Following the step-wise recommended by Ringle et al. (Ringle et al., 2014), this study removed manifest variables of each latent construct with AVE below 0.50, one by one, reloading the PLS Algorithm. AVE is the mean of factor loadings squared, thus in order to increase the value of AVE, variables with factor loadings (correlations) of lower value should be removed. Manifest variables PF2 (factor loading=0.347), PF3 (factor loading=0.439), PF4 (factor loading=0.490), BS4 (factor loading=0.530) and IC4 (factor loading=0.581) were removed until all values of AVE, composite reliability and Cronbach’s alpha (α) were above the recommend threshold, respectively, 0.50, 0.70 and 0.70. *Table 28* shows the outcomes of the adjusted model for AVE, composite reliability, R square, R square adjusted and Cronbach’s alpha. *Figure 27* shows the path draft adjusted model of the many-to-one constructs.

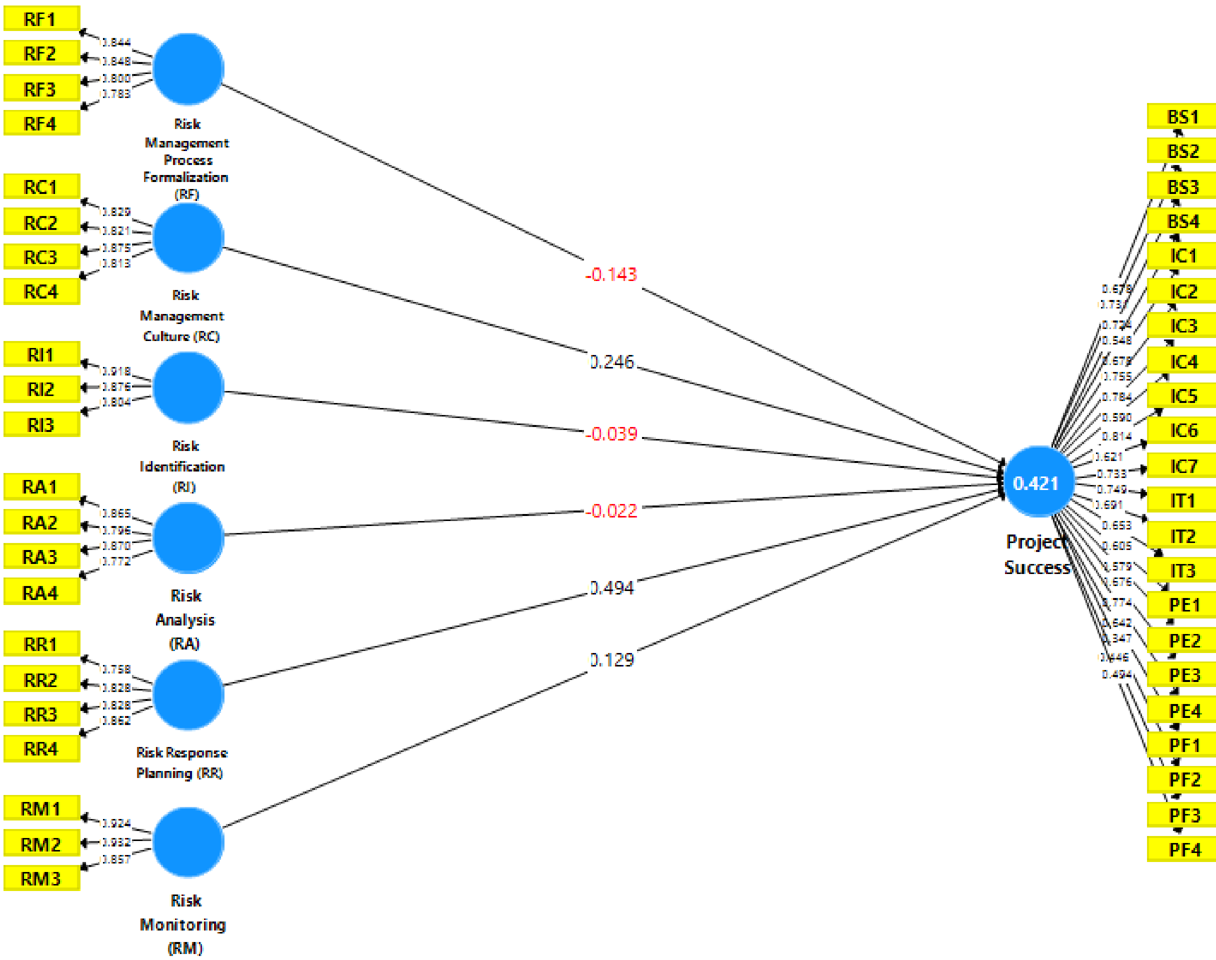

Figure 26. Path model of the many-to-one constructs (original model)

Source: created by the author

Table 27. Quality criteria for many-to-one constructs (original model)

First-order constructs vs Second-order construct	AVE	Composite Reliability	R Square	R Square Adjusted	Cronbach's Alpha
Project Success (PS)	**0.436**	0.943	0.421	0.397	0.936
Risk Analysis (RA)	0.683	0.896	-	-	0.847
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Identification (RI)	0.752	0.901	-	-	0.835
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.671	0.891	-	-	0.837
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

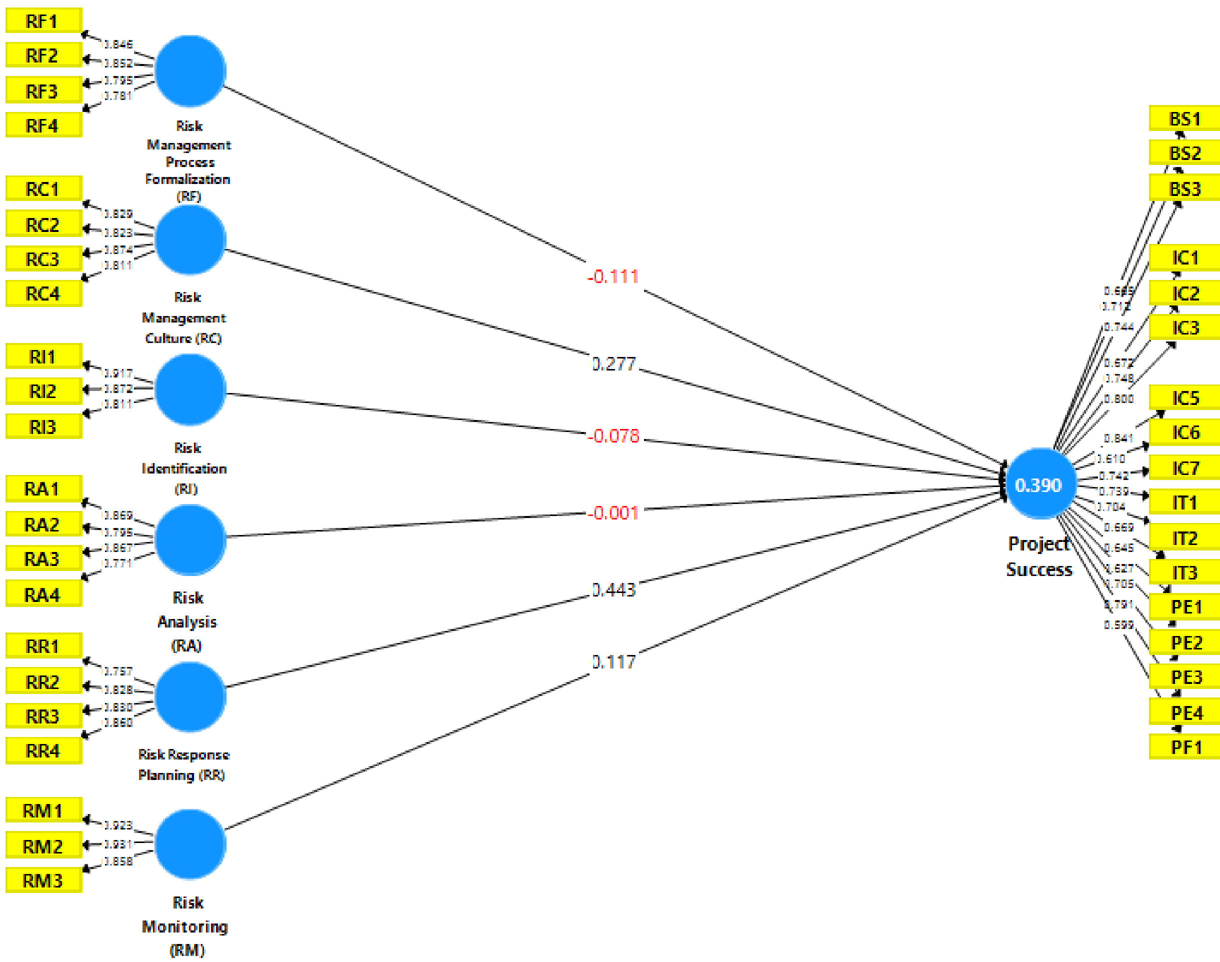

Figure 27. Path model of the many-to-one constructs (adjusted model – first draft)

Source: created by the author

Table 28. Quality criteria for many-to-one constructs (adjusted model – first draft)

First-order constructs vs Second-order construct	AVE	Composite Reliability	R Square	R Square Adjusted	Cronbach's Alpha
Project Success (PS)	0.504	0.945	0.390	0.366	0.937
Risk Analysis (RA)	0.683	0.896	-	-	0.847
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Identification (RI)	0.753	0.901	-	-	0.835
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.671	0.891	-	-	0.837
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

The discriminant validity assessed by the cross loading showed that the factor loadings of each manifest variable is higher on its associated construct than on other constructs (see *Table 31*). The discriminant validity assessed by comparing the square roots of the AVE values of each construct in regard to the correlations between the constructs showed that square roots of the AVE values of all constructs were bigger than the correlations between the constructs, except for four cases, risk analysis vs risk identification, risk analysis vs risk management process formalization, risk identification vs risk monitoring, and risk identification vs risk management process formalization (see *Table 29*). Although all differences are lower than 3.19%, a priori, this study applied a more rigorous approach, removing other manifest variables that have smaller differences in the cross loads factoring between the two latent variables. Manifest variables RA3, RI1, RI2 and RI3 were removed, one by one, comparing again as described previously. The outcome showed that square roots of the AVE values of all constructs were bigger than the correlations between the constructs (see *Table 30*). *Figure 28* shows the final adjusted measurement model.

Table 29. Fornell-Larker criterion of many-to-one constructs (adjusted model – first draft)

	PS	**RA**	**RC**	**RI**	**RM**	**RF**	**RR**
PS	0.710						
RA	0.470	0.827					
RC	0.548	0.736	0.835				
RI	0.478	**0.836**	0.712	0.868			
RM	0.526	0.756	0.767	**0.877**	0.905		
RF	0.444	**0.846**	0.765	**0.838**	0.773	0.819	
RR	0.595	0.762	0.726	0.787	0.793	0.719	0.820

Source: created by the author

Table 30. Fornell-Larker criterion of many-to-one constructs (final adjusted model)

	PS	RA	RC	RM	RF	RR
PS	0.710					
RA	0.472	0.826				
RC	0.549	0.712	0.835			
RM	0.526	0.703	0.767	0.905		
RF	0.445	0.806	0.765	0.773	0.819	
RR	0.595	0.739	0.726	0.793	0.719	0.820

Source: created by the author

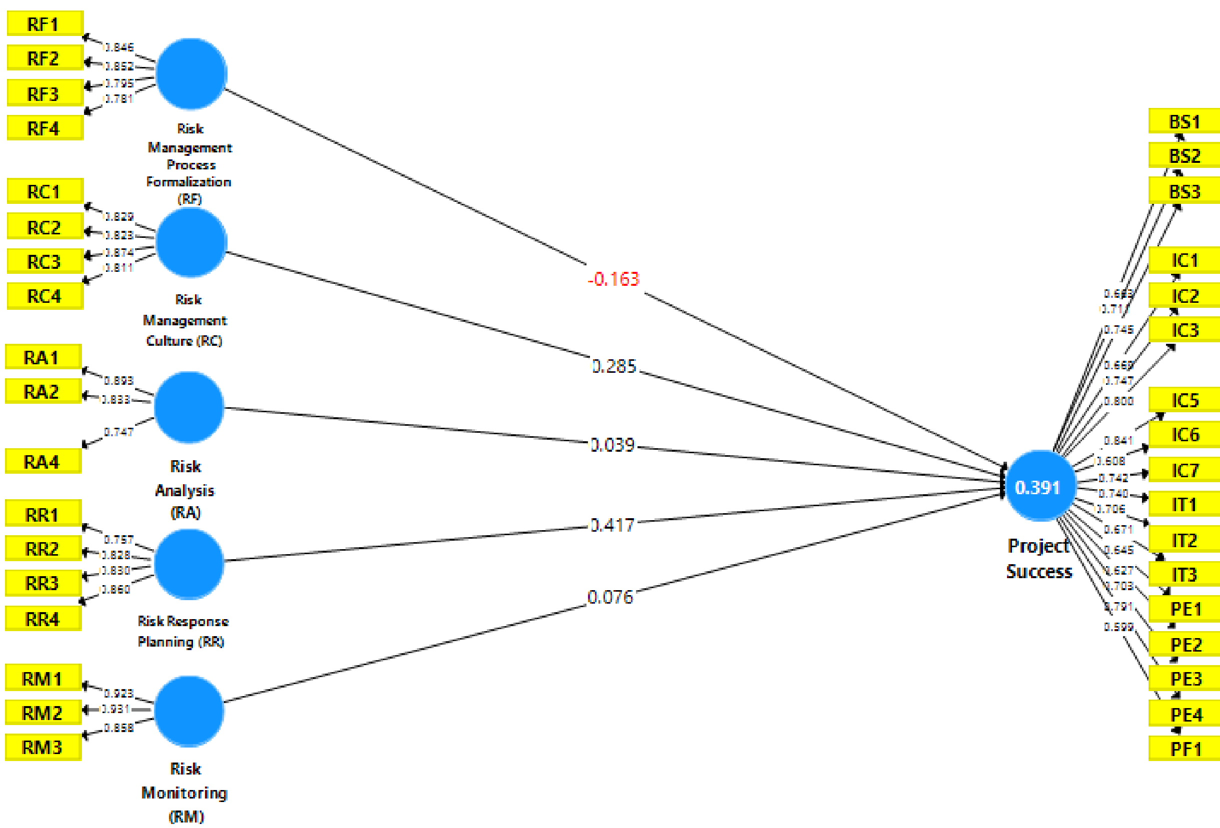

Figure 28. Path model of the many-to-one constructs (adjusted model – second draft)

Source: created by the author

Table 31. Cross loading results of the many-to-one constructs (adjusted model – first draft)

	PS	RA	RC	RI	RM	RF	RR
BS1	0.665	0.313	0.399	0.294	0.387	0.318	0.466
BS2	0.712	0.312	0.363	0.398	0.436	0.330	0.413
BS3	0.744	0.388	0.406	0.345	0.397	0.300	0.433
IC1	0.672	0.194	0.236	0.306	0.375	0.229	0.385
IC2	0.748	0.284	0.358	0.386	0.406	0.264	0.454
IC3	0.800	0.278	0.359	0.304	0.325	0.239	0.359
IC5	0.841	0.380	0.464	0.353	0.390	0.329	0.481
IC6	0.610	0.183	0.202	0.212	0.315	0.223	0.330
IC7	0.742	0.252	0.277	0.275	0.331	0.239	0.391
IT1	0.739	0.450	0.421	0.367	0.379	0.342	0.500
IT2	0.704	0.388	0.514	0.343	0.365	0.363	0.359
IT3	0.669	0.428	0.505	0.321	0.332	0.350	0.405
PE1	0.645	0.246	0.338	0.297	0.307	0.277	0.379
PE2	0.627	0.304	0.371	0.305	0.283	0.354	0.403
PE3	0.705	0.218	0.331	0.294	0.359	0.315	0.368
PE4	0.791	0.541	0.543	0.530	0.551	0.497	0.551
PF1	0.599	0.329	0.352	0.320	0.325	0.285	0.401
RA1	0.451	0.869	0.629	0.666	0.627	0.710	0.672
RA2	0.410	0.795	0.639	0.627	0.565	0.670	0.637
RA3	0.384	0.867	0.658	0.815	0.746	0.790	0.680
RA4	0.270	0.771	0.472	0.673	0.556	0.619	0.497
RC1	0.475	0.648	0.829	0.704	0.689	0.685	0.575
RC2	0.477	0.629	0.823	0.566	0.621	0.628	0.636
RC3	0.456	0.590	0.874	0.549	0.653	0.649	0.613
RC4	0.415	0.585	0.811	0.551	0.591	0.587	0.597
RF1	0.423	0.743	0.685	0.753	0.708	0.846	0.693
RF2	0.359	0.697	0.647	0.620	0.551	0.852	0.538
RF3	0.310	0.695	0.578	0.739	0.650	0.795	0.507
RF4	0.349	0.633	0.584	0.633	0.619	0.781	0.593
RI1	0.465	0.733	0.655	0.917	0.844	0.727	0.724
RI2	0.418	0.753	0.652	0.872	0.747	0.743	0.694
RI3	0.349	0.692	0.537	0.811	0.677	0.719	0.626
RM1	0.494	0.682	0.670	0.781	0.923	0.681	0.696
RM2	0.511	0.687	0.708	0.841	0.931	0.703	0.754
RM3	0.416	0.687	0.710	0.755	0.858	0.723	0.704
RR1	0.397	0.731	0.624	0.682	0.652	0.715	0.757
RR2	0.458	0.594	0.574	0.637	0.648	0.586	0.828
RR3	0.537	0.572	0.587	0.552	0.557	0.489	0.830
RR4	0.539	0.634	0.606	0.728	0.752	0.607	0.860

Source: created by the author

5.2.2 Adjustment of the structural model of the many-to-one constructs

After the adjustment of the measurement model, the next step is the analysis of the structural model. As described in the section 4.8, the analysis considered first the Pearson coefficient of determination (R^2). Due to removal of four variables from the model, it is expected new values for AVE, composite reliability, R square, R square adjusted and Cronbach's alpha. *Table 32* shows that all values of AVE, composite reliability and Cronbach's alpha (α) are above the recommend threshold, respectively, 0.50, 0.70 and 0.70. Moreover, R^2 is above 26% which means a significant effect (Cohen, 1988) on the dependent variables.

Table 32. Quality criteria for many-to-one constructs (adjusted model – second draft)

First-order constructs vs Second-order construct	**AVE**	**Composite Reliability**	**R Square**	**R Square Adjusted**	**Cronbach's Alpha**
Project Success (PS)	0.503	0.945	0.391	0.370	0.937
Risk Analysis (RA)	0.683	0.865	-	-	0.771
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.671	0.891	-	-	0.837
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

Second, bootstrapping analysis was carried out to evaluated if the correlation are significant ($p \leq 0.05$ or test-t > 1.96) and *Table 33* shows that all test-t values are bigger than 1.96 and all p-values are lower than 0.05 for two hypotheses that remained in the model, after several iterations. *Figure 29* shows the third draft version of the adjusted measurement model.

Table 33. Path coefficients of the many-to-one constructs (final adjusted model)

	Original Sample	**Sample Mean**	**Standard Deviation**	**Test-t**	**P Values**
Risk Management Culture (RC) -> Project Success (PS)	0.247	0.253	0.111	2.224	0.026
Risk Response Planning (RR) -> Project Success (PS)	0.416	0.423	0.101	4.118	0.000

Source: created by the author

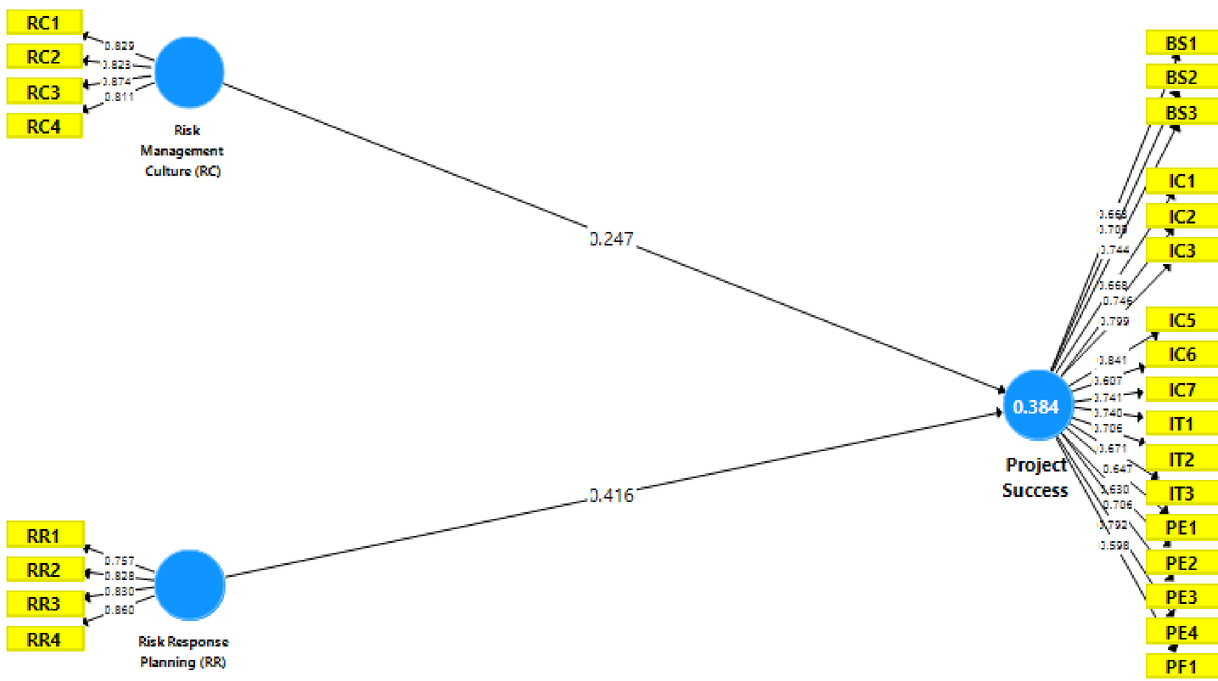

Figure 29. Path model of the many-to-one constructs (final adjusted model)

Source: created by the author

5.3 First-Order Constructs (Many-to-Many)

This section is related to the relationships between the first-order constructs of Project Risk Management (PRM) and the first-order constructs of Project Success (PS) and, consequently, to the hypotheses H2a, H2b, H2c, H2d, H2e, H3a, H3b, H3c, H3d, H3e, H4a, H4b, H4c, H4d, H4e, H5a, H5b, H5c, H5d, H5e, H6a, H6b, H6c, H6d, H6e, H7a, H7b, H7c, H7d and H7e. For the sake of this section, the term "many-to-many constructs" used here and onwards is related to these relationships.

5.3.1 Adjustment of the measurement model of the many-to-many constructs

First, the PLS Algorithm was loaded over the original proposed model. *Figure 30* shows the measurement model with the values of the correlations between the manifest variables (MV) and the latent variable (LV), the R^2 of each dependent variable and the coefficient of linear regression between each LV. The values of AVE were all above the recommend threshold of 0.50, except for the construct Preparing for the Future (PF) (AVE=0.483). *Table 34* shows the outcomes of the original model for AVE, composite reliability, R square, R square adjusted and Cronbach's alpha.

Following the step-wise recommended by Ringle et al. (Ringle et al., 2014), this study removed manifest variables of each latent construct with AVE below 0.50, one by one, reloading the PLS Algorithm. AVE is the mean of factor loadings squared, thus in order to increase the value of AVE, variables with factor loadings (correlations) of lower value should be removed. The first manifest variable removed was PF2 (factor loading=0.529). All values of AVE were above the recommend threshold of 0.50, but the values of Cronbach's alpha (α) were all above the recommend threshold of 0.70, expect for the construct preparing for the future (PF) (α =0.622). Two other manifest variable were removed, PF1 (factor loading=0.6000) and PF3 (factor loading=0.751) until all values of AVE, composite reliability and Cronbach's alpha (α) were above the recommend threshold, respectively, 0.50, 0.70 and 0.70. *Table 35* shows the outcomes of the adjusted model for AVE, composite reliability, R square, R square adjusted and Cronbach's alpha.

Since the first-order construct Preparing for the Future (PF) remained with only one manifest variable (PF4), we decided to remove this variable and consequently this first-order construct due to the fact that this only one does not represent properly this construct for the purpose of this study. *Figure 31* shows the first draft of the adjusted measurement model.

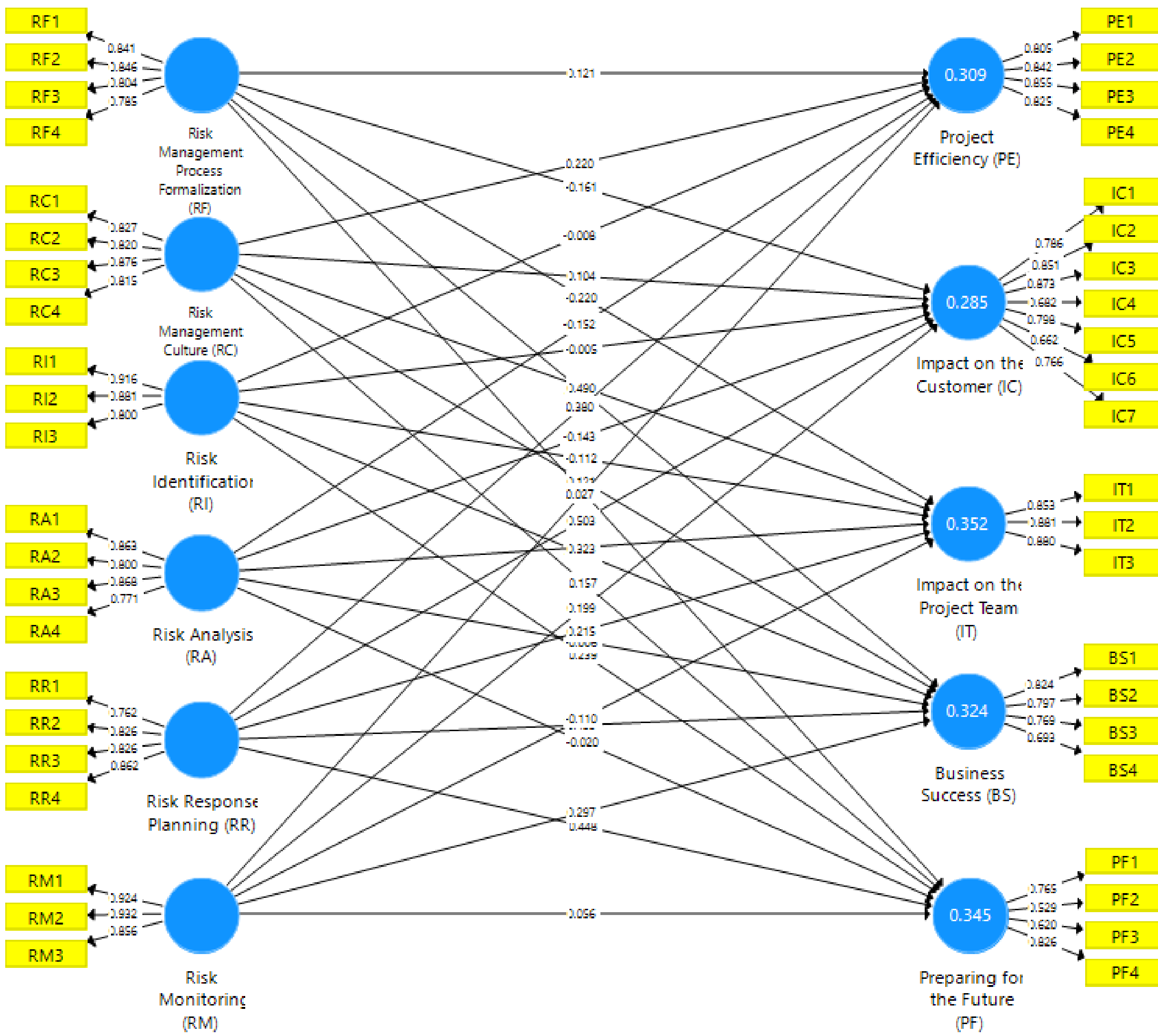

Figure 30. Path model of the many-to-many constructs (original model)

Source: created by the author

Table 34. Quality criteria of the many-to-many constructs (original model)

First-order constructs	**AVE**	**Composite Reliability**	**R Square**	**R Square Adjusted**	**Cronbach's Alpha**
Business Success (BS)	0.597	0.855	0.324	0.297	0.774
Impact on the Customer (IC)	0.605	0.914	0.285	0.256	0.889
Impact on the Project Team (IT)	0.759	0.904	0.352	0.326	0.841
Preparing for the Future (PF)	**0.483**	0.784	0.345	0.319	**0.680**
Project Efficiency (PE)	0.692	0.900	0.309	0.281	0.854
Risk Analysis (RA)	0.683	0.896	-	-	0.847
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Identification (RI)	0.752	0.901	-	-	0.835
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.671	0.891	-	-	0.837
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

Table 35. Quality criteria of the many-to-many constructs (adjusted model – first draft)

First-order constructs	**AVE**	**Composite Reliability**	**R Square**	**R Square Adjusted**	**Cronbach's Alpha**
Business Success (BS)	0.597	0.855	0.325	0.297	0.774
Impact on the Customer (IC)	0.605	0.914	0.284	0.255	0.889
Impact on the Project Team (IT)	0.759	0.904	0.354	0.328	0.841
Project Efficiency (PE)	0.692	0.900	0.308	0.281	0.854
Risk Analysis (RA)	0.682	0.895	-	-	0.847
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Identification (RI)	0.753	0.901	-	-	0.835
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.671	0.891	-	-	0.837
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

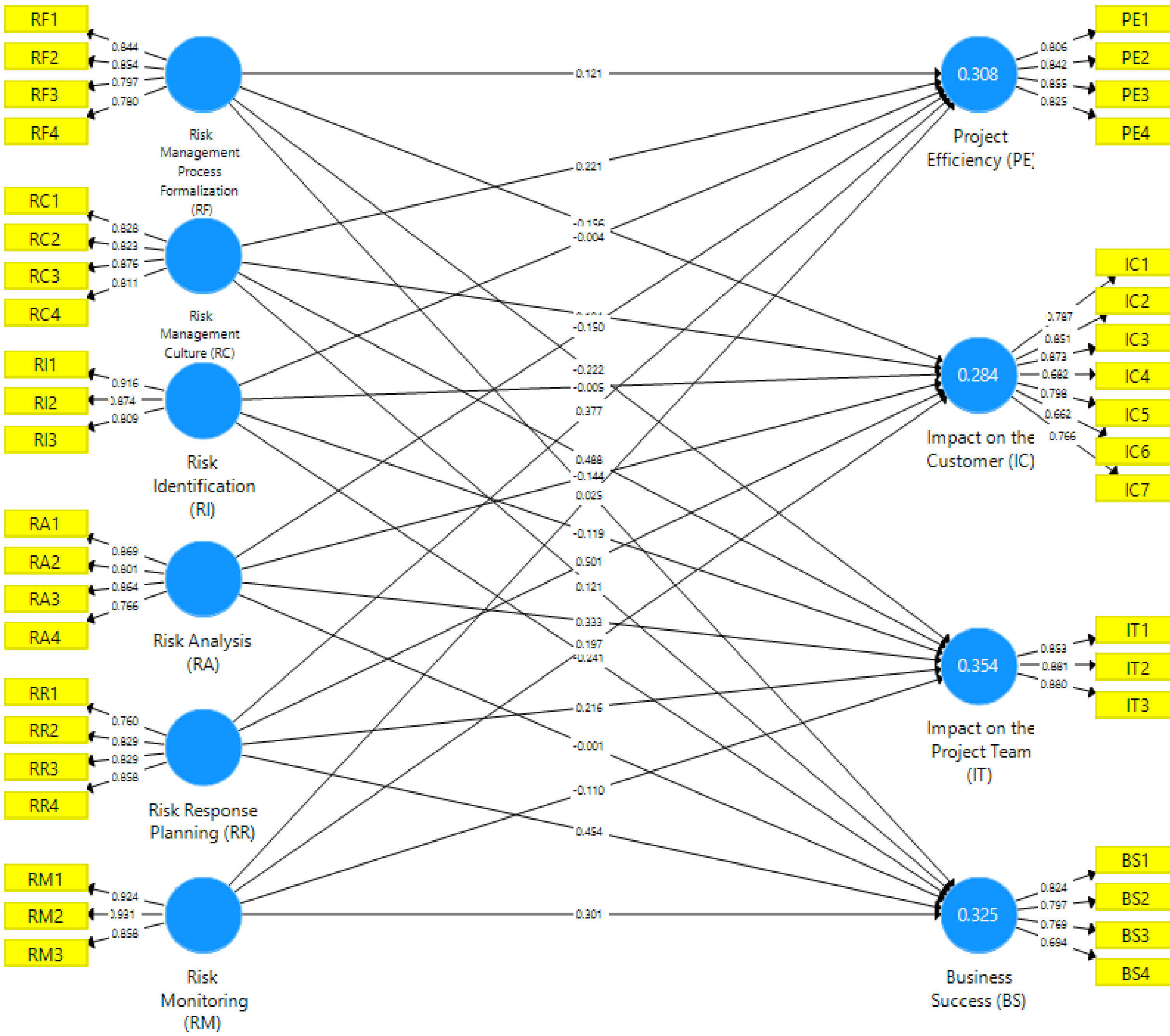

Figure 31. Path model of the many-to-many constructs (adjusted model – first draft)

Source: created by the author

The discriminant validity assessed by the cross loading showed that the factor loadings of each manifest variable is higher on its associated construct than on other constructs (see *Table 38*). The discriminant validity assessed by comparing the square roots of the AVE values of each construct in regard to the correlations between the constructs showed that square roots of the AVE values of all constructs were bigger than the correlations between the constructs, except for five cases, business success x impact on the customer, risk analysis x risk identification, risk analysis x risk management process formalization, risk identification x risk monitoring, and risk identification x risk management process formalization (see *Table 36*). Although all differences are lower than 2.36%, a priori, this study applied a more rigorous approach, removing other manifest variables that have smaller differences in the cross loads factoring between the two latent variables. Manifest variables RF3, RI3 and IC6 were removed, one by one, comparing again as described previously. The outcome showed that square roots of the AVE values of all constructs were bigger than the correlations between the constructs (see *Table 37*). *Figure 32* shows the first draft of the adjusted measurement model.

Table 36. Fornell-Larker criterion of many-to-many constructs (adjusted model – first draft)

	BS	IC	IT	PE	RA	RC	RI	RM	RF	RR
BS	0.772									
IC	**0.776**	0.778								
IT	0.605	0.615	0.871							
PE	0.575	0.710	0.605	0.832						
RA	0.405	0.329	0.487	0.418	0.826					
RC	0.458	0.390	0.551	0.493	0.736	0.835				
RI	0.410	0.386	0.394	0.448	**0.835**	0.712	0.867			
RM	0.491	0.441	0.411	0.470	0.755	0.767	**0.876**	0.905		
RF	0.383	0.310	0.404	0.450	**0.846**	0.765	**0.838**	0.772	0.819	
RR	0.542	0.507	0.484	0.526	0.764	0.726	0.788	0.793	0.719	0.820

Source: created by the author

Table 37. Fornell-Larker criterion of many-to-many constructs (adjusted model – second draft)

	BS	IC	IT	PE	RA	RC	RI	RM	RF	RR
BS	0.772									
IC	0.755	0.802								
IT	0.605	0.608	0.871							
PE	0.576	0.719	0.606	0.832						
RA	0.405	0.332	0.487	0.419	0.826					
RC	0.459	0.397	0.551	0.493	0.736	0.835				
RI	0.422	0.390	0.410	0.431	0.802	0.707	0.925			
RM	0.491	0.433	0.411	0.470	0.755	0.767	0.863	0.905		
RF	0.395	0.313	0.399	0.448	0.822	0.760	0.757	0.745	0.844	
RR	0.542	0.504	0.484	0.526	0.764	0.726	0.769	0.793	0.726	0.820

Source: created by the author

Table 38. Cross loading results of the many-to-many constructs (adjusted model – first draft)

OB x LV	BS	IC	IT	PE	RA	RC	RI	RM	RF	RR
BS1	0.824	0.606	0.422	0.439	0.314	0.400	0.294	0.387	0.317	0.466
BS2	0.797	0.708	0.451	0.485	0.311	0.363	0.398	0.436	0.330	0.411
BS3	0.769	0.620	0.617	0.564	0.390	0.406	0.345	0.397	0.300	0.432
BS4	0.694	0.449	0.371	0.260	0.224	0.222	0.224	0.285	0.228	0.355
IC1	0.637	0.787	0.360	0.453	0.193	0.236	0.305	0.375	0.228	0.383
IC2	0.597	0.851	0.434	0.614	0.284	0.358	0.386	0.406	0.264	0.453
IC3	0.629	0.873	0.536	0.657	0.278	0.359	0.303	0.325	0.239	0.358
IC4	0.467	0.682	0.332	0.430	0.172	0.162	0.221	0.212	0.134	0.326
IC5	0.670	0.798	0.656	0.724	0.381	0.463	0.353	0.390	0.328	0.480
IC6	0.602	0.662	0.417	0.388	0.183	0.202	0.212	0.315	0.222	0.329
IC7	0.604	0.766	0.577	0.535	0.254	0.277	0.274	0.331	0.239	0.390
IT1	0.607	0.606	0.853	0.526	0.452	0.421	0.368	0.379	0.342	0.500
IT2	0.521	0.532	0.881	0.539	0.389	0.515	0.343	0.365	0.363	0.360
IT3	0.459	0.475	0.880	0.519	0.431	0.505	0.321	0.332	0.350	0.406
PE1	0.436	0.521	0.475	0.806	0.247	0.339	0.297	0.307	0.277	0.380
PE2	0.331	0.516	0.458	0.842	0.305	0.371	0.305	0.283	0.355	0.403
PE3	0.503	0.618	0.444	0.855	0.219	0.331	0.294	0.359	0.315	0.368
PE4	0.599	0.674	0.599	0.825	0.541	0.543	0.530	0.551	0.497	0.551
RA1	0.387	0.321	0.469	0.392	0.869	0.629	0.666	0.627	0.710	0.672
RA2	0.346	0.251	0.500	0.354	0.801	0.638	0.628	0.565	0.670	0.639
RA3	0.361	0.304	0.319	0.343	0.864	0.658	0.815	0.746	0.790	0.681
RA4	0.200	0.180	0.263	0.265	0.766	0.472	0.673	0.556	0.619	0.499
RC1	0.366	0.369	0.441	0.464	0.647	0.828	0.704	0.689	0.685	0.576
RC2	0.438	0.341	0.475	0.397	0.629	0.823	0.566	0.621	0.628	0.637
RC3	0.408	0.297	0.469	0.418	0.591	0.876	0.549	0.653	0.648	0.614
RC4	0.310	0.291	0.456	0.359	0.588	0.811	0.551	0.591	0.587	0.597
RF1	0.419	0.321	0.339	0.387	0.742	0.685	0.753	0.708	0.844	0.693
RF2	0.255	0.250	0.352	0.401	0.697	0.647	0.620	0.551	0.854	0.540
RF3	0.247	0.193	0.312	0.337	0.694	0.578	0.739	0.650	0.797	0.508
RF4	0.312	0.236	0.319	0.342	0.634	0.584	0.633	0.619	0.780	0.595
RI1	0.387	0.413	0.376	0.409	0.731	0.655	0.916	0.844	0.727	0.724
RI2	0.393	0.296	0.382	0.386	0.753	0.652	0.874	0.747	0.743	0.696
RI3	0.276	0.283	0.253	0.371	0.691	0.537	0.809	0.677	0.719	0.625
RM1	0.477	0.405	0.412	0.415	0.681	0.670	0.781	0.924	0.681	0.696
RM2	0.453	0.435	0.383	0.481	0.686	0.708	0.842	0.931	0.702	0.754
RM3	0.397	0.349	0.314	0.371	0.687	0.710	0.755	0.858	0.722	0.704
RR1	0.336	0.257	0.397	0.432	0.732	0.624	0.684	0.652	0.714	0.760
RR2	0.444	0.400	0.336	0.413	0.594	0.574	0.636	0.648	0.585	0.829
RR3	0.481	0.473	0.491	0.410	0.574	0.587	0.552	0.557	0.488	0.829
RR4	0.497	0.499	0.360	0.473	0.634	0.605	0.728	0.752	0.607	0.858

Source: created by the author

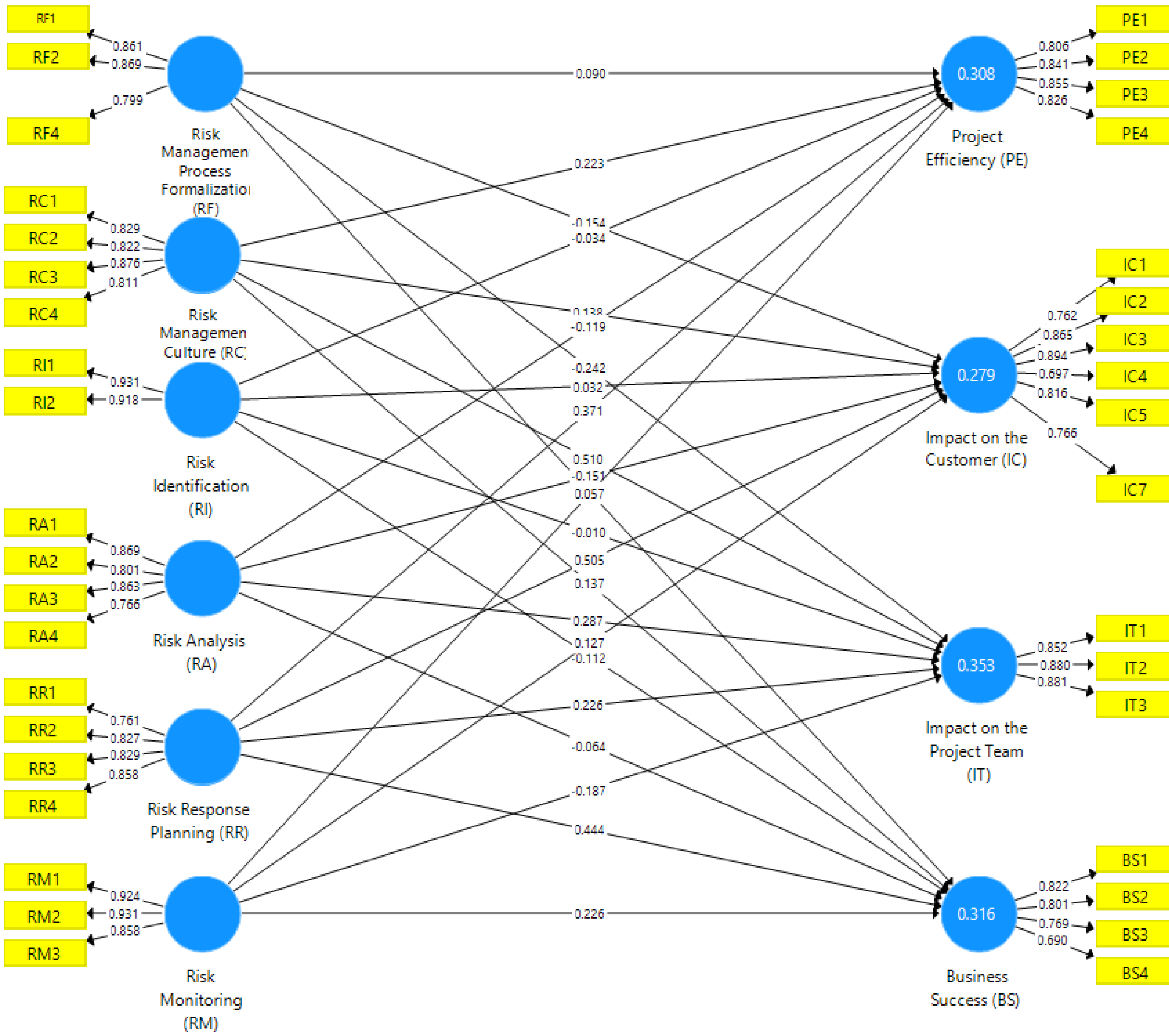

Figure 32. Path model of the many-to-many constructs (adjusted model – second draft)

Source: created by the author

5.3.2 Adjustment of the structural model of the many-to-many constructs

After the adjustment of the measurement model, the next step is the analysis of the structural model. As described in the section 4.8, the analysis considered first the Pearson coefficient of determination (R^2). Due to removal of three variables from the model, it is expected new values for AVE, composite reliability, R square, R square adjusted and Cronbach's alpha. *Table 39* shows that all values of AVE, composite reliability and Cronbach's alpha (α) are above the recommend threshold, respectively, 0.50, 0.70 and 0.70. Moreover, all R^2 are above 26% which means a significant effect (Cohen, 1988) on the dependent variables.

Table 39. Quality criteria of the many-to-many constructs (adjusted model – second draft)

First-order constructs	**AVE**	**Composite Reliability**	**R Square**	**R Square Adjusted**	**Cronbach's Alpha**
Business Success (BS)	0.597	0.855	**0.316**	0.289	0.774
Impact on the Customer (IC)	0.644	0.915	**0.279**	0.250	0.888
Impact on the Project Team (IT)	0.759	0.904	**0.353**	0.327	0.841
Project Efficiency (PE)	0.692	0.900	**0.308**	0.280	0.854
Risk Analysis (RA)	0.682	0.895	-	-	0.847
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Identification (RI)	0.855	0.922	-	-	0.830
Risk Monitoring (RM)	0.819	0.931	-	-	0.889
Risk Management Process Formalization (RF)	0.712	0.881	-	-	0.798
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

Second, bootstrapping analysis was carried out to evaluated if the correlation are significant ($p \leq 0.05$ or test-t > 1.96) and *Table 40* shows that all test-t values are bigger than 1.96 and all p-values are lower than 0.05 for five hypotheses that remained in the model, after several iterations. *Figure 33* shows the final adjusted measurement model which will be used for discussion in the next chapter. *Table 41* shows for the final adjusted model that all values of AVE, composite reliability and Cronbach’s alpha (α) are above the recommend threshold, respectively, 0.50, 0.70 and 0.70. Moreover, almost all R^2 are above 26% which means a significant effect (Cohen, 1988) on the dependent variables.

Table 40. Path coefficients of the many-to-many constructs (final adjusted model)

Path coefficients	Original Sample	Sample Mean	Standard Deviation	Test-t	P Values
Risk Management Culture (RC) -> Impact on the Project Team (IT)	0.554	0.561	0.068	8.190	0.000
Risk Management Culture (RC) -> Project Efficiency (PE)	0.237	0.244	0.104	2.270	0.023
Risk Response Planning (RR) -> Business Success (BS)	0.543	0.552	0.057	9.445	0.000
Risk Response Planning (RR) -> Impact on the Customer (IC)	0.506	0.513	0.064	7.964	0.000
Risk Response Planning (RR) -> Project Efficiency (PE)	0.358	0.364	0.107	3.350	0.001

Source: created by the author

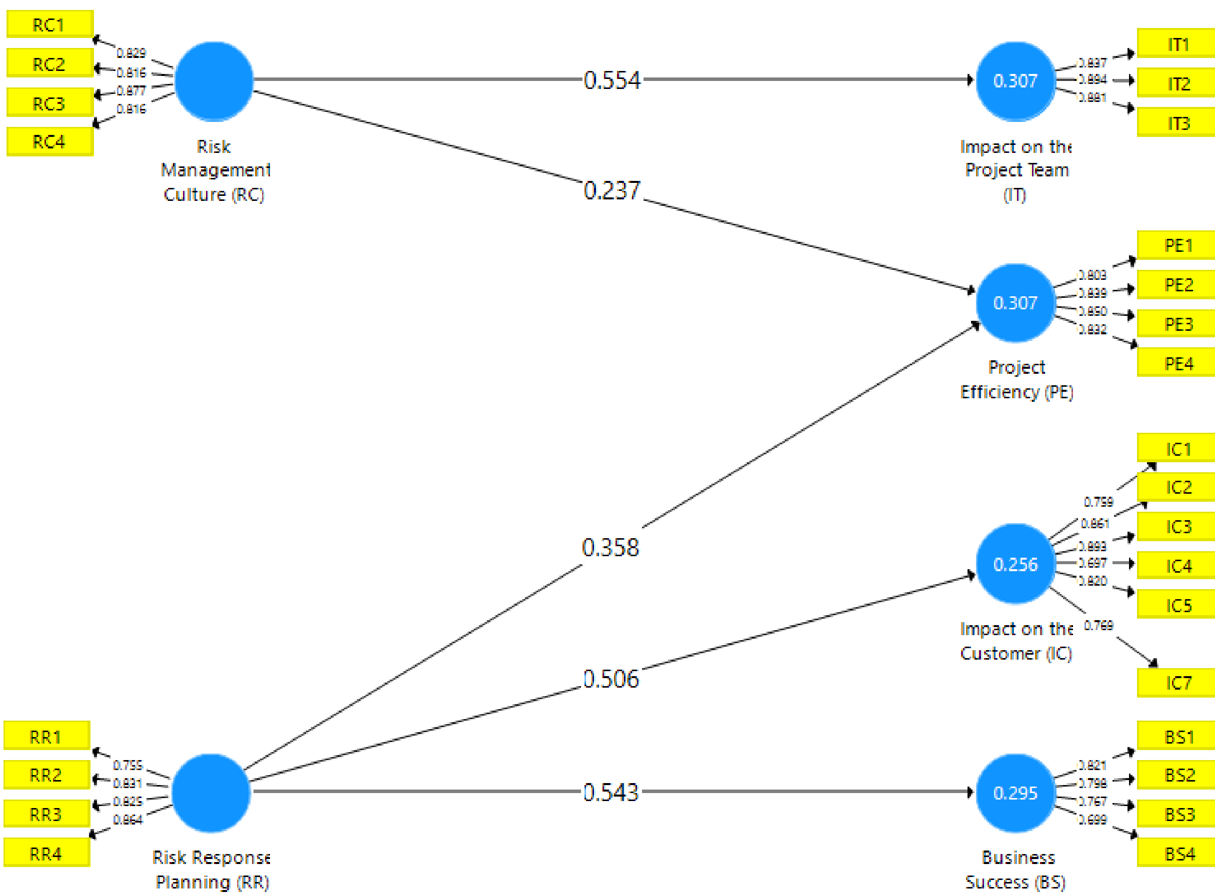

Figure 33. Path model of the many-to-many constructs (final adjusted model)

Source: created by the author

Table 41. Quality criteria of the many-to-many constructs (final adjusted model)

First-order constructs	AVE	Composite Reliability	R Square	R Square Adjusted	Cronbach's Alpha
Business Success (BS)	0.597	0.855	0.295	0.290	0.774
Impact on the Customer (IC)	0.644	0.915	0.256	0.251	0.888
Impact on the Project Team (IT)	0.759	0.904	0.307	0.302	0.841
Project Efficiency (PE)	0.691	0.899	0.307	0.298	0.854
Risk Management Culture (RC)	0.697	0.902	-	-	0.855
Risk Response Planning (RR)	0.672	0.891	-	-	0.837

Source: created by the author

Moreover, the quality indicators predictive validity (Q^2) and Effect Size (f^2) of the adjusted model were assessed and *Table 42* shows that Q^2 values are greater than zero and f^2 values are almost bigger than 0.3, so both are satisfactory.

Table 42. Quality indicators Q^2 and f^2 of the many-to-many constructs (final adjusted model)

First-order constructs	Q^2	f^2
Business Success (BS)	0.159	0.328
Impact on the Customer (IC)	0.145	0.480
Impact on the Project Team (IT)	0.215	0.474
Project Efficiency (PE)	0.180	0.457
Risk Management Culture (RC)	-	0.469
Risk Response Planning (RR)	-	0.438

Source: created by the author

5.4 Summary of Supported Hypotheses

Based on the outcomes of the previous section which are summarized in the *Table 43*, eight out of thirty-seven hypotheses were supported in this study, namely H1, H4, H4a, H4b, H4d, H6, H6a and H6c. *Figure 34* shows the list of supported and non-supported hypotheses of this study and *Figure 35* shows the adjusted conceptual model.

Table 43. Path coefficients of the constructs (final adjusted model)

Path coefficients	Original Sample	Sample Mean	Standard Deviation	Test-t	P Values
Project Risk Management (PRM) -> Project Success (PS)	0.576	0.592	0.052	11.036	0.000
Risk Management Culture (RC) -> Project Success (PS)	0.247	0.253	0.111	2.224	0.026
Risk Response Planning (RR) -> Project Success (PS)	0.416	0.423	0.101	4.118	0.000
Risk Management Culture (RC) -> Impact on the Project Team (IT)	0.497	0.487	0.134	3.722	0.000
Risk Management Culture (RC) -> Project Efficiency (PE)	0.237	0.238	0.106	2.240	0.025
Risk Response Planning (RR) -> Business Success (BS)	0.543	0.550	0.059	9.162	0.000
Risk Response Planning (RR) -> Impact on the Customer (IC)	0.509	0.518	0.062	8.224	0.000
Risk Response Planning (RR) -> Project Efficiency (PE)	0.357	0.367	0.108	3.323	0.001

Source: created by the author

#	Hypotheses	Results
H1	**The project risk management influences positively the project success.**	**Support**
H2	Project risk identification is positively related to the project success.	Not support
H2a	Project risk identification is positively related to the project efficiency.	Not support
H2b	Project risk identification is positively related to the impact on the customer.	Not support
H2c	Project risk identification is positively related to the impact on the project team.	Not support
H2d	Project risk identification is positively related to the business success.	Not support
H2e	Project risk identification is positively related to the preparing to the future.	Not support
H3	Project risk analysis is positively related to the project success.	Not support
H3a	Project risk analysis is positively related to the project efficiency.	Not support
H3b	Project risk analysis is positively related to the impact on the customer.	Not support
H3c	Project risk analysis is positively related to the impact on the project team.	Not support
H3d	Project risk analysis is positively related to the business success.	Not support
H3e	Project risk analysis is positively related to the preparing to the future.	Not support
H4	**Project risk response planning is positively related to the project success.**	**Support**
H4a	**Project risk response planning is positively related to the project efficiency.**	**Support**
H4b	**Project risk response planning is positively related to the impact on the customer.**	**Support**
H4c	Project risk response planning is positively related to the impact on the project team.	Not support
H4d	**Project risk response planning is positively related to the business success.**	**Support**
H4e	Project risk response planning is positively related to the preparing to the future.	Not support
H5	Project risk monitoring and control is positively related to the project success.	Not support
H5a	Project risk monitoring and control is positively related to the project efficiency.	Not support
H5b	Project risk monitoring and control is positively related to the impact on the customer.	Not support
H5c	Project risk monitoring and control is positively related to the impact on the project team.	Not support
H5d	Project risk monitoring and control is positively related to the business success.	Not support
H5e	Project risk monitoring and control is positively related to the preparing to the future.	Not support
H6	**Project risk management culture is positively related to the project success.**	**Support**
H6a	**Project risk management culture is positively related to the project efficiency.**	**Support**
H6b	Project risk management culture is positively related to the impact on the customer.	Not support
H6c	**Project risk management culture is positively related to the impact on the project team.**	**Support**
H6d	Project risk management culture is positively related to the business success.	Not support
H6e	Project risk management culture is positively related to the preparing to the future.	Not support
H7	Project risk management process formalization is positively related to the project success.	Not support
H7a	Project risk management process formalization is positively related to the project efficiency.	Not support
H7b	Project risk management process formalization is positively related to the impact on the customer.	Not support
H7c	Project risk management process formalization is positively related to the impact on the project team.	Not support
H7d	Project risk management process formalization is positively related to the business success.	Not support
H7e	Project risk management process formalization is positively related to the preparing to the future.	Not support

Figure 34. List of supported hypotheses

Source: created by the author

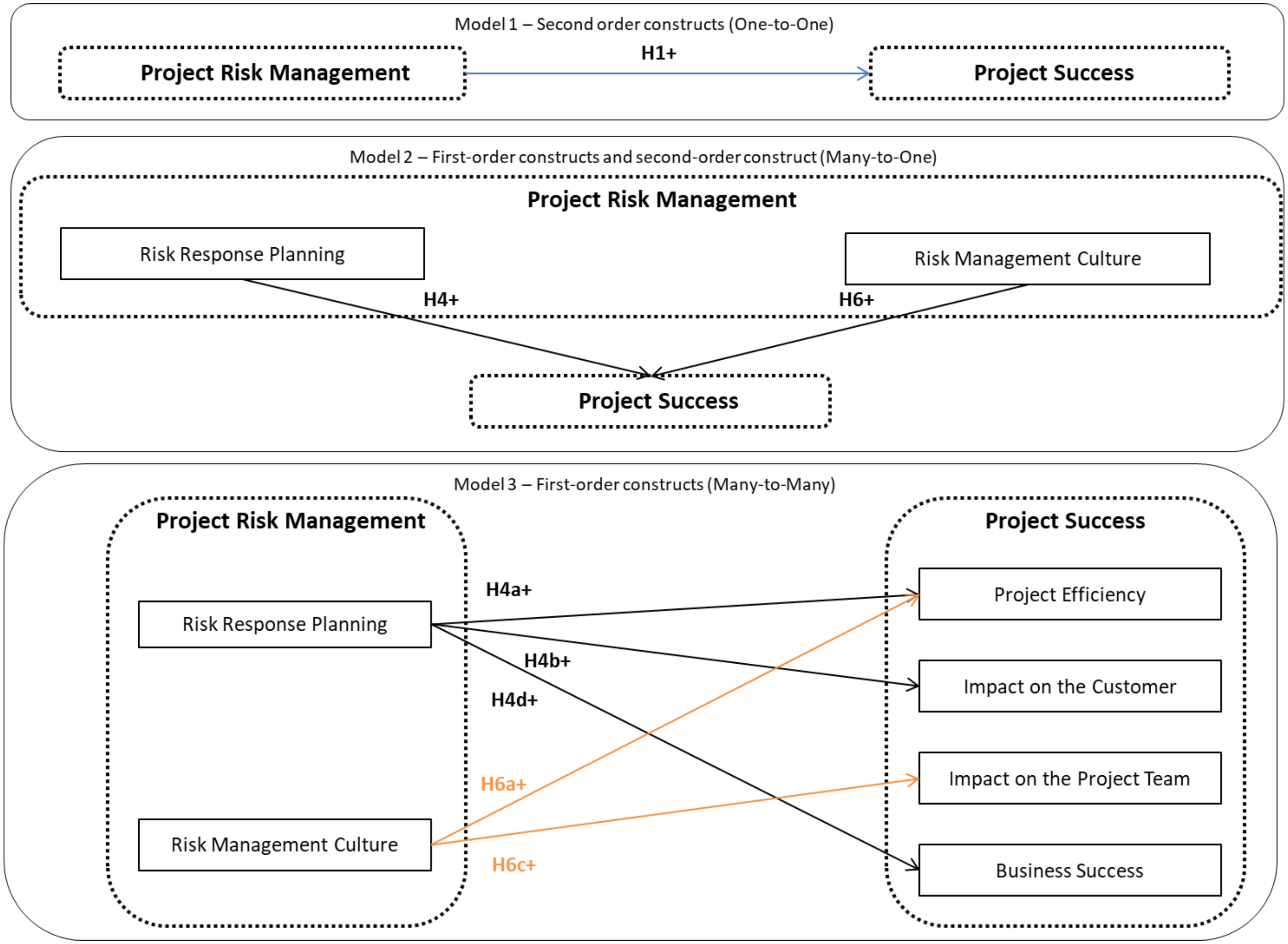

Figure 35. Adjusted conceptual model

Source: created by the author

6 ANALYSIS AND DISCUSSION

As stated in the beginning, the objective of this study is to analyze if project risk management influences project success in IS/IT projects and to achieve it, three main specific objectives were established, to know:

1. Analyze the relationship between project risk management and project success;
2. Analyze the relationship between project risk management dimensions and project success;
3. Analyze the relationship among each project risk management dimension and project success dimension;

Thirty-seven hypotheses were proposed, one for the first specific objective, six for the second specific objective and thirty for the third specific objective. Eight out of thirty-seven hypotheses were supported in this study and this section presents the discussion for each hypothesis supported and not supported.

Analyze the relationship between project risk management and project success

The first specific objective was evaluated and verified by one hypothesis (H1). This hypothesis was supported by this study. Project risk management influences positively the project success (H1), it is statistically significant ($\rho<0.001$) and 33.2% of variance explained by the model in relation to the project success. This result corroborates other studies that found positive relationship between project risk management and project success (Carvalho & Rabechini Junior, 2014; Rabechini Junior & Carvalho, 2013; Teller et al., 2014; Zwikael & Ahn, 2011). It reinforces the importance of project risk management for the project success but it is still impossible to identify which components of project risk management better contribute to this outcome.

Analyze the relationship between project risk management dimensions and project success

The second specific objective was evaluated and verified by six hypotheses (H2, H3, H4, H5, H6 and H7). Two out of six hypotheses were supported by this study (H4 and H6).

The project risk response planning is positively related to the project success (H4), it is statistically significant ($\rho<0.001$) and 38.4% of variance explained by the model in relation to the project success. It is in line with other studies that showed the importance to define and put in place strategies and action plans to tackle risks which, as consequence, brings a positive result to the project success (Chua, 2009; Gefen et al., 2008; Hu, Zhang, et al., 2013; Hung et al., 2014; Jingyue Li et al., 2008; J. Y.-C. Liu & Yuliani, 2016; S. Liu, 2016; Sharma & Gupta, 2012). It raises an important warning regarding the disengagement in the early stage of the project risk management ((Kutsch et al., 2013) showing that to achieve a better benefit in terms of positive project success, risk response planning should be followed properly receiving much more attention. It could mean less effort invested by project managers on early stages and more in further stages.

The project risk management culture is positively related to the project success (H6), it is statistically significant ($\rho<0.05$) and 38.4% of variance explained by the model in relation to project success. It is adherent to the vital importance of risk management culture and its impact to the project success as stated by many authors (Sanchez et al., 2009; Teller, 2013; Teller et al., 2014). Furthermore, a well-stablished risk management culture implies the sense of responsibility of risk owner for the response action plans (Teller et al., 2014; Thamhain, 2013; Yeo & Ren, 2009), in line with the result found for risk response planning.

The influence of project risk identification and project risk analysis on project success were not supported by this study, respectively, hypotheses H2 and H3, despite they have being recognized in the literature as the main steps followed by the project managers in project risk management (Bannerman, 2008; Kutsch et al., 2014, 2013, Kutsch & Hall, 2009, 2010; Kutsch & Maylor, 2011; Taylor et al., 2012; Wickboldt et al., 2011). Despite that, they have gained more attention (more number of studies) according to the systematic review carried out in this study. This outcome also does not corroborate with the findings of de Bakker (de Bakker et al., 2011,

2012) which showed that risk identification was the most influential risk management activity that have contributed to the project success. It opens a range of opportunities to investigate the effective impact of project identification and project analysis on project success.

The influence of project risk management process formalization on project success (H7) was not supported by this study, despite it has been recognized as an key contributor to the project success (de Bakker et al., 2010; Teller, 2013). This may be in line with studies that highlighted that risk management process can be perceived as a cumbersome set of activities and not effective under some conditions (Aloini et al., 2007b; Atkinson et al., 2006; de Bakker et al., 2010).

The influence of project risk monitoring and control on project success (H5) was not supported by this study. It is not possible to make significant comparisons with other studies due to the lack of them in the systematic review undertaken in this study.

Analyze the relationship among each project risk management dimension and project success dimension

The third specific objective was evaluated and verified by thirty hypotheses for risk identification (H2a, H2b, H2c, H2d and H2e), risk analysis (H3a, H3b, H3c, H3d and H3e), risk response planning (H4a, H4b, H4c, H4d and H4e), risk monitoring and control (H5a, H5b, H5c, H5d and H5e), risk management culture (H6a, H6b, H6c, H6d and H6e) and risk management process formalization (H7a, H7b, H7c, H7d and H7e), all related to the influence on project success dimensions as extensively detailed in previous chapters. Five out of thirty hypotheses were supported by this study (H4a, H4b, H4d, H6a and H6c).

The project risk response planning is positively related to the project efficiency (H4a), it is statistically significant ($\rho<0.001$) and 30.7% of variance explained by the model in relation to project efficiency. It means that taking many actions aimed to the sources of risk and tackling proactively and/or preventively risks influence positively the achievement of traditional indicators of time and budget, mainly. The project risk response planning is positively related to the impact on the customer (H4b), it is statistically significant ($\rho<0.001$) and 25.9% of variance explained by the model in relation to the impact on the customer. It means that taking many actions and tackling risks influence positively the customer by meeting their interests. The project risk response planning is positively related to the business success (H4d), it is statistically significant ($\rho<0.001$) and 29.4% of variance explained by the model in relation to the business success. It means that taking many actions and tackling risks influence positively the business success by meeting the organization's interests.

The project risk management culture is positively related to the project efficiency (H6a), it is statistically significant ($\rho<0.05$) and 30.7% of variance explained by the model in relation to the project efficiency (PE). It means that an open communication of risk and risk awareness influence positively the achievement of traditional indicators of time and budget, mainly. The project risk management culture is positively related to the impact on the project team (H6c), it is statistically significant ($\rho<0.001$) and 34.4% of variance explained by the model in relation to the impact on the project team. It means that an open communication of risk and risk awareness influence positively the project team engagement and motivation.

All hypotheses related to the first-order construct Preparing for the Future (PF) (H2e, H3e, H4e, H5e, H6e and H7e) should not be supported by this study once this construct was removed from the model due to low values of AVE and Cronbach's alpha (α). One possible cause could be the diversity of respondents per industry (see *Figure 6*) which brings distinct perceptions of future benefits for their respective organizations. Further investigation is necessary to better identify the root causes and propose the proper adjustment of the manifest variables, if applicable.

All other hypotheses related to the first-order constructs risk identification, risk analysis, risk monitoring and control and project risk management process formalization were not supported by this study.

7 CONCLUSION

This study was undertaken to analyze how the project risk management influences project success in IS/IT projects. To achieve this main objective, three specific objectives were proposed. These objectives, namely analyze the relationship between project risk management and project success, analyze the relationship between project risk management dimensions and project success; and analyze the relationship among each project risk management dimension and project success dimension were carried out by the quantitative research approach and one conceptual model composed by thirty-seven hypotheses was proposed and evaluated (as per chapter 3). This study found that eight out of thirty-seven hypotheses were statistically significant. This study shows that project risk management affect positively the project success and different results were found when looking in detail for the effect of each dimension of project risk management on each dimension of project success. This study presents significant implications for theory and practice as shown ahead. Nevertheless, there are limitations to be considered and future studies to be proposed.

7.1 Implications for Theory

This study contributes to theory by showing that project risk management influences positively the project success in IS/IT projects, but this positive effect occurs only per two out of five dimensions of project risk management, namely risk management culture and risk response planning, in relation to four out of five dimensions of project success, namely project efficiency, impact on the customer, impact on the project team and business success. While prior studies has tended to examine the influence of project risk management as a single construct in regard to project success, the last one designed as a single or multidimensional construct, this is the first study that has investigated project risk management in regard to project success, both being designed as multidimensional constructs.

Therefore, our finding is of theoretical significance for project risk management field in IS/IT projects because it provides insight into how each dimension of project risk management is perceived by experienced project team members in relation to the achievement of the projects goals. It sheds light on the four sequential and cyclic processes of project risk management as well as on the risk management culture and risk management process formalization to enhance the discussion of the influence of project risk management on project success, sometimes described as positive or as limited, as well as the disengagement of project managers over these processes.

Moreover, this study also contributes to the theory developing and validating an instrument for multidimensional project risk management not previously available in the literature that could be adapted and used for further investigations.

7.2 Implications for Practice

The results of this study show that project risk management has a positive effect on project success and the perception of experienced project team members regards to this effect varies in relation to their mindset (e.g. risk awareness) and the activities performed over the project risk management process. Project management practitioners should recognize the positive impact of project risk management on project success, especially by the dimensions of risk management culture and risk response planning. In particular, risk management culture influence positively the project efficiency and the impact on the project team, and risk response planning influence positively the project efficiency, the impact on the customer and the business success.

Managers should create mechanisms to incentive an open canal of communication between projects team members and stakeholders related to key risks, should create an environment that reinforce the importance of project risk management in the day by day of the organization, and should guarantee the proper ownership of each risk and the accountability of the actions plan. Managers should influence people for thinking about risks in their ordinary and extraordinary activities and should empower people accordingly to their responsibilities so they could act with some degree of freedom to make decisions and protect the business value.

Project management practitioners should carry out root cause analysis of the sources of risks, develop preventive and proactive actions plan and act to deal with risks materializations. Managers should push the organization to guarantee the proper execution of the actions plans in order to achieve the business goals.

Managers and project management practitioners should invest more effort, energy and time on risk awareness culture and deployment of actions plan instead of putting great effort on formal process of risk identification, risk analysis, risk management process formalization and risk monitoring. This study is not stating that these processes are not relevant or necessary, but there are a plenty of limitations and challenges already pointed out by the literature, such as resources, costs and time constraints, lack of authority by project managers, unclear benefits of the project risk management outcomes that could be properly addressed by practical and effortless activities as perceived by project management practitioners.

7.3 Limitations

As with all academic research, this study has some limitations. First, our study is based on limited sample, but still valid for the research purpose. Second, respondents from different countries, organizations type and size may have different perceptions of project risk management and project success. For example, one of the causes of the removal of the first-order construct Preparing to the Future (PF) could be related the different perceptions of its measuring items, including the opposite interpretation of its meaning. Third, despite the reliability and validity of the measuring instrument confirmed in this study, the broad coverage of some items for the first-order constructs risk identification and risk analysis may have biased the respondents' perception affecting the final outcome in terms of influence on project success and its dimensions. Fourth, the systematic review narrowed the scope of papers for those related to IS/IT projects so other relevant papers in the project risk management field which could be support the objectives of this study were not covered.

7.4 Future Works

There are several proposals for future works. First, one could consider the moderating effect of control variables under the relationship between project risk management and project success. Second, one broader study could cover only respondents related to the IS/IT supplier side in opposite to the consumer side. Third, new studies should be undertaken to better test and adapted the proposed multidimensional construct for project risk management in order to understand why project managers disengage from adopting project risk management and propose alternatives to address this issue. Forth, this study could be replicated to other areas, such as construction, government, educational, etc. to verify and compare the results. Fifth, other investigations could evaluate why some of the hypotheses were not confirmed, for instance, why project managers do not perceive risk identification affecting the project success.

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APPENDIX A – SURVEY QUESTIONNARIE

Doctoral Research in Project Risk Management - Nove de Julho University

Welcome to this academic survey (theme Project Risk Management)

Hi,

My name is Fabricio Garcia Imbrizi and I am a Doctoral Candidate in the Post-Graduate Program in Business Administration at Nove de Julho University, Sao Paulo, Brazil, under supervision of Prof. Dr. Antonio Emerson Maccari and co-supervision of Prof. Dr. Marcos Rogério Mazieri.

Herewith, we cordially invite you to participate in this academic survey. Your experience, as a project management practitioner, in *IT/IS projects*, will help us to better understand some challenges in Project Risk Management.

It should take you about 10 minutes to complete the questionnaire.

Please note that your answers to all questions are used for our statistical analysis only - the information you provide will in no way be used to identify you personally and all responses will remain completely anonymous. All of the findings will remain completely confidential and cannot be attributed to any one individual or organization.

No names or IP address will be collected.

Do not hesitate to contact us if you require further information.

Thank you so much for your time and attention.

Kind regards,

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Demographic Questions - Respondent Background

We would like to know a bit about you, so that when we analyse the results we can put them in the right context.

Note that all data will be captured and analysed anonymously.

* Academic background

- High school or less
- Undergraduate/bachelor's degree
- Postgraduate certificate/diploma
- Master's degree
- Doctoral

* Total work experience (years)

* Project management experience (years)

* Project risk management experience (years)

* Certified project/programme manager (PMP, CAPM, PPM, etc)

- Yes
- No

* English language skills

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Demographics Questions – Organization Characteristic

We would like to know a bit about the company you work/have worked, so that when we analyse the results we can put them in the right context.

Note that all data will be captured and analysed anonymously.

* Number of employees in entire organization

- ◯ Fewer than 100
- ◯ 100 – 299
- ◯ 300 – 999
- ◯ 1,000 – 2,499
- ◯ 2,500 – 4,999
- ◯ 5,000 – 9,999
- ◯ 10,000 or more

* How long have you been at the organization (years)?

* Industry

* In what country do you work?

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Demographics Questions – Project Characteristic

We would like to know a bit about the latest completed project you have worked, so that when we analyse the results we can put them in the right context.

Note that all data will be captured and analysed anonymously.

* Your role in the project team

- ◯ Director of PMO
- ◯ Portfolio Manager
- ◯ Program Manager
- ◯ Project Manager
- ◯ Risk Manager
- ◯ Team Lead
- ◯ Team Member
- ◯ Other (please specify)

* Project environment

- ◯ Virtual Project
- ◯ Co-located Project
- ◯ Virtual and Co-located project

* Type of approach

- ◯ Traditional (e.g. waterfall)
- ◯ Agile
- ◯ Hybrid (Traditional/Agile)
- ◯ Other (please specify)

* Type of IS/IT project

* Project duration

- 1 to 6 months
- 7 to 12 months
- 13 to 18 months
- 19 to 24 months
- 25 to 30 months
- 31 to 36 months
- > 36 months

* Project team size

- 1 to 4 members
- 5 to 9 members
- 10 to 14 members
- 15 to 19 members
- 20 to 35 members
- > 35 members

* Team language

- 1 Language
- 2 Languages
- 3 or more languages

* Total project net value (without taxes)

- lower than 250k EUR | 220k GBP | 310k USD | 1M BRL
- between 250k EUR | 220k GBP | 310k USD | 1M BRL and 1M EUR | 880k GBP | 1.2M USD | 4M BRL
- between 1M EUR | 880k GBP | 1.2M USD | 4M BRL and 5M EUR | 4.4M GBP | 6M USD | 20M BRL
- between 5M EUR | 4.4M GBP | 6M USD | 20M BRL and 10M EUR | 8.8k GBP | 12M USD | 40M BRL
- bigger than 10M EUR | 8.8k GBP | 12M USD | 40M BRL

* Sourcing orientation

- In-house
- Outsourced

* Project margin variation from the original target (Initial Business Case Target)

- ◯ <-20%
- ◯ -20 to -10%
- ◯ -10 to 0%
- ◯ 0 to +10%
- ◯ +10 to +20%
- ◯ >+20%

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Research Questions

Considering the latest project completed, please, answer each question below on the scale ranging from "strongly disagree" to "strongly agree".

* Responsibilities in risk management are clearly defined

Strongly disagree — Strongly agree

* The individual risk managers feel responsible for the risks and the associated measurements for their resolution

Strongly disagree — Strongly agree

* Risks are registered and maintained in spreadsheets, systems or other type of record

Strongly disagree — Strongly agree

* We take many actions aimed at the sources of risk (e.g., training, technical security precautions, improvement of work methods)

Strongly disagree — Strongly agree

* We continuously monitor the impact of measures initiated for risk resolution

Strongly disagree — Strongly agree

* The project met functional performance requirements

Strongly disagree — Strongly agree

* The project improved the customer's performance

Strongly disagree — Strongly agree

* The project resulted in commercial success for the organization

Strongly disagree — Strongly agree

* The project will help create new markets or new customers/ users and increase organizational outreach

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

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Research Questions

Considering the latest project completed, please, answer each question below on the scale ranging from "strongly disagree" to "strongly agree".

* The risk management process is explained in detail in a process description (e.g., manual)

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* Employees at all levels of the project regard risk management as a part of their everyday business activities

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* Risks are assessed based on qualitative tools and techniques (e.g. AHP, expert judgment, interviews)

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* We take many actions which minimize the impact when a risk event occurs (e.g., taking out insurance, planning reserves, hedging)

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project was completed on time

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project met technical specifications

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* There is a high chance that the customer would come back for additional business

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project increased the organization's profitability or helped other organizational goals (for example, increased organizational assets or increased operational capabilities)

Strongly disagree				Strongly agree
◯	◯	◯	◯	◯

* The project created new technologies or new capabilities for future use

Strongly disagree				Strongly agree
◯	◯	◯	◯	◯

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Research Questions

Considering the latest project completed, please, answer each question below on the scale ranging from "strongly disagree" to "strongly agree".

* We use standardized forms for risk management

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* Employees at all levels of the project are conscious of the necessity of the risk management (high risk awareness)

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* Risks are assessed based on quantitative tools and techniques (e.g., decision tree analysis, EMV, Monte Carlo Simulation, PERT)

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* We take many actions in advance, before the risk event occurs

Strongly disagree ◯ ◯ ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project was completed within budget

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project fulfilled customer's needs

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* Team members felt fulfilled and able to grow personally and professionally by working on this project

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* The project improved organizational reputation and stature

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

* The organization learnt many lessons from the project to improve future performance

Strongly disagree				Strongly agree
◯	◯	◯	◯	◯

Doctoral Research in Project Risk Management - Nove de Julho University

Research Questions

Considering the <u>latest project completed</u>, please, answer each question below on the scale ranging from "strongly disagree" to "strongly agree".

* As a part of risk management there are extensive regulations regarding content, scope and the external form of risk documents (workflows)

Strongly disagree … Strongly agree

* Sources of risk and potential consequences are identified over the project

Strongly disagree … Strongly agree

* Risks are prioritized according to the risk analysis

Strongly disagree … Strongly agree

* We continuously monitor changes in the identified risks over time

Strongly disagree … Strongly agree

* The project was completed within project margin

Strongly disagree … Strongly agree

* The customer is using the product

Strongly disagree … Strongly agree

* Team members were highly energized at the end of the project (rather than exhausted)

Strongly disagree … Strongly agree

* The project increased the organization's market share

Strongly disagree … Strongly agree

Doctoral Research in Project Risk Management - Nove de Julho University

Research Questions

Considering the <u>latest project completed</u>, please, answer each question below on the scale ranging from "strongly disagree" to "strongly agree".

* The individual risk managers communicate risks openly and honestly

Strongly disagree ○ ○ ○ ○ ○ ○ ○ Strongly agree

* Risks are identified based on tools and techniques (e.g., brainstorming, checklists, lessons-learned documents, scenario analysis)

Strongly disagree ○ ○ ○ ○ ○ ○ ○ Strongly agree

* We conduct intensive analyses of causes and deviations for in terms of the sources of risk

Strongly disagree ○ ○ ○ ○ ○ ○ ○ Strongly agree

* We continuously monitor new risks which arise in addition to those already identified

Strongly disagree ○ ○ ○ ○ ○ ○ ○ Strongly agree

* Risks are assessed based on the probability versus impact (e.g. probability x impact matrix)

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

* The completed project was managed in an efficient manner

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

* The customer was highly satisfied

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

* The project increased the loyalty of team members to the organization

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

* The project will lead to additional new business or new products or services

Strongly disagree				Strongly agree
○	○	○	○	○

APPENDIX B - GENERAL

Characteristics of the various publications in scope.

	Publication	Project risk management approach	Project success approach	Risk management and project success evidence	Research characteristics
1	Conrow and Shishido (1997)	Management	Traditional (T, C, R)	Anecdotal	1 Case
2	Gemmer (1997)	Management	Performance	Anecdotal	1 Case
3	Ropponen and Lyytinen (1997)	Management	Extended	Statistical	Survey, 83 respondents
4	Keil et al. (1998)	Evaluation	Traditional (T, C, R)	Statistical	Delphi, 45 respondents
5	Jiang and Klein (1999)	Contingency	Extended	Statistical	Survey, 86 respondents
6	Whittaker (1999)	Evaluation	Traditional (T, C, R)	Statistical	Survey, 186 respondents
7	Jiang et al. (2000)	Management	Extended	Statistical	Survey, 106 respondents
8	McGrew and Bilotta (2000)	Management	Time	Anecdotal	2 Cases
9	Ropponen and Lyytinen (2000)	Management	Traditional (T, C, R)	Statistical	Survey, 83 respondents
10	Barki et al. (2001)	Contingency	Traditional (T, C, R)	Statistical	Case/survey, 75 projects
11	Akkermans and van Helden (2002)	Evaluation	Performance	Anecdotal	1 Case
12	Aladwani (2002)	Management	Extended	Statistical	Survey, 42 respondents
13	Maguire (2002)	Evaluation	Quality of deliverables	No	1 Case
14	Procaccino et al. (2002)	Evaluation	Extended	Statistical	Survey, 21 respondents
15	Scott and Vessey (2002)	Evaluation	Traditional (T, C, R)	Anecdotal	2 Cases
16	Baccarini et al. (2004)	Management	Traditional (T, C, R)	No	Interviews, 18 respondents
17	Lassudrie and Gulla-Menez (2004)	Management	Traditional (T, C, R)	Anecdotal	1 Case
18	Wallace and Keil (2004)	Evaluation	Traditional (T, C, R)	Statistical	Survey, 500 respondents
19	Wallace et al. (2004a)	Evaluation	Traditional (T, C, R)	Statistical	Survey, 500 respondents
20	Wallace et al. (2004b)	evaluation	Traditional (T, C, R)	Statistical	Survey, 500 respondents
21	Ehie and Madsen (2005)	Evaluation	Traditional (T, C, R)	Statistical	Survey, 36 respondents
22	Kutsch and Hall (2005)	Management	Traditional (T, C, R)	Anecdotal	Interview, 20 respondents
23	Zafiropoulos et al. (2005)	Management	Traditional (T, C, R)	No	1 Case
24	Dey et al. (2007)	Management	Traditional (T, C, R)	No	1 Case
25	Han and Huang (2007)	Evaluation	Extended	Statistical	Survey, 115 respondents
26	Sauer et al. (2007)	Contingency	Traditional (T, C, R)	Statistical	Survey, 412 respondents
27	Tesch et al. (2007)	Management	Traditional (T, C, R)	No	Workshop, 23 respondents
28	Huang and Han (2008)	Evaluation	Time	Statistical	Survey, 98 respondents
29	Bannerman (2008)	Management	Traditional (T, C, R)	No	17 Cases, 23 respondents

Figure 36. Characteristics of the 29 empirical studies published between 1997 and 2009 of the meta-analysis undertaken by de Bakker et al. (2010)

Source: de Bakker et al. (2010)